The Pipeline from Dental Education to Practice: The Pennsylvania Experience

Myron R. Schwartz, M.A.

Abstract: The pipeline from Pennsylvania dental education to Pennsylvania practice, rural practice, and low service area practice is described and analyzed. The article contends that pipeline development is an effective vehicle in meeting the public health mandate of ensuring access to dental care for all residents. Data from the American Dental Association served as the basis for addressing the two major research questions: 1) what are the educational origins of the dentist workforce in Pennsylvania, in rural areas of Pennsylvania, and in underserved areas of Pennsylvania? and 2) what is the proportion of Pennsylvania-educated dentists who practice in Pennsylvania, in rural areas of Pennsylvania, and in underserved areas of Pennsylvania? As an overall assessment, one can consider the Pennsylvania dental pipeline inadequate to meet the Commonwealth’s public health goals. The pipeline is not adequately developed to repopulate the current Pennsylvania-educated dentist workforce, especially in the most needy areas. Understanding the prospects for further pipeline development is best achieved by considering the pipeline within the context of the practice model of dentistry and the current and future supply of dentists.

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Recent trends in the size of the dentist workforce are unique when compared to similar trends for other health care providers. In Pennsylvania, dentists are the only class of health care providers for which the number of active licenses has declined in recent years. Additionally, dentists exhibit an inequitable geographic distribution. The population-normed supply of dentists in urban areas considerably exceeds that found in rural areas. Access and utilization inequities with respect to income are even more pronounced. This is a consequence of a practice model that relies on a patient’s ability to pay and the existence of only limited public support for indigent care. These circumstances, among others, are important considerations in meeting the public health mandate of ensuring access to dental care for all.

Effective public health policy designed to accomplish this mandate can be of either national or state origins. However, a state’s interest in dental care access is more profound and immediate. States also have several advantages in developing more direct and effective interventions. First, access barriers are more common for indigent populations. Since Medicaid and related insurance programs are state-designed and administered, states are in a unique position to develop an intervention that affects these populations. Second, states have licensing authority for dentists and provide oversight for the delivery of dental care. Third, access is a local phenomenon. States are in an ideal position to intercede in a manner that coordinates local initiatives and to cooperate with local communities in promoting access to care. Finally, states have regulatory authority of within-state (dental) education and contribute significant financial resources to schools of dental medicine and to dental students.

Any effort to improve dental care access will require establishing an adequate overall supply of dentists while, simultaneously, ensuring an equitable geographic distribution of the dentist workforce. Given the authority that states have over both the educational system and the delivery of dental care, it follows that a promising strategy for increasing access to care is to maximize the number of graduates from state dental schools who practice within the state, within rural areas, and within areas of low dentist supply. One can conceptualize the link between education and practice location as a “pipeline” from a state’s dental education to in-state service. The pipeline from Pennsylvania’s dental schools to service in these areas is the focus of this research.

This article examines the contribution that Pennsylvania’s dental schools make to the Com-
monwealth of Pennsylvania’s dental workforce, the rural dental workforce, and the dental workforce in underserved areas. A variety of approaches can be used to examine this contribution, two of which are presented here. One approach is to take a snapshot of the current dentist workforce and describe its educational origins. A second approach is to calculate the percentage of a school’s graduates who are currently practicing in areas of interest within the state. The former approach is most appropriately considered a description of the current workforce with respect to its educational origins. The latter approach is best considered a description of Pennsylvania dental schools with respect to how well they populate the workforce in the Commonwealth. The resulting description of the Pennsylvania dentist pipeline will be discussed within the context of the public investment in dental education, current market forces, and the predominant dentist practice model.

Methods

Data presented in this paper are based on American Dental Association (ADA) data from 2006. The version of the ADA data used here includes all graduates of Pennsylvania dental schools and all dentists with a Pennsylvania address. For each, the following information was included in the file: 1) dental school, 2) year of graduation, 3) current address, and 4) practice and activity status. The ADA does not indicate whether the address supplied is a practice address. This research assumes that the address is a practice address or that, in cases in which it is not, it is geographically proximate to the practice site. There is no way to determine measurement error incurred by this assumption.

All addresses have been geocoded to determine the geographic coordinates of the address. Approximately three-fourths of addresses were matched to the street, block, or actual structure. The remaining addresses were assigned the coordinates of the geographic centroid of the zip code in which they are located. After the coordinates were determined, GIS analyses were performed to determine the urban-rural status of the address and the local dentist supply. “Urban” was defined as a location within an urbanized area. An urbanized area is the densely settled area in and around a metropolitan city. All other addresses were classified as rural.

Local dentist supply estimates use a method that minimizes a problem inherent in small areas estimation. When estimating provider supply for small geographic areas, traditional methods often produce very different results for two contiguous areas that have the same or nearly the same access to providers. This results in a poor representation of the actual provider supply available to the local population. The method employed here addresses that problem by utilizing the following procedures. First, a buffer is constructed extending ten miles from all points on the border of each municipality in the Commonwealth forming a polygon concentric to the original municipality. Then, dentists and populations are counted within the buffered area (when the buffered area is partly located in a bordering state, the dentists and population in the bordering state are included in the calculations). The ratio of population to dentists is calculated, and that ratio is treated as the dentist supply indicator for the original municipality. A dentist is assigned the supply level for the municipality in which he or she is located. A dentist is considered to be in a low dentist service area if the municipality in which he or she practices is in the lowest quartile of municipalities with respect to its service level. Only dentists currently providing patient care are included in the analyses. Dentists classified by the ADA as currently in a residency program are excluded from the analysis.

Results

Educational Origins of the Dentist Workforce

At the start of 2006, 7,433 dentists were providing patient care in Pennsylvania (see Table 1). Among these dentists, 13.6 percent (1,009) were providing patient care in rural areas, and 86.4 percent (6,424) were providing care in urban areas. Approximately 67 percent of the total population lives in urban areas and 33 percent in rural areas. This results in quite a disparity between the urban and rural dentist supply. The population to dentist ratio in rural areas (4,034:1) is over three times greater than that found in urban areas (1,278:1).

The first method of describing the pipeline employed here was to take a snapshot of the current dentist workforce and describe its educational origins. About 75 percent (5,595) of the current patient care dental workforce in the Commonwealth of Pennsylvania graduated from the three in-state dental
schools. This percentage is slightly less in rural areas and slightly more in urban areas. This rate compares favorably with the equivalent rate for physicians: about 44 percent of the physician workforce graduated from Commonwealth medical schools.³

Three schools of dentistry are located in Pennsylvania. Two are located within state-related universities, the University of Pittsburgh School of Dental Medicine and Temple University School of Dentistry; and one is a private institution, the University of Pennsylvania School of Dental Medicine. Temple (31.2 percent) and Pittsburgh (29.8 percent) dental school graduates each comprise about one-third of the active patient care workforce, while graduates from the sole private institution, the University of Pennsylvania, constitute 14.3 percent of the dentist workforce. The three dental schools’ contribution to the urban and rural workforce varies little from their contribution to the statewide workforce. Temple and Pennsylvania graduates constitute slightly less of the rural dentist workforce than the urban workforce, and Pittsburgh graduates constitute slightly more of the rural dentist workforce than the urban workforce. Graduates from all other schools constitute 24.7 percent of the workforce: 30.2 percent in rural areas and 23.9 percent in urban areas.

Pennsylvania dental school graduates constitute about three-fourths of the workforce in low dentist supply areas of the Commonwealth, approximately the same contribution that they make to the statewide workforce. The University of Pittsburgh School of Dental Medicine, by a significant margin, contributes more dentists to low service areas in the Commonwealth than the other two schools. Pittsburgh graduates comprise 49.5 percent of the dentists in the lowest supply quartile of municipalities. Temple grads constitute 19.1 percent, and University of Pennsylvania grads only 6.7 percent of dentists in these municipalities. Out-of-state schools distribute dentists to these areas in the same proportion that they distribute dentists to the remainder of the Commonwealth.

### Practice Location of Pennsylvania Dental School Graduates

The second method used to describe the pipeline was to calculate the percentage of Pennsylvania-educated dentists who currently practice in the state. This approach can be considered a description of Pennsylvania dental schools with respect to how well they populate the workforce in Pennsylvania.

Overall, 43.1 percent of Pennsylvania dental school graduates (since 1980) currently provide patient care in the Commonwealth (see Table 2). This percentage, however, varies significantly from school to school. Graduates of the University of Pittsburgh School of Dental Medicine have a greater probability of providing patient care in Pennsylvania than graduates of the other two dental schools. Well over half (57.5 percent) practice in Pennsylvania, while only 49.8 percent of Temple graduates and 25.2 percent of University of Pennsylvania graduates provide patient care in the Commonwealth. Pittsburgh graduates are also more likely to practice in rural areas (8.6 percent)

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**Table 1. Educational origins of Pennsylvania’s patient care dental workforce**

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Rural</th>
<th>Urban</th>
<th>In the Lowest Supply Quartile of Municipalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>7,433 (100%)</td>
<td>1,009 (100%)</td>
<td>6,424 (100%)</td>
<td>283 (100%)</td>
</tr>
<tr>
<td>All PA Dental Schools</td>
<td>5,595 (75.3%)</td>
<td>704 (69.8%)</td>
<td>4,891 (76.1%)</td>
<td>213 (75.3%)</td>
</tr>
<tr>
<td>Temple</td>
<td>2,319 (31.2%)</td>
<td>285 (28.2%)</td>
<td>2,034 (31.7%)</td>
<td>54 (19.1%)</td>
</tr>
<tr>
<td>Pittsburgh</td>
<td>2,216 (29.8%)</td>
<td>321 (31.8%)</td>
<td>1,895 (29.5%)</td>
<td>140 (49.5%)</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>1,060 (14.3%)</td>
<td>98 (9.7%)</td>
<td>962 (15.0%)</td>
<td>19 (6.7%)</td>
</tr>
<tr>
<td>All Other Schools</td>
<td>1,838 (24.7%)</td>
<td>305 (30.2%)</td>
<td>1,533 (23.9%)</td>
<td>70 (24.7%)</td>
</tr>
<tr>
<td>Maryland</td>
<td>229 (3.1%)</td>
<td>55 (5.5%)</td>
<td>174 (2.7%)</td>
<td>9 (3.2%)</td>
</tr>
<tr>
<td>West Virginia</td>
<td>155 (2.1%)</td>
<td>48 (4.8%)</td>
<td>107 (1.7%)</td>
<td>7 (2.5%)</td>
</tr>
<tr>
<td>NYU</td>
<td>153 (2.1%)</td>
<td>22 (2.2%)</td>
<td>131 (2.0%)</td>
<td>2 (0.7%)</td>
</tr>
<tr>
<td>Foreign</td>
<td>149 (2.0%)</td>
<td>6 (0.6%)</td>
<td>143 (2.2%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Georgetown</td>
<td>143 (1.9%)</td>
<td>25 (2.5%)</td>
<td>118 (1.8%)</td>
<td>9 (3.2%)</td>
</tr>
<tr>
<td>Tufts</td>
<td>81 (1.1%)</td>
<td>10 (1.0%)</td>
<td>71 (1.1%)</td>
<td>3 (1.1%)</td>
</tr>
<tr>
<td>Case Western</td>
<td>74 (1.0%)</td>
<td>8 (0.8%)</td>
<td>66 (1.0%)</td>
<td>6 (2.1%)</td>
</tr>
</tbody>
</table>
and in low service areas (3.5 percent). Pittsburgh graduates are three times more likely than Temple graduates and six times more likely than Pennsylvania graduates to practice in the lowest supply areas.

Over 50 percent (56.9) of Pennsylvania dental school graduates are either not providing direct patient care or are practicing outside the Commonwealth. About 2 percent remain in Pennsylvania, but are not primarily engaged in patient care (see Table 3). The remainder are practicing in other states. Over 30 percent of University of Pennsylvania graduates and 15 percent of Temple graduates practice in the neighboring states of New Jersey and New York. Pittsburgh graduates not serving in Pennsylvania are widely distributed, although only about 40 percent depart the state.

In sum, less than half of all dental school graduates remain in Pennsylvania to provide patient care, and far fewer remain to serve in rural or low service areas. Consistent with their relative contributions to the current dentist workforce, the University of Pittsburgh is more likely than Temple or the University of Pennsylvania to send its graduates into Pennsylvania service, rural service, and service in low supply areas. Commonwealth dental schools educate dentists who serve in many states; New Jersey and New York are the most frequent out-of-state destinations.

### Practice Location of Pennsylvania Dental School Graduates by Cohort

In general, dentists who recently graduated from the Commonwealth’s three dental schools are less likely to remain in Pennsylvania than those who graduated before them (see Figure 1). The 1985-89 graduation cohort is the most likely of all graduation cohorts since 1980 to remain in Pennsylvania to

<table>
<thead>
<tr>
<th>Table 2. Percentage of Pennsylvania dental school graduates, 1980 or later, currently providing patient care in selected areas (excluding those currently in a residency program or other dental education)</th>
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<tbody>
<tr>
<td><strong>All PA Graduates</strong></td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>PA Patient Care</td>
</tr>
<tr>
<td>Rural PA Patient Care</td>
</tr>
<tr>
<td>Urban PA Patient Care</td>
</tr>
<tr>
<td>Not in PA Patient Care</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3. Destination of Pennsylvania dental school graduates, 1980 or later, by percentage (includes all statuses except those currently in a residency program or other dental education)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All PA Graduates</strong></td>
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<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Pennsylvania Patient Care</td>
</tr>
<tr>
<td>Other Pennsylvania</td>
</tr>
<tr>
<td>New Jersey</td>
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<tr>
<td>New York</td>
</tr>
<tr>
<td>California</td>
</tr>
<tr>
<td>Florida</td>
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<tr>
<td>Maryland</td>
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<tr>
<td>Virginia</td>
</tr>
<tr>
<td>Massachusetts</td>
</tr>
<tr>
<td>All Others</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
provide patient care. Over 50 percent of these graduates are now Pennsylvania patient care dentists. The percentage has decreased for each successive cohort since then, and for the most recent cohort (2000-04), this percentage has declined to about 30 percent.

The same pattern holds true for service in rural Pennsylvania (see Figure 2). Once again, the 1985-89 cohort is the cohort most likely to provide patient care in rural areas (about 6.5 percent), and the most recent graduation cohort is least likely (about 5 percent).

A similar pattern is evidenced with respect to the pipeline from Pennsylvania dental schools into service in low supply areas (see Figure 3; in this figure, the definition of a low supply municipality is more inclusive than that used in Tables 1 and 2). The percentage of graduates who practice in low supply municipalities has declined continuously since 1980, from almost 12.5 percent for the 1980-84 cohort to under 5 percent for the 2000-04 cohort.

**Discussion**

In recent years, there has emerged a public acknowledgment of the importance of access to oral health care, especially for populations that have traditionally been underserved. This public concern is motivated by the costs of poor oral health for children and the inadequacies of the dental care delivery system. Widespread access to oral health care is dependent upon several factors. Among these are an adequate overall supply of dentists, an equitable
geographic distribution of these dentists, affordability of services for the indigent, and mechanisms to promote access for disabled and medically compromised populations. Because of the primacy of dentist supply factors in addressing the access problem, the research reported here focuses on the supply of dentists and their distribution. Moreover, even though access is a concern at both the state and federal levels, states are in a position to more comprehensively address the problem. Since the state has relatively broad authority over both the educational system and the practice of dentistry, it follows that a promising strategy to help address the problem of access has its basis in the connection between in-state dental education and subsequent service to the state. We have labeled this connection the “pipeline from dental education to practice.”

A pipeline strategy to improve access seeks to maximize the number of state-educated dentists who provide service to the state, especially in areas of need. Consequently, the primary goal of this research was to describe the dental education to dentist practice pipeline in Pennsylvania. That description serves as important background information in the development of policies that seek to improve access to dental care.

**Dental Education in the United States**

There are fifty-six schools of dentistry currently operating in the United States, including the District of Columbia and Puerto Rico. Unlike medical schools, which have a presence in nearly all states,
eighteen states are without a school of dentistry and have no direct way of educating dentists. Twenty states make no direct investment in dental education, although eleven states without dental schools have agreements with seven out-of-state schools to accept a limited number of students. This has significant implications for state pipelines, since so many states have no direct way of educating dentists and many states, like Pennsylvania, have more than their proportional share of dental school capacity.

Changes in the capacity of the American dental education system over the past forty years have important implications for both the current dentist workforce and the supply of dentists in the near future. There were 3,290 dental school graduates in the 1960-61 academic year. The number of graduates increased steadily to 3,775 in the 1970-71 academic year. Around that time, there was an infusion of federal funds into dental education (much of it related to provisions in Title VII of the Public Health Service Act) that contributed to the establishment of new dental schools (thirteen between 1960 and 1980) and increased the capacity of existing schools. As a result, the number of graduates increased to 5,353 by the 1984-85 academic year. Soon after that, this infusion of federal funds was curtailed, and concerns regarding an oversupply of dentists began to emerge among professional groups. This resulted in a rather rapid decline in dental education capacity over the following ten years. During this period of time
(1980s-90s), seven dental schools closed their doors, and many of the remaining schools substantially reduced their educational capacity. The combination of school closures and the reduction in capacity was equivalent to the loss of twenty average-sized schools. By 1992-93, the number of graduates had declined to 3,778 and increased only marginally until recently. At the turn of the millennium, the number of graduates had increased to 4,171. There is some evidence that capacity is beginning to grow significantly again, and by 2003 the number of graduates had risen to 4,443. It appears that applications to dental school are beginning to increase also. Applications had reached a recent peak of 9,829 in 1997 but declined 25 percent by 2001, only to rise 1.2 percent the following year.

These rather dramatic historical changes in dental education capacity have produced a top-heavy population pyramid for dentists. The current workforce includes a large cohort of older dentists who were educated in the peak capacity years (the late 1970s through the mid-1980s) and significantly fewer younger dentists who are members of the much smaller graduation cohorts entering the labor force since the mid-1980s. These large graduation cohorts are now reaching retirement age, while the number of current dental school graduates is insufficient to replace them. As a consequence, the number of dentists in the workforce is declining. Further exacerbating the declining supply is the increased participation of women in the workforce who, along with older dentists, tend to engage in less clinical care than younger men. In fact, the average time devoted to patient care has decreased to about thirty-three hours a week.

Postdoctoral dental education is not a requirement for the practice of general dentistry. However, there has been a significant increase in the number of dentists choosing a residency program in general practice or advanced general dentistry. Almost 40 percent of the 2005 class of dental school graduates plan to participate in a residency program. One state, Delaware, now requires the completion of a certified residency as a requirement for practice, and another, New York, is imposing the requirement in 2007. Postdoctoral medical education is, arguably, the best predictor of eventual practice location for physicians. The impact of the location of dental residency programs on the dentist pipeline is not well documented. One might predict a much lesser impact than that found with physicians, since the duration of these programs (typically one year) is much shorter than physician residencies (typically three or four years). However, with increasing dentist participation in postdoctoral education, it will be an important pipeline consideration in the future.

### Public Support for Dental Education and Dental Care in the United States

Unlike medical education, which receives substantial federal support, there currently is little federal financial investment in dental education. Significant federal support existed only for a brief period in the 1970s. Currently, the federal contribution to predoctoral dental education is less than 1 percent of aggregate dental school revenues. State and local contributions are more significant, but have recently witnessed a substantial decline. In 1991, state and local contributions constituted 66 percent of aggregate dental school revenues for the thirty-six public dental schools, but by 2001, the contribution had decreased to 49 percent. Private dental schools receive very little support from state and local sources, but these contributions have also been in decline (from 10 percent to less than 3 percent).

These declines are significant, and they have the potential to affect the supply of dentists. As previously described, attenuation of federal funding for dental education in the United States has produced a net loss of the equivalent of twenty medium-sized dental schools. Although the capacity of dental education has increased recently, continued expansion is questionable if additional reductions in public funding are experienced. Currently, the major source of revenues for predoctoral dentist education is state funding (for public and public/state-related schools). Tuition is second and clinical revenues third. Additional tuition increases may be difficult to institute in the presence of the burgeoning debt experienced by dental students. The ability of these non-public revenue sources to compensate for further reductions in public funding has its limits; consequently, further reductions may result in attenuating the ability of dental schools to increase their educational capacity in the future.

Public support for dental education can best be characterized as limited. The case can also be made that public support for dental services is likewise limited. Dental care is not covered under Medicare, and coverage is a state option under the federal-state Medicaid program. Medicaid dental services are extremely limited in forty states.
jectives to increase access include support for dentists within the National Health Service Corps and the mandatory provision of dental care in new Community Health Centers. These initiatives, although important, are limited in addressing national access problems. States also engage in similar initiatives. The scope of these varies from state to state.

**Dental Education in Pennsylvania**

Current enrollment at both Temple (500) and Pennsylvania (497) is approximately 500 students. The program at Pittsburgh is smaller, with current enrollment at 340 students. All three schools report that they have no immediate plans to increase class size. The three schools also report that the predominant category of students is from out of state. In 2001, only 10 percent of applications to Pennsylvania dental schools were from Pennsylvania residents. This is a decrease from 12 percent in 1996. However, Pennsylvania residents are disproportionately selected. Thirty-one percent of enrollees in 2001 resided in-state; this also is a decline from 41 percent in 1996. In contrast, the presence of underrepresented minorities (URM) in the dental student population is increasing. Ten percent of applications and 12 percent of enrollees were URMs in 2001, up from 7 and 10 percent, respectively, in 1996.

There are forty-one residency programs in Pennsylvania. Twenty of them are located within the dental schools, and the reminder are in other locations, predominantly hospitals.

**Public Support for Dental Education and Dental Care in Pennsylvania**

The state government provides financial support for dental education and, in the past, has supported dental clinics associated with all three schools. The level of support is difficult to estimate, since these appropriations are commingled with education line items at the larger universities.

Pennsylvania’s medical assistance (MA) program provides limited dental services for its enrollees. Despite reasonable but not comprehensive coverage within the MA program, utilization is quite minimal. This ostensibly is due to the limited participation of providers and the historical expectations and use patterns of enrollees. The Children’s Health Insurance Program (CHIP) also insures dental services through Blue Cross. In addition to support for dental services through public insurance programs, Pennsylvania also operates a student loan and challenge grant program with the intent of increasing access to dental services in underserved areas.

An important Commonwealth-supported access initiative is the school-based dental program. Pennsylvania’s schools are mandated to ensure that children have dental exams in the first, third, and seventh grades. Students can have these exams performed by their family dentist; if this cannot be done, schools will perform the exams. In urban districts, an average of 38 percent of students receive school-based exams; in rural districts, 51 percent receive state-supported exams.

**The Pennsylvania Pipeline**

In many respects, assessing how well a state’s dentist pipeline performs is not a simple matter. This, in large part, is due to the inequitable distribution of dental schools across the nation. Eighteen states do not have a dental school, and there is a rather large geographic region around the Rocky Mountains in which no dental school is located. In the rest of the nation, a disproportionate share of schools is located in the Northeast Corridor and in California. As a consequence, many states must rely solely on dentists who were educated in other states and, in some cases, states that are quite a distance away. Since so few states are similar with respect to educational infrastructure and the infrastructure in bordering states, a comparison of the performance of the dental pipelines across states will be ambiguous.

Structurally, Pennsylvania with a disproportionate share of dental education capacity (about 1,340 students) should be expected to have a relatively large share of its workforce educated in-state. Pennsylvania is located in a region (the Northeast) that has a disproportionately large share of dental education capacity as well. One might expect that the educational opportunities in neighboring states would attenuate the percentage of the workforce that is state-educated. This, in fact, is true. Of the thirty-three states (including the District of Columbia) with dental schools, Pennsylvania ranks highly with respect to the percentage of its current workforce who were state-educated, but not among the very highest. Twenty states have a lesser percentage of state-educated dentists, while only twelve states have a greater one. Over 75 percent of the current patient care workforce in Pennsylvania received their dental degrees from one of the three Commonwealth schools.
The disproportionate share of dental education capacity found within the Commonwealth would lead one to expect that Pennsylvania is an exporter of dental graduates and, consequently, score relatively low on the percentage of graduates retained in the state. One might also expect that the relatively high educational capacity of neighboring states might attenuate this effect somewhat. This also, in fact, is the case. Pennsylvania scores low with respect to the percentage of its graduates retained for service to the state, but not among the very lowest. Among states with dental schools, only eleven retain a lower percentage of its graduates for in-state service, while twenty-one states retain a higher percentage. Our data indicate that, since 1980, Pennsylvania has retained about 43 percent of its graduates for in-state patient care and an additional 2 percent for other dentist-related service.

It is difficult to make a definitive assessment concerning Pennsylvania’s pipeline with respect to its retention rate for state-educated dentists and the composition of its dentist workforce since there is no universal standard of comparison. However, one can safely assert that 1) Pennsylvania will have difficulty in repopulating its state-educated dentists with current retention rates; 2) the pipeline is inadequate to address the public health mandate of universal access; and 3) Pennsylvania retention rates are not inconsistent with its educational infrastructure. This scenario indicates that these rates have the potential to either increase or decrease and that policy changes have the potential to affect either a diminution or an increase in pipeline capacity.

There are several reasons why maximizing overall dentist retention is good public health policy. Certainly, in the presence of a decreasing supply of dentists nationally, a reliable supply of homegrown dentists will serve to slow the declining supply at home. Moreover, a healthy pipeline with respect to the general supply of dentists affords policymakers more control over the training of dentists and practice of dentistry. The advantages associated with developing a dentist pipeline that maximizes the overall supply of dentists are significant. However, developing the capacity of the pipeline to supply low service areas with dentists is even more critical to the public health mandates of universal access to dental care.

In this report, we have considered two important sub-state geographic areas, rural and low dentist supply areas. Both have significantly fewer dentists than the remainder of the state. An effective pipeline will disproportionately populate these areas with dentists and contribute to the equality of access to dental care. Unfortunately, Pennsylvania’s pipeline does not perform in that manner. Pennsylvania dental graduates comprise about the same percentage (or slightly less) of the workforce in these low service areas as they do in the remainder of the state. Moreover, the percentage of Pennsylvania graduates with practice destinations in these areas is modest. For example, only 5.8 percent of graduates are currently providing patient care in rural areas of the Commonwealth. This is about 13.4 percent of all graduates who remain to provide patient care in Pennsylvania—about the same percentage of Pennsylvania dentists who are currently providing care in rural areas. (From 1980 to present, 43.1 percent of all graduates have been retained for Pennsylvania patient care, and 5.8 percent are retained in rural areas; the percent of Pennsylvania retained graduates in rural areas is 5.8/43.1 or 13.4.) If the pipeline from the Commonwealth’s dental schools to rural areas continues at the same rate, it will only maintain the current inequality and not contribute to diminishing it. There is evidence (from this research) that the distribution of dental graduates to rural areas is on the decline, further exacerbating the inequality. The percentage of recent graduates providing patient care in low service municipalities is less than the current percentage of dentists in these areas. At best, the Pennsylvania dentist pipeline will only serve to maintain the current inequality in the geographic distribution of dentists within Pennsylvania and, most likely, will contribute to increasing the inequality—it will not contribute to its elimination.

As an overall assessment, the Pennsylvania pipeline should be considered inadequate to meet the Commonwealth’s public health goals. Using the retention rate for graduates since 1980 (about 43 percent) as a basis for future retention (estimates based on an educational capacity of 1,400 students, slightly more than the 1,340 current enrollees), the dental schools in the Commonwealth would send about 150 dentists a year to Pennsylvania. If the age structure of currently practicing dentists was more equitably distributed, this retention rate would constitute a replacement level for the current dentists who were educated within the state. However, the age structure of the current dentist workforce is top-heavy, and a large cohort of dentists is expected to retire in the near future. Consequently, projections based on this retention rate would result in less than replacement level for the near term, only to reach a replacement level in thirty to forty years. A more accurate projection would use the retention rate for the most recent
graduation cohort. In that scenario, the schools will send only about 105 dentists to Pennsylvania each year. At that rate, it would take over fifty years to replace the Pennsylvania-educated dentists practicing in the state, well below replacement level, especially in the short term. As a result, to maintain the current level of dental service within the Commonwealth, Pennsylvania must increase its educational capacity, improve the efficiency of its pipeline, or import more dentists from out of state.

When considered as a whole, the Pennsylvania dentist pipeline is less than ideal. However, pipeline development varies significantly by school. Graduates of the University of Pittsburgh School of Dental Medicine have a much higher probability of providing patient care in Pennsylvania, in rural Pennsylvania, and in underserved Pennsylvania than either of the other two dental schools. Pittsburgh graduates are 15 percent more likely than Temple graduates and 128 percent more likely than University of Pennsylvania graduates to provide patient care in Pennsylvania. If the University of Pittsburgh’s retention rates were the state standard, the three schools would return 200 graduates a year to the Commonwealth rather than 150 (estimates based on an educational capacity of 1,400 students, slightly more than the 1,340 current enrollees). Similarly, Pittsburgh’s rate of retention for rural Pennsylvania is 26 percent higher than Temple and 244 percent higher than the University of Pennsylvania. If the historical rural retention rates of the University of Pittsburgh School of Dental Medicine were characteristic of all three schools, Pennsylvania dental schools would graduate thirty rural dentists per year, instead of twenty. The differences are even more pronounced in areas of low dentist supply. Pittsburgh graduates are nearly two and a half times more likely than Temple graduates and almost five times more likely than University of Pennsylvania graduates to provide patient care in areas with the lowest dentist supply.

Unfortunately, the historical contributions of the Pittsburgh dental school to Pennsylvania service have declined significantly among the most recent graduation cohorts. Almost 70 percent of the 1980-94 graduates have remained in Pennsylvania to provide service, but since 1994 only 46 percent have remained. This trend is characteristic of all Pennsylvania dental school graduates (see Figure 1), but is even more pronounced among Pittsburgh graduates. The experience of the most recent graduates is undoubtedly the more reliable predictor of future trends, and it suggests that the historical contributions that the Pittsburgh dental school has made will be severely abated in the future. Nevertheless, the University of Pittsburgh still contributes significantly more dentists to the Pennsylvania dentist workforce than its two counterparts.

The Future of the Pennsylvania Pipeline

If the current pipeline is functioning at a level that is inadequate to repopulate the dentist workforce, especially in areas of low dentist service, what can we expect in the future? The current trends don’t suggest that a more rigorous pipeline is on the horizon. Upon inspection of the historical trends in retention rates for Pennsylvania (Figure 1), rural Pennsylvania (Figure 2), and areas of low dentist supply (Figure 3), one can readily observe that these rates are decreasing over time. A simple extrapolation suggests that retention rates will probably decrease, rather than increase, if pipeline development activity is not undertaken.

Additional factors exist that also inhibit an increased distribution of dental graduates to rural and underserved areas. Federal investment in dental education has diminished significantly since the 1970s and 1980s, and state financial support has seen a diminution in more recent years. This has resulted in an increase in student tuition and, concomitantly, an increase in student debt upon graduation. Average debt upon graduation has increased from around $40,000 in 1990 to almost $130,000 in 2005. When students graduate with such a significant debt burden, they are more likely to seek employment in an area that maximizes the compensation for their service. In rural areas, community health centers, inner city clinics, and other areas of need, compensation for service is less than that received in wealthier locales. Given the limited supply of dentists overall, significant opportunities exist for new dentists to establish practices in urban and suburban areas. The high cost of dental education also is a barrier to low-income students. The percent of lower income students has steadily declined, and the percentage of students from the highest income group has steadily increased in the past ten years. Low-income students are more likely to practice in areas of need. All of these trends result in a decrease in the strength of the dentist pipeline into areas of low supply.

These trends are reflected in the intentions of the most recent graduating class of dental students. Only 5 percent have plans to practice in an urban areas.
or rural area with a population of less than 10,000. Recent graduates have also expressed a limited interest in public service. Graduates of dental schools in 2005 often rated community dentistry and ethics as being excessively represented in the curriculum, and few students reported that more training should be provided in these areas. In general, these trends and structural constraints suggest that, without purposeful intervention, the ability of the pipeline to deliver dentists to Pennsylvania will weaken in the future.

**What Can Be Done to Strengthen the Pipeline: The Physician Model**

Scientific analyses of the effectiveness of general strategies to strengthen the pipeline from dental education to practice, especially in areas of need, are quite minimal. However, a more robust literature exists with respect to the physician pipeline and can be used as a model for dentists. There are significant differences between physicians and dentists in regard to their education and practice models that limit the applicability of physician research to dentists. These include the following: 1) dentists are much more often independent practitioners; 2) most dentists are generalists; 3) there is no universal residency requirement for dentists; and 4) residency programs are of shorter duration for dentists. Nevertheless, there are enough similarities that some basic postulates that apply to the physician pipeline can be applied to dentists.

For physicians, research has suggested that a functioning pipeline is built upon a foundation of appropriate medical school recruitment policies. Premedical education background of students is the foundation for establishing a pipeline from medical education to in-state practice and rural practice. A comparatively higher percentage of students who were raised in the state in which they attend medical school will eventually practice in that state. The percentage increases if the physician also completes a residency in the same state. The best predictor of eventual rural practice is a rural background and an interest in primary care. Premedical college education may also affect retention. Students who attended small local colleges were more gender and ethnically diverse and more likely to practice in a rural (and potentially) underserved area.

In the physician model, a pipeline built on this foundation, although functional, should be considered “leaky.” Specially developed undergraduate and graduate medical programs are needed to repair those leaks and to further develop the capacity of the pipeline. Curricula that include rural experience at both the undergraduate and graduate levels reinforce rural practice intentions and increase the retention rate once a practice is established.

These basic postulates derived from the physician model should be applicable to dentists. The most important of these is that the foundation of the pipeline is based on dental school recruitment. Enrolling more in-state students, rural students, lower income students, and minority students should strengthen the dentist pipeline to in-state service and to low supply areas. Dental school curricula that emphasize rural practice and community dentistry should strengthen the pipeline and help retain those students with a predisposition to practice in rural and underserved areas. Additionally, special programs to encourage licensed dentists to practice in areas identified as underserved will also contribute to the overall impact of the pipeline. These include loan repayment programs, programs that support the development of dental practice sites, and other practice incentives. These types of programs are currently being employed in most states for both physicians and dentists.

**What Can Be Done to Strengthen the Pipeline: Current Initiatives**

In Commonwealth dental schools, Pennsylvania applicants are disproportionately selected from all applicants. Although only 10 percent of all applications were from Pennsylvania residents in 2001, 31 percent of enrollees were. It is not clear how much effect formal school policy has on this phenomenon. The percentage of dental school applications from in-state students has declined in recent years, as has the number of enrollees.

Temple University has formed alliances with several Pennsylvania colleges to develop the pipeline from undergraduate education into professional dental education. Temple also participates in the Robert Wood Johnson Foundation’s Pipeline program intended to garner the participation of more minorities into the dental profession. The University of Pittsburgh actively recruits from traditionally black colleges in Pennsylvania, but few minority students enroll. All three dental schools incorporate some strategies to encourage service in rural or underserved areas. The University of Pittsburgh has a community dentistry program that exposes students to underserved areas, both urban and rural. Additionally, the school partners with the
Pennsylvania Area Health Education Center and its mission to improve health care in underserved areas. Temple’s pipeline program involves an active community dentistry component with clinical training in underserved areas in Philadelphia. The University of Pennsylvania incorporates academically based service-learning courses in all four years of its program. In the first two years, students provide dental education at schools and community centers; in the third and fourth years, they provide clinical service in low-income areas via a mobile van.

Commonwealth-sponsored initiatives that support the pipeline are also in place. These include the loan repayment and challenge grant programs, as well as state-supported loans that encourage students to remain in Pennsylvania.

What Can Be Done to Strengthen the Pipeline: Future Initiatives

Most of the general strategies to strengthen the dentist pipeline suggested by the physician model and the limited dentist literature are currently in place in Pennsylvania, albeit minimally. The effectiveness of additional initiatives to develop the dentist pipeline in the Commonwealth will not achieve maximal effectiveness if the current dentist workforce supply persists and public support for universal access stays at its current level. These major structural characteristics of the dental profession establish the parameters within which practice location decisions are made. Currently, they favor the choice of a practice in more affluent areas and do not encourage in-state service.

Dental school recruitment policy holds the most promise for pipeline development. Establishing formalized links with Pennsylvania colleges is one strategy for enhancing in-state recruitment. Special programs that expose potential applicants to the profession are effective also, especially with minority students. Differential tuition and fee schedules can also make dental school enrollment more attractive for Commonwealth residents. These are policies that need to be developed privately by each of the dental schools. However, the Pennsylvania government does have some influence in the policies of the two state-related dental schools, and it retains the option to offer incentives to all three schools.

Any initiative that will help ease the debt burden of students will encourage more low-income students to enroll in dental school. Other strategies to encourage more participation of underrepresented minorities in dental school have been documented in the literature, e.g., Baylor College of Dentistry has developed formal linkages with Texas school districts, colleges, community organizations, dental clinics, and community dentists. Other programs rely on this same strategy of combining community outreach, presence in local communities, and active recruitment efforts.

Establishing a universal residency requirement (PGY-1) may contribute to the pipeline by encouraging a residency location in Pennsylvania and exposing graduate dentists to community dentistry. A universal residency requirement also extends service to populations traditionally not well served by dentists.

The continuation and expansion of state programs that encourage the practice of dentistry within the Commonwealth and within underserved areas of the Commonwealth contribute to the pipeline. Loan repayment and similar programs can be considered a direct pipeline strategy, while other programs that promote access in general can be considered an augmentation to the pipeline.

Structural Constraints to Pipeline Development

The dentist pipeline operates within important structural characteristics of the profession of dentistry in the United States. Understanding the prospects for further pipeline development is best considered within the context of the practice model of dentistry and the current and future supply of dentists. Arguably, the most important structural factor is the size of the dentist workforce. The absolute supply of dentists is projected to decrease in the near future. This relatively low supply of dentists has enhanced the opportunity for new dentists to establish practices in affluent areas, where compensation for their services is maximized. At the same time, the cost of dental education has increased significantly, and dental students are graduating with a substantial debt burden. It is a financially prudent decision for graduates to seek employment opportunities that can comfortably retire that debt. These two trends in combination are strong “pull” factors attracting dentists to affluent areas and away from rural and low-income areas. As long as dentist supplies remain relatively low, efforts to enhance the pipeline will have to be instituted within this countervailing structural constraint and, consequently, be of decreased effectiveness.

The second major structural parameter that attenuates the effectiveness of pipeline development is
the prevailing practice model of dentistry. The model of dentist practice is one that is best conceived of as an “ability to pay” model. Comprehensive dental insurance coverage is not widespread, and public support for indigent care is limited. Consequently, dental services are much more available to those with sufficient income to pay for those services. When public insurance is available, it compensates dentists at rates much less than their usual and customary charges. These structural features tend to inhibit dentists’ participation in community dentistry or their decision to locate in areas that are not affluent. As long as these structural features exist, efforts to enhance the pipeline will have to be instituted within these countervailing structural constraints and, consequently, be of decreased effectiveness.

Finally, because Pennsylvania has a disproportionately large share of dental education capacity and because many states are without dental schools, Pennsylvania is an exporter of trained dentists. Any strategy to develop the Pennsylvania pipeline must account for the national distribution of dental schools.

Summary and Conclusions

As an overall assessment, the Pennsylvania dental pipeline appears to be inadequate to meet the Commonwealth’s public health goals. The pipeline is not developed adequately enough to repopulate the current Pennsylvania-educated dentist workforce. This is largely a consequence of more recent graduation cohorts less frequently choosing practice destinations in the Commonwealth and in underserved areas of the Commonwealth. The existing Pennsylvania-educated workforce is a combination of older (earlier cohorts) and younger dentists (more recent cohorts). Recent graduates who have chosen to serve in the Commonwealth at a lesser frequency cannot replace the larger cohort of older dentists who chose to serve in these areas in greater proportions. Preferences of recent dental graduates suggest that these trends will continue into the future.

The development of the pipeline from Pennsylvania dental schools to practice in Pennsylvania, in rural Pennsylvania, and underserved Pennsylvania is an appropriate response to the public health mandate of universal access to oral health care. It also is reasonable, given the public’s investment in dental service and dental education, that the Commonwealth retains a significant proportion of the dentists whom it educates. Pennsylvania’s pipeline needs some enhancement to respond to these expectations. The knowledge and techniques to develop that pipeline are known, but their effective implementation will be a difficult one, since structural constraints on pipeline development abound.

REFERENCES

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