

Working Paper #92

**Washington State's Dental Hygienist
Workforce through 2020:
Influential Factors and
Available Data**

March 2004

by

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This research was funded by Grant #1 U79 HP 00007-01 from the HRSA Bureau of Health Professions, National Center for Health Workforce Analysis. The authors thank David Hemion for his helpful review, Alice Porter for her superb editing, and Seth Blades for valuable research assistance.



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The WWAMI Center for Health Workforce Studies is supported by the Bureau of Health Professions' National Center for Health Workforce Information and Analysis. Grant No. 1U76-MB-10006-03; \$250,000; 100%.

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Washington State's Dental Hygienist Workforce through 2020: Influential Factors and Available Data

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EXECUTIVE SUMMARY AND QUESTIONS FOR REVIEW

This report describes the efforts of the University of Washington Center for Health Workforce Studies to identify trends in Washington's dental hygienist workforce. We based our analysis on state licensing data, dental practice survey data, educational program completions data, and population census data. From these sources, we developed models to project supply and demand for dental hygienists through the end of the next decade.

In common with other states, Washington is experiencing a shortage of dental hygienists. Our two models project a slight easing of Washington State's dental hygiene workforce shortage through 2012, at which time the projections diverge. One model projects continued improvement; the other model shows the shortage worsening through 2020. Recent increases in dental hygiene education program capacity may help alleviate the shortage but will not close the gap entirely by 2020. The accuracy of the model projections, however, should be considered in light of the limitations in the availability of both reliable data and supporting literature. We offer these projections for discussion and critique as an opportunity to explore possibilities for improving data sources and our understanding of the future supply of and demand for dental hygienists in Washington.

IMPORTANT FACTORS AFFECTING THE DENTAL HYGIENE WORKFORCE

Several factors may affect the future supply and demand of dental hygienist services, including the following:

- Educational program enrollments are funded to increase in Washington, increasing supply.
- New technology, materials, and information systems are being installed that, in the long-term, should increase productivity, but also increase demand.
- Proposed changes in regulations governing dental hygiene credentialing may increase supply.

- The supply of dentists—under whose supervision most dental hygienists practice—is decreasing.
- How a proposed expansion of dental hygienists' scope of practice would affect the total supply of services is unclear.
- An aging dental hygiene workforce will decrease supply.
- Improvements in oral health will reduce demand for some dental procedures but increase each patient's lifetime demand for dental services through greater retention of teeth. The net impact on demand is unclear.
- Washington's population is growing, leading to increased demand for services.
- Demand for services will rise or fall depending on changes in the number of people insured.

RESEARCH APPROACH AND LIMITATIONS

To model dental hygienist supply and demand in Washington, we used four principal data sources: (1) 1998-99 state licensing data and a supplementary licensing survey from the Washington State Department of Health Office of Health Professions Quality Assurance, (2) a 2001 survey of dentists by the Washington State Dental Association, (3) educational program completions data for dental hygiene programs in the state from 1996 to 2003, and (4) U.S. Census Bureau state population data.

These are the best data available for Washington, but they are missing critical information needed for making accurate workforce projections. For example, data are not available on job turnover, provider migration in or out of the state, and exits from the profession. Our assumptions about changes in Washington's total population and educational capacity are probably oversimplified. We are not able to predict or quantify future changes in the state's

health services delivery system and health policy. Our analysis of aggregate state supply and demand could mask critical shortages in specific regions and communities of Washington State. In addition, projections of the relatively small dental hygienist workforce are more volatile than are projections for larger state workforces (dental hygienists number in the 3,000s, compared with nursing, for example, in the 50,000s).

RESULTS

This report shows one method of projecting dental hygienist workforce demand and two alternative methods of projecting supply. The same demand model is compared with each supply model to generate two scenarios assessing the balance between supply and demand. All values reported represent persons, not positions or FTEs. Following are descriptions of these models and their projections:

Demand Model: We used state total population projections from the U.S. Census Bureau, state licensing data, and data from a 2001 survey of dentists in Washington State to model demand. The survey found a 24.5 percent vacancy rate, or need for just over 1,000 dental hygienists in the state. The model projects an increase in demand, based on population growth, ranging from 53 to 60 providers annually through 2020.

Supply Model I: This model estimates future supply as a function of recent trends in state licensing of dental hygienists, supplemented by data from two surveys. Supply Model I projects increases in employed providers of 78 dental hygienists per year. Supply increases relative to demand, closing the gap by about half by 2020, when the vacancy rate is projected to be 11.6 percent.

Supply Model II: This model estimates future supply as a function of educational program completions and provider retirements, supplemented by data from two surveys. Model II assumes that recent expansions of educational capacity in Washington will be sustained, about 135 new graduates annually. Supply Model II also projects increases in supply relative to demand until about 2012, when projected retirements and increased demand caused by state population growth more than offset this expansion. The shortage begins to worsen again approaching 2020, when it again exceeds 24 percent.

QUESTIONS FOR REVIEW

Our two scenarios project a slight easing of Washington State's dental hygiene workforce shortage through 2012, when the scenarios diverge. One scenario projects continued improvement; the other shows the shortage worsening through 2020. But these projections were developed with very limited data.

Before such projections can be used to inform policy, they must be reviewed by stakeholders familiar with the environment in which this workforce operates. These stakeholders can provide subjective assessments of how the profession is likely to change where quantifiable data do not exist currently, and they can generate estimates about how these changes may affect workforce supply and demand. Below are some questions for which we seek stakeholder input. This list is not exhaustive, and we welcome additional insights regarding influential factors and useful trend data.

- (1) Will Washington's dental hygiene programs continue to graduate about 135 dental hygienists per year? What are the pressures facing the educational pathway to dental hygiene?
- (2) How many of Washington's dental hygienists were trained out of state? How many of those trained in Washington stay here to work? What is the net impact on supply?
- (3) This report makes no distinction between practice in generalist or specialist dentistry. How do the prospects for dental hygiene practice in these areas differ?
- (4) How equitably are dental hygienists distributed throughout the state? Are there area shortages or surpluses?
- (5) Our demand estimates are based solely on total state population growth. How will a state population that is aging (according to the U.S. Census Bureau) affect demand for dental services? What impact will other demographic changes have on demand?
- (6) How will new dental technology and practice affect supply and demand?
- (7) If dental hygienists were to take on greater scope of practice in Washington, how would demand and supply be affected?
- (8) How can we obtain more recent and accurate data to assess the current dental hygienist workforce? What are practical long-term strategies for creating the data needed to monitor dental hygienist supply and demand on an ongoing basis?
- (9) What new state and federal policies may change dental hygienist supply and demand?
- (10) Will economic changes (e.g., recession) cause population demand for care to increase or decrease substantially during the next decade?

Washington State's Dental Hygienist Workforce through 2020: Influential Factors and Available Data

INTRODUCTION

The federal Bureau of Labor Statistics forecasts a 43.1 percent increase in the number of dental hygienists nationally from 2002 to 2012 (Bureau of Labor Statistics, n. d.). In Washington State, dental hygienists supply nearly 40 percent of all generalist dental visits (Wright et al., 2001). Recent studies suggest a significant shortage of dental hygienists in Washington State in terms of vacant positions (Hart, 2001) and in terms of oral health workforce requirements (Wright et al., 2001).

How will the supply and demand of dental hygienists change in the state of Washington, and what factors will affect the dental hygienist workforce? We reviewed literature on the dental hygienist workforce and analyzed available data in an attempt to answer these questions. We were able to identify several trends and impending changes in dental hygiene and oral health care, but because of serious limitations in the availability of data for Washington State, we are able to offer only rudimentary and tentative answers to these questions. The overriding message of this exercise is that we need much more data just to understand the current state of affairs, and these projections of future supply and demand should be viewed as exploratory rather than predictive, subject to a number of influential trends that we have few or no data to quantify.

FACTORS AFFECTING SUPPLY AND DEMAND OF DENTAL HYGIENE SERVICES

Workforce supply refers to the number of dental hygiene services that can be provided. Supply is affected over time either by changes in the number of providers or changes in the conditions of service provision. For example, an aging workforce decreases the supply of providers—and therefore the supply of services—through deaths and retirements. Increases in productivity—the unit of output per unit of input— increase the workforce supply. An increase in the supply of services does not necessarily mean an increase in the number of persons providing those services. For example, new technology that allows each full-time equivalent provider, or FTE, to provide a greater number of patient services causes an increase in the total supply of services.

Demand refers to the actual number of dental hygiene services that the population is willing and able to pay for, regardless of financing or whether services are necessary. Population growth and population aging, all other things being equal, lead to a higher total burden of disease and demand for cosmetic services and thus a higher overall demand for health care services.

The dental hygiene profession is undergoing changes that make predicting the future difficult even if data were available for a perfect reading of the current situation. A survey in 2001 showed that dental hygienist vacancies are difficult for Washington dentists to fill (Hart, 2001), with the highest vacancy rates in rural areas and along the more populated Interstate-5 corridor. Any dental hygienist workforce projection needs to be placed in the context of these inequities in distribution.

Table 1 shows the most likely factors that will affect the future supply and demand of dental hygiene services.

It is evident from this table that there are countervailing forces acting on both supply and demand levels. A brief explanation of these forces follows:

Table 1. Factors Affecting Supply and Demand of Dental Hygienists

Factor	Effect on Supply of Services	Effect on Demand for Services
Increases in educational capacity	Increase	
Elimination of credentialing barriers	Increase	
Improved technology	Increase	Increase
Increase in dental hygienists' independent practice	?	
Decreasing supply of dentists	?	
Aging workforce	Decrease	
Improvements in oral health		Increase/Decrease
Population growth		Increase
Change in the number of insured		?

Increases in Educational Capacity: Two-year community and technical colleges in Washington have received funding to expand capacity in critical health care shortage areas, including dental hygienists (Health Care Personnel Shortage Task Force, 2004).

Elimination of Credentialing Barriers: A new law passed in 2004 allows dental hygienists from other states to obtain a renewable limited Washington license that excludes restorative procedures. This change should increase supply.

Improved Technology: New equipment, materials, treatment technologies, and information systems will improve productivity in oral health (Beazoglou et al., 2002; Seldin, 2001). Gains in productivity reduce the number of FTEs needed to perform a given volume of services. In this way, the overall supply of services can increase, even as the size of the dental workforce stays the same or even decreases, all other things being equal. Technology innovations creating new types of dental services can also increase demand.

Increase in Dental Hygienists' Independent Practice: Dental hygienists may perform preventive dental procedures independently, but most practice under the supervision of dentists. If more dental hygienists engaged in independent practice, or if state law changed to allow dental hygienists a greater scope of practice, the effects on the total supply of dental services are unclear. If more dental hygienists practiced independently, they could potentially provide more preventive services—a supply increase. But without an increase in the number of dental hygienists, dentists' offices could then face a shortage. This shortage could cause a decrease in the supply of restorative services to the extent that they could not be covered by dental assistants or the dentists themselves. The net result of policy and practice changes such as

these, which have been discussed in Washington State, cannot always be foreseen.

Decreasing Supply of Dentists: The proportion of dentists approaching retirement in Washington is higher than that of the nation as a whole. Fifty-seven percent of rural dentists surveyed in 2001 planned to retire by the end of 2013 (Hart, 2001). If these retirements occur, the remaining dentists will likely hire some of the dental hygienists once employed by retiring dentists. In some communities, however, it is possible that not all hygienists will find employment as the supply of dentists contracts. Whether or not this trend will result in any appreciable impact on the supply of dental hygienists is not easily predicted.

Aging Workforce: The median age of the dental hygienist workforce is increasing (Fields & Dill, draft), leading to increasing rates of retirement.

Improvements in Oral Health: A trend toward improved oral health in the general population is reducing the total amount of care demanded by the average patient in a given year (Beazoglou et al., 2002; Brown & Lazar, 1998). But the resulting greater retention of teeth will increase demand for dental hygienist services over a typical patient's lifetime (Bureau of Labor Statistics, 2004). The net impact of improved oral health is unclear.

Population Growth: The U.S. Census Bureau forecasts that Washington State's population will grow by about one and a quarter million persons between now and 2020, increasing demand for services.

Change in the Number of Insured: Demand for services will rise or fall depending on the number of people insured.

DATA AND METHODOLOGICAL LIMITATIONS

The data and methods used in this analysis suffer from several drawbacks:

Scarcity of Data: Few data are available that relate to Washington's dental hygienist workforce. The only trend data that exist provide gross numbers of licenses and educational program completions. We were able to extrapolate estimates of a few limited aspects of supply and demand using four unrelated sources: a survey of licensees that accompanied the 1998-99 professional licensing and license renewal process, a 2001 survey of dentists, educational program completions data from 1996-2003, and U.S. Census state population data.¹

We used state licensing data from the Washington State Department of Health Office of Health Professions Quality Assurance. The Department of Health also conducted a supplementary survey during the 1998-99 licensing and renewal process. This is the most recent survey of Washington's dental hygienists. (Note: we are currently in the process of performing a 2004 survey.)

Another key source of data for this report is a 2001 survey of dentists conducted by the Washington State Dental Association (Hart, 2001).

Educational program completions data come from the National Center for Education Statistics Integrated Postsecondary Education Data System (NCES IPEDS) and directly from educational program directors in the state from 1996 through 2003.

We could find no data on job turnover, provider migration in or out of the state, or exits from the profession; these and other critical individual variables are not factored into any estimates in this report. In addition, we have not incorporated any estimates of system-level changes in health care and economic trends into our analysis. In effect, we treated all of these factors as constants, with no net effects on future supply or demand. We know that they will change, but available data do not allow us to take account of their influences at the state level. The limited analysis presented here relies on an extensive set of assumptions that are open to question and revision. For example, our demand model projects growth in demand for dental hygienists based solely on total state population growth. What other factors will affect demand? Projections may be highly sensitive to variations in assumptions and factors external to our analysis. In addition, it must be noted that our demand model is rather simple, based on vacancies. A more sophisticated multivariate economic model that simultaneously includes changes in supply and

demand (and accompanying price changes) is even farther beyond present data capability.

Exclusion of Geographic Variation: Dental hygiene services are unlikely to be perfectly distributed according to local population needs. Adequate data do not exist to analyze regional differences in the dental hygienist workforce over time. An analysis of state supply and demand in the aggregate showing an apparent equilibrium or surplus of providers can still mask critical shortages in substate areas.

Size of the Workforce: The dental hygienist workforce is small compared to the largest health occupations in the state. It is in the 3,000s, as compared, for example, to nursing, which is in the 50,000s. This smaller size makes projections more volatile. Small annual changes in educational program completions, retirement rates, demand for services, etc., can cause much larger fluctuations over time in the balance between demand and supply.

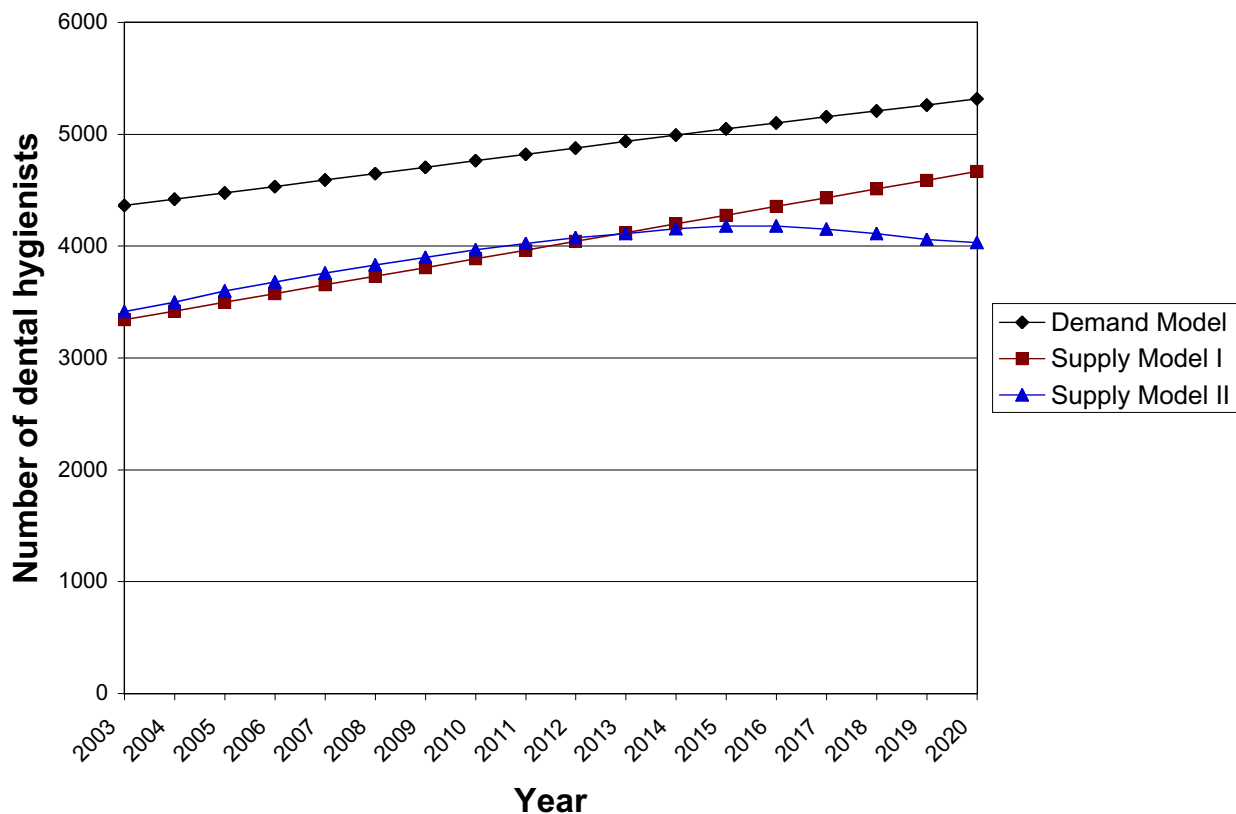
RESULTS

Our analysis of available data on dental hygienists in Washington yielded the following results:

Demographics: According to Washington State licensing data in 1998-1999, 98 percent of dental hygienists in current practice were women, and 89 percent were non-Hispanic white.

Shortage of Dental Hygienists to Continue through 2020: We created two projection scenarios of the Washington State dental hygienist workforce for this report, shown in Figure 1 (see Appendix for a detailed explanation of methods). One scenario compares our Supply Model I to our Demand Model, and the other compares Supply Model II to our Demand Model. Both scenarios assume that demand for services and rates of increase in supply of providers (adjusted for population growth) will continue at current levels. Based on a 24.5 percent vacancy rate in 2001 (Hart, 2001), the scenario using Supply Model I suggests that the current statewide shortage will be reduced by about half by 2020, when the projected vacancy rate becomes 11.6 percent. An alternative scenario using Supply Model II projects the shortage to lessen to 17 percent in 2012, increasing thereafter through 2020, when it again exceeds 24 percent. Recent increases in dental hygiene education program capacity, included in Supply Model II, may help alleviate the shortage but not close the gap entirely by 2020.²

**Figure 1. Dental Hygienists in Washington State 2003-2020:
A Demand Model and Two Alternative Supply Models**



Projections include the following state-level data:

- Total active professional licenses.
- Total employees and vacancies.
- Total general population projections.
- Dental hygiene program completions.
- Retirement projections.

Unavailable data that would improve projections:

- Need for and distribution of professionals in substate areas.
- Trend data on vacancies/turnover.
- Provider practice characteristics (e.g., full- v. part-time, career length, generalist/specialist practice).
- Job satisfaction measures and compensation data.
- Dentist supply trends.
- Demand differentials by demographic group (burden of disease by age, ethnicity, urban/rural, etc.).
- Provider migration in and out of state.
- Regulation and credentialing changes.
- Scope of practice changes.
- Educational trends (e.g., cost, availability, demand for training).
- Technological and practice change (e.g., productivity, new procedures).
- Macroeconomic trends affecting health care (e.g., total economic growth, trends in insurance coverage).
- Other health care systems/organizational trends.

QUESTIONS RAISED BY THIS REPORT

Our two scenarios project a slight easing of Washington State's dental hygiene workforce shortage through 2012, when the scenarios diverge. One scenario projects continued improvement; the other shows the shortage worsening through 2020. But these projections were developed with very limited data. Before such projections can be used to inform policy, they must be reviewed by stakeholders familiar with the environment in which this workforce operates. These stakeholders can provide subjective assessments of how the profession is likely to change where quantifiable data do not exist currently, and they can generate estimates about how these changes may affect workforce supply and demand. Below are some questions for which we seek stakeholder input. This list is not exhaustive, and we welcome additional insights regarding influential factors and useful trend data.

- (1) Will Washington's dental hygiene programs continue to graduate about 135 dental hygienists per year? What are the pressures facing the educational pathway to dental hygiene?
- (2) How many of Washington's dental hygienists were trained out of state? How many of those trained in Washington stay here to work? What is the net impact on supply?
- (3) This report makes no distinction between practice in generalist or specialist dentistry. How do the prospects for dental hygiene practice in these areas differ?
- (4) How equitably are dental hygienists distributed throughout the state? Are there area shortages or surpluses?
- (5) Our demand estimates are based solely on total state population growth. How will a state population that is aging (according to the U.S. Census Bureau) affect demand for dental services? What impact will other demographic changes have on demand?
- (6) How will new dental technology and practice affect supply and demand?
- (7) If dental hygienists were to take on greater scope of practice in Washington, how would demand and supply be affected?
- (8) How can we obtain more recent and accurate data to assess the current dental hygienist workforce? What are practical long-term strategies for creating the data needed to monitor dental hygienist supply and demand?
- (9) What new state and federal policies may change dental hygienist supply and demand?
- (10) Will economic changes (e.g., recession) cause population demand for care to increase or decrease substantially during the next decade?

APPENDIX: A DEMAND MODEL AND TWO ALTERNATIVE SUPPLY MODELS

This report shows one method of projecting dental hygienist workforce demand (Demand Model) and two alternative methods of projecting dental hygienist supply (Supply Model I, Supply Model II). These models were developed using the best data available for Washington. The same demand model is compared with each supply model to generate two scenarios assessing the balance between supply and demand. All values reported represent persons, not positions or FTEs. The shaded rows in the accompanying tables are the raw numbers representing the principal components of provider supply and demand that add up to each year's projected total surplus or shortage (covered under the Results section of each analysis).

DEMAND MODEL

This model uses state population projections, state licensing data, and data from a 2001 survey of dentists in Washington State that included questions about dental hygienist employees and vacancies. Estimated total demand in 2001 was adjusted to take account of increasing demand resulting from population growth in each subsequent year.

The following detailed explanations refer to the Demand Model in Tables A1 and A2 where rows are numbered D1-D3:

- (D1) We obtained state population projections for 2000, 2005, 2015, and 2025 from the U.S. Census Bureau. We assumed that population would grow at a constant rate in each of the years between these estimates.
- (D2) We calculated the total demand in 2001 as the sum of currently practicing (S3, explained below) and vacancies (results row 1, explained below). These numbers differ slightly between Supply Models I and II. Supply Model I estimates 3,183 currently practicing providers in 2001 and 1,033, for a total demand of 4,216. Supply Model II estimates currently practicing providers in 2001 at 3,225 and vacancies at 1,047, for a total demand of 4,272. The two supply models yield a total demand of either 71 (Model I) or 72 (Model II) providers per 100,000 population. The demand model projects demand for dental hygienists to grow in constant proportion to population growth. The difference between these two demand estimates (one used in Table A1 and the other in Table A2) through 2020 is not substantial, only 60 to

75 total providers annually. For simplicity, we used the mean of the two demand estimates for graphical presentation in Figure 1. Vacancy rates reported in the text, however, compare each model's supply estimates with its corresponding demand estimates. Each model's values are also presented in Tables A1 and A2.

- (D3) In Model I, the net annual increase in demand due to population growth, maintaining a ratio of 71 providers per 100,000, ranges from 53 to 57 providers per year through 2020. In Model II, with a ratio of 72 providers per 100,000, demand increases from 54 to 60 providers per year through 2020.

SUPPLY MODEL I: LICENSING TRENDS

This model uses recent trends in state licensing of dental hygienists to project future supply. We did not have information about the specific components that led to yearly changes in the number of licenses. Therefore, we assumed (recognizing this is likely an oversimplification) that whatever combination of forces driving these increases historically would continue at about the same rate.

The following detailed explanations refer to Supply Model I in Table A1, rows S1-S5:

- (S1) 1996-2001 figures are derived from the Washington State Department of Health's biennial reports summarizing total active licenses as of July 30 in odd years. Summary data were available from 1993 through 2001, inclusive. We estimated even years as the midpoints between numbers of licenses in odd years. Based on our analysis of 1999 licensing data, we know that total active licenses overestimate supply because these numbers include licensees not in practice and some duplicate records.
- (S2) Yearly net increases in active licensees for 1996 through 2000 inclusive are based on actual licensing data as reported in (S1). We used the mean yearly increase for this five-year period, 102.8, as the estimate for increases from 2001 to 2020.
- (S3) The value for 1999 comes from an analysis of a survey of licensees that accompanied the 1999 professional licensing and license renewal process finding 3,027 dental hygienists in current practice (Wright et al., 2001).

The values for subsequent years, 2000 through 2020, are based on estimates of the annual increase in supply of dental hygienists. As explained in (S5), we estimated that practicing providers would increase at a constant rate of 78 annually. Using this method, the estimated number of providers per 100,000 increased from 52.4 in 1999 to 53.6 in 2001.

- (S4) We estimated that 75.9 percent of active licensees (S1) were currently practicing (S3) in 1999 by dividing (S1) by (S3).
- (S5) To project growth in currently practicing licensees, the model begins by looking at the growth trend in total licensees from 1996 through 2001. During this period, total licensees grew at a mean annual rate of 102.8 (S2). We used this historical mean annual growth rate in total licenses to estimate the annual rate of increase from 1999 through 2020. To obtain estimates of only those dental hygienists currently practicing, total licensees (which include both dental hygienists in practice and those not in practice who continue to maintain their licenses) must be adjusted downward. We adjusted the annual increase in licensees of 102.8 to reflect that on average, only 75.9 percent of active licensees (estimated in S4 above) were employed as dental hygienists in 1999. This adjustment yields an annual increase of 78 providers through 2020.

Results: The following detailed explanations refer to the Results Section of Table A1, rows 1 and 2:

- (1) Dentists surveyed in 2001 reported a 24.5 percent vacancy rate for dental hygienists (Hart, 2001). Based on the Model I estimate of 3,183 dental hygienists in practice in 2001, 1,033 vacancies would constitute a 24.5 percent vacancy rate, assuming that each dental hygienist fills only one position. We projected vacancies in each subsequent year by adding the annual increase in demand (D3) and subtracting new providers (S5).
- (2) Vacancies are expressed as a percentage of total demand in each year. A positive number represents a shortfall of providers; a negative number represents a surplus.

Summary of Supply Model I: The number of dental hygienist licensees increased during the years for which we have data (1995 to 2001) at an average rate of 102.8 per year. We estimated that the proportion of active licensees in practice in 1999 was 75.9 percent

based on an analysis of state health professions licensing data. We applied this proportion to our estimates of future annual increases in licenses. Using this method, we projected increases in employed dental hygienists of 78 per year. The annual increase in demand, based on population growth, ranges from 53 to 57 through 2020. Beginning with 1,033 vacancies in 2003, a 24.5 percent shortfall of dental hygienists in the state, Supply Model I shows increases in supply relative to demand, closing the gap by about half by 2020, when the vacancy rate is 11.6 percent.

SUPPLY MODEL II: EDUCATIONAL OUTPUT AND RETIREMENTS

This model uses data on educational program completions and provider ages to project future supply. We attempted to estimate net change in supply by taking account of newly educated entrants to the profession and exits due to retirement.

The following detailed explanations refer to Supply Model II in Table A2, rows S1-S7:

- (S1) Same as Supply Model I, (S1).
- (S2) The 1999 figure is the same as Supply Model I, (S3). Subsequent years are based on increases in educational program completions net of retirements, explained in S4-7 below.
- (S3) Same as Supply Model I, (S4).
- (S4) We obtained program completions data from two sources. NCES IPEDS data for seven Washington dental hygiene programs are publicly available for the years 1996-98 and 2000. We obtained data for 1999 and 2001-03 directly from these seven programs and an eighth new program with completions beginning in 2003.

A perceived shortage of dental hygienists in Washington has resulted in the appropriation of funds to increase enrollment capacity in dental hygiene programs (Health Care Personnel Shortage Task Force, 2004). We projected educational program completions to continue at the higher rate of recent years to take account of this capacity increase. The imputed value of 135 completions per year from 2004 through 2006 is the annual mean of the completions for 2001, 2002, and 2003. We assumed that all program completers sit for and pass the required licensing examinations

- (S5) At any given time, some proportion of program completers will not be in practice. Our estimates, based on available licensing and

practice data, suggest that about 75.9 percent of current license holders are in active practice (as in Supply Model I, row S4). We adjusted values downward by this proportion to yield active providers resulting from yearly program completions.

- (S6) The 1998-99 state licensing survey asked licensees their age. We had no data on exits from the profession due to death, outmigration, change in occupation, etc., and therefore attrition in our model is captured exclusively through aging out providers surveyed in 1998-99 as they reach age 65.
- (S7) The net annual increase in supply is simply the difference between the gain from educational program completions (S5) less retirements (S6).

Results: The following detailed explanations refer to the Results Section of Table A2, rows 1 and 2. These methods are the same as those used to derive the results for Supply Model I.

- (1) Dentists surveyed in 2001 reported a 24.5 percent vacancy rate for dental hygienists (Hart, 2001). Based on the Model II estimate of 3,225 dental hygienists in practice in 2001, 1,047 vacancies would constitute a 24.5 percent vacancy rate, assuming that each dental hygienist fills only one position. We projected vacancies in each subsequent year by adding the annual increase in demand (D3) and subtracting new providers (S5).
- (2) Vacancies are expressed as a percentage of total demand in each year. A positive number represents a shortfall of providers; a negative number represents a surplus.

Summary of Supply Model II: The number of educational program completions from 1995 to 2001 averaged 129 dental hygienists per year. Output increased to a mean of 135 per year in 2001, 2002, and 2003, and the recent expansion of capacity suggests that the increase is likely to be sustained. For purposes of this projection, we assumed that all completers of dental hygiene programs would obtain state certification (licensing) to practice. An analysis of the state health professions licensing data showed that an estimated 75.9 percent of active dental hygienist licensees are in practice at any given time. We adjusted educational output in each year using this percentage, which resulted in increases to supply of 102 or 103 providers per year. Our projections of retirements, based on ages of licensed providers, result in annual reductions to supply that grow from 16 in 2003 to about 140 approaching 2020. Our estimates of the annual increase in demand, based on population growth, are in the mid-50s through 2020. Beginning with 1,047 vacancies in 2003, a 24.5 percent shortfall of dental hygienists in the state, Supply Model II shows increases in supply relative to demand through 2012, when the gap is smallest at 17.0 percent. The shortage begins to worsen again approaching 2020, when it again exceeds 24 percent.

Table A1. Projection Using Supply Model I: Dental Hygienist Licensing Trends

Supply Model I	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(S1) Active licensees	3,535	3,616	3,801	3,986	4,017	4,049																			
(S2) Net increase in active licensees	81	185	185	31	32	103	103	103	103	102	103	103	103	103	102	103	103	103	103	102	103	103	103	103	102
(S3) Total currently practicing (per 100,000)				3,027 (52.4)	3,105 (53.0)	3,183 (53.6)																			
(S4) Proportion of active licensees currently practicing				75.9%																					
(S5) Net increase in currently practicing				78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78
Demand Model	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(D1) State population (in 1000s)	5,516	5,602	5,687	5,773	5,858	5,938	6,018	6,098	6,178	6,258	6,338	6,418	6,498	6,578	6,658	6,738	6,818	6,898	6,978	7,058	7,133	7,208	7,283	7,358	7,433
(D2) Total demand (71 per 100,000)						4,216	4,273	4,330	4,386	4,443	4,500	4,557	4,614	4,670	4,727	4,784	4,841	4,898	4,954	5,011	5,064	5,118	5,171	5,224	5,277
(D3) Annual increase in demand						57	57	56	57	57	57	57	56	57	57	57	57	56	57	57	53	54	53	53	53
Results	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(1) Total vacancies						1,033	1,012	991	969	948	927	906	885	863	842	821	800	779	757	736	711	687	662	637	612
(2) Vacancies / total demand (%)						24.5	23.7	22.9	22.1	21.3	20.6	19.9	19.2	18.5	17.8	17.2	16.5	15.9	15.3	14.7	14.0	13.4	12.8	12.2	11.6

Table A2. Projection Using Supply Model II: Dental Hygienists Educational Output and Retirements

Supply Model II	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020		
(S1) Active licensees	3,535	3,616	3,801	3,986	4,017	4,049																					
(S2) Total currently practicing (per 100,000)				3,027 (52.4)	3,129 (53.4)	3,225 (54.3)																					
(S3) Proportion of active licensees currently practicing				75.9%																							
(S4) Educational program completions	110	129	126	132	132	137	129	140	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135
(S5) New completers currently practicing				102	103	102	103	102	103	102	103	102	103	102	103	102	103	102	103	102	103	102	103	102	103	102	103
(S6) Retirements				9	7	6	12	16	6	19	24	28	35	37	47	49	65	80	80	102	130	140	156	132	138	138	
(S7) Net increase in currently practicing				102	96	96	91	86	97	83	79	74	68	65	56	53	38	42	23	0	-27	-38	-53	-30	-35	-35	

Demand Model	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(D1) State population (in 1000s)	5,516	5,602	5,687	5,773	5,858	5,938	6,018	6,098	6,178	6,258	6,338	6,418	6,498	6,578	6,658	6,738	6,818	6,898	6,978	7,058	7,133	7,208	7,283	7,358	7,433
(D2) Total demand (72 per 100,000)						4,272	4,332	4,390	4,448	4,506	4,563	4,621	4,679	4,736	4,794	4,851	4,909	4,967	5,024	5,082	5,136	5,190	5,244	5,298	5,352
(D3) Annual increase in demand						60	58	58	58	57	58	58	57	58	57	58	58	57	58	54	54	54	54	54	54

Results	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(1) Total vacancies						1,047	1,011	978	950	911	885	864	848	837	830	831	836	856	871	906	960	1,041	1,133	1,240	1,324
(2) Vacancies / total demand (%)						24.5	23.3	22.3	21.4	20.2	19.4	18.7	18.1	17.7	17.3	17.1	17.0	17.2	17.3	17.8	18.7	20.0	21.6	23.4	24.7

NOTES

¹ The Labor Market and Economic Analysis Branch of the Washington State Employment Security Department has produced projections and job vacancy estimates, but because its figures for size of the workforce were significantly higher, and its job vacancy estimates were lower, than those suggested by any other data source, we did not incorporate its estimates into this analysis.

² The current projection assumes continued output of 135 dental hygienists per year based on the past two years. Prior to 2001, annual output averaged 129 per year.

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