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

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by

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Washington State's Radiographer 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 radiographer workforce. We based our analysis state licensing data, hospital staffing data, educational completions data, and population census data. From these sources, we developed models to project supply and demand for radiographers through the end of the next decade.

In common with other states, Washington is experiencing a shortage of radiographers. Our models suggest that recent increases in radiographer education program capacity could raise the supply to meet demand within the next five to seven years. The model projections, however, should be considered in light of the limitations both in reliable data and readily available supporting literature. We offer these projections for discussion and critique as an opportunity to explore possibilities for improving data sources and our understanding of this issue.

IMPORTANT FACTORS AFFECTING THE RADIOGRAPHY WORKFORCE

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

- Educational program enrollments are funded to increase in Washington, but uncertainty remains about sufficient numbers of faculty and clinical sites to provide capacity.
- A new type of service provider—the radiologic assistant—is being introduced. An enhanced career ladder could make the profession more attractive and increase productivity and supply.
- New filmless technology is being installed that, in the long-term, increases productivity.
- More stringent educational accreditation standards could limit expansion of educational capacity.
- The supply of radiologists and nuclear medicine physicians—under whose supervision technologists must practice—is decreasing.
- Professional entry requirements may increase, which could reduce supply.
- Competing career opportunities are drawing women (who have traditionally made up the bulk of the imaging workforce) to other occupations.
- An aging workforce, combined with an aging population needing more services, could create a shortage of personnel.
- The development of new and more complex diagnostic and therapeutic applications of imaging are likely to increase demand.

RESEARCH APPROACH AND LIMITATIONS

To model radiographer supply and demand in Washington (including radiation therapy technologists, nuclear medicine technologists, and radiologic technologists), 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 2002 study of staffing in nonfederal acute care hospitals by the University of Washington Center for Health Workforce Studies and the Washington State Hospital Association, (3) educational completions data for radiologic technology 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. In addition, projections of the relatively small radiographer workforce are more volatile than are projections for larger workforces (radiographers number in the 3,000s, compared with nursing, for example, in the 50,000s).

RESULTS

This report shows one method of projecting radiographer 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.

Demand Model: We used state total population projections from the U.S. Census Bureau and hospital-sector vacancies to model demand and extrapolated from hospital employment and vacancies to estimate total state employment and vacancies (both hospital and nonhospital sectors). There was a 10 percent shortfall of radiographers in the state, and the model projects an annual increase in demand, based on population growth, ranging from the mid- to low-50s through 2020.

Supply Model I: This model estimates future supply as a function of recent trends in state licensing of radiographers, supplemented by data from two surveys. Supply Model I projects increases in employed providers of 154 to 155 radiographers per year. Supply increases relative to demand, with equilibrium around 2007, and eventually outstrips demand by 25 percent in 2020.

Supply Model II: This model estimates future supply as a function of educational completions and provider retirements, supplemented by data from two surveys. Model II assumes that recent expansions of educational capacity will be sustained, about 160 new graduates annually. Supply Model II also projects increases in supply relative to demand, with equilibrium around 2010, but projected retirements eventually more than offset this expansion. Unlike Supply Model I, this model shows a sustained equilibrium for several years after 2010 until, approaching 2020, the vacancy rate begins to climb slightly.

QUESTIONS FOR REVIEW

Our models project an easing of Washington State's radiographer workforce shortage. But these models 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) How realistic are the future demand estimates in this report, which are based solely on state population growth? What impact will other demographic changes have on demand?

(2) Will Washington's radiologic technology programs continue to graduate about 160 radiographers per year? How many radiographers are trained outside of postsecondary educational institutions (e.g., in hospitals)? What are the pressures facing the educational pipeline to radiography?

(3) How many of Washington's radiographers were trained out of state? How many of those trained in Washington stay here to work? What is the net impact on supply?

(4) This report aggregates all types of imaging professions. How do prospects for different branches of radiography and different types of practice (i.e., entry-level v. specialized) differ?

(5) How do the hospital and nonhospital sectors compare? When only hospital vacancy rates are available to estimate nonhospital vacancies, what kind of error (if any) is introduced?

(6) How equitably are radiographers distributed throughout the state? Are there area shortages or surpluses?

(7) How will new imaging technology affect supply and demand?

(8) How can we obtain more recent and accurate data to assess the current radiographer workforce? What are practical long-term strategies for creating the data needed to monitor radiographer supply and demand on an ongoing basis?

(9) What new state and federal policies may change radiographer 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 Radiographer Workforce through 2020: Influential Factors and Available Data

INTRODUCTION

The federal Bureau of Labor Statistics forecasts a 23.1 percent increase in the number of radiographers nationally from 2000 to 2010 (Bureau of Labor Statistics, n. d.). National enrollment in radiographer training programs rose three years in a row, with a growing share of programs—two-thirds—at full capacity (2000, 2001, 2002). Despite this increase, the American Society of Radiologic Technologists (ASRT) recently estimated that, if current enrollment trends in radiologic technology continue, the nation would experience a 30 percent shortage of radiographers by 2010 (American Society of Radiologic Technologists, 2002; Costello, 2002).[1] Some studies suggest a current shortage both nationally and locally (First Consulting Group, 2001; Skillman et al., 2003; U.S. Radiology Partners, 2002a, 2002b).

How will the supply and demand of radiographers change in the state of Washington, and what factors will affect the radiographer workforce? We reviewed literature on the radiographer workforce and analyzed existing data in an attempt to answer these questions. We were able to identify a long list of trends and impending changes in radiography and 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 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.

We use the term "radiographers" throughout to refer to radiologic technologists (including those in specialized practice such as computed tomography—CT—or magnetic resonance—MR), radiation therapy technologists, and nuclear medicine technologists. Radiologic technologists make up the bulk of the radiographer workforce, and radiologic technology is the gateway to more specialized types of practice.

Although providers frequently engage in multiple modalities of practice, they are not interchangeable. Our study was forced to blur diagnostic and therapeutic, basic and specialized categories of practice because key data sources did not distinguish between provider types. Radiographers are trained primarily on the job or in community and vocational colleges. A small number are trained at the baccalaureate level. In Washington, all radiographers hold the same state license, regardless of type of practice and regardless of any professional association or other types of certifications they hold.

FACTORS AFFECTING SUPPLY AND DEMAND OF RADIOGRAPHY SERVICES

Supply refers to the number of radiography 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 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 produces more images per full-time equivalent provider, or FTE, causes an increase in the total supply of services.

Demand refers to the actual number of radiography 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 thus a higher demand for health care services.

The radiographer profession is undergoing rapid changes that make predicting the future difficult even if data were available for a perfect reading of the current situation. A recent state study showed that radiographers are one of the most difficult kinds of personnel for hospitals to recruit (Skillman et al., 2003). A survey of oncology practices[2] found the same vacancy rate for radiation therapy technologists both nationally and in Washington State: 18.3 percent.

There are, however, variations by region of the state. There are also variations by hospital size: smaller hospitals in Washington had a more difficult time filling vacancies, while larger hospitals were more likely to contract radiographers to fill vacancies (Skillman et al., 2003). These local findings are supported by national data suggesting that rural and university hospitals face the greatest shortages of radiographers (Reiner, 2002). Any workforce forecast 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 radiographer services.

Table 1. Factors Affecting Supply and Demand of Radiographers

Factor	Effect on Supply of Services	Effect on Demand for Services
Increases in educational capacity	Increase	
New type of service provider: "radiologic assistant"	Increase	
New filmless technology	Increase	
More stringent educational accreditation standards	Decrease	
Decreasing supply of radiologist/nuclear medicine MDs	Decrease	
Increased professional entry requirements	Decrease	
Competing career opportunities for women	Decrease	
Aging workforce and population	Decrease	Increase
New diagnostic and therapeutic applications		Increase

It is evident from this table that there are countervailing forces acting on supply levels. At the same time, all signs point to increasing demand for radiographer services. A brief explanation of these forces follows:

Increases in Educational Capacity: A national survey of training programs found that lack of faculty (inhibited by low compensation), lack of clinical sites, or lack of staff for clinical sites were factors limiting enrollment capacity (American Society of Radiologic Technologists, 2002; Costello, 2002). No systematic survey has been undertaken in Washington, but counter to these national trends, two-year community and technical colleges have received funding to expand capacity in critical health care shortage areas, including imaging technologists (Health Care Personnel Shortage Task Force, 2004; Washington State Board for Community and Technical Colleges, 2003).

New Type of Service Provider: A radiologic assistant position is being created that is similar to the MD/physician assistant model. Thirteen programs will train radiologic technologists for advanced practice under physician supervision. This enhanced career ladder could make the profession more attractive and increase productivity (Dyson et al., 2003), effectively increasing supply.

New Filmless Technology: The introduction of filmless imaging technology appears to reduce productivity during the adoption phase but eventually increases productivity (Reiner, 2002). 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 number of radiographers stays the same or even decreases, all other things being equal.

More Stringent Educational Accreditation Standards: The Joint Review Committee on Education in Radiologic Technology, the principal accrediting body for radiologic technology education programs, recently adopted new standards. By 2009, educational program directors in radiologic technology and radiation therapy must hold a master's degree, and full-time clinical coordinators must hold a bachelor's degree (Dyson et al., 2003). These changes could make educational program staffing more difficult. If staffing problems lead to program disruptions or limit expansion of educational capacity, the supply of new radiographers may not keep up with demand.

Decreasing Supply of Radiologists and Nuclear Medicine Physicians: The supply of technologists depends on the supply of radiologists and nuclear medicine physicians, since technologists must practice under physician supervision (Dyson et al., 2003; Lull & Littlefield, 1993). The number of radiology residency graduates decreased in the 1990s, including a 35 percent drop during 1994-99, in response to managed care. This trend, in addition to increasing retirements of the aging radiologist workforce, will reduce the supply of imaging services (Lull & Littlefield, 1993; U.S. Radiology Partners, 2002b). In addition, nuclear medicine physicians are reported to be in "turf" battles with cardiologists over cardiac nuclear medicine procedures. The effects of the potential fragmentation of "full-service" nuclear medicine are not yet clear.

Increased Professional Entry Requirements: There is not a consensus on what constitutes an appropriate level of training for entry into the radiographer profession. The ASRT advocates an associate degree, while others advocate a bachelor's degree. Either proposal could throw hospital programs into jeopardy (Dyson et al., 2003). Increasing entry-level standards could reduce supply.

Competing Career Opportunities for Women: Recruitment of women, who have traditionally made up the bulk of the imaging workforce, may become increasingly difficult as new employment opportunities draw women to other occupations (DiStefano et al., 1990). New technology career opportunities in other fields, such as information technology, offer higher pay, sometimes with shorter training periods (Levenson, 2002). These opportunities are likely to compete for potential entrants to the imaging profession, particularly in Washington State. Even among those choosing radiography, "stand alone" imaging centers are reported to offer better hours, higher pay, better retirement plans, and even stock options, drawing employees away from the hospital sector (First Consulting Group, 2001). If this is the case, hospital sector supply could suffer, but we do not have data to distinguish between hospital and nonhospital sectors in this analysis.

Aging Workforce and Population: An aging workforce, combined with an aging population needing more services, could create a shortage of personnel or exacerbate current shortages (Reiner, 2002; Volkin & Dargan, n. d.). In Washington, from 1995 to 2025, the proportion of the population ages 65 and older will nearly double from 11.6 percent to 20.2 percent (U.S. Census Bureau).

New Diagnostic and Therapeutic Applications: The demand for MRIs, CT scans, and other diagnostics is increasing faster than the supply of technologists trained in these specialized radiography areas (Levenson, 2002). The growing variety and complexity of imaging services available are likely to force up demand (Levenson, 2002; Reiner, 2002).

DATA AND METHODOLOGICAL LIMITATIONS

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

Scarcity of Data: Few data relate to the state's radiographer workforce. The only trend data that exist provide gross numbers of licenses and educational 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 2002 survey of hospital administrators, educational program completions data from 1996-2003, and U.S. Census state population data.[3]

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 provides the most recent survey data available on Washington's credentialed health care professionals.

Another key source of data for this report is a 2002 study of staffing in nonfederal acute care hospitals conducted by the Washington State Hospital Association and the University of Washington Center for Health Workforce Studies (Skillman et al., 2003).

Educational 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 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 extrapolates from hospital sector vacancies to project demand for the entire state radiographer workforce. Are vacancy rates the same in the hospital and nonhospital sectors? 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: Radiographer services are unlikely to be perfectly distributed according to local population needs. Adequate data do not exist to analyze regional differences in the radiographer 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 radiographer 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 completions, retirement rates, demand for services, etc., can cause much larger fluctuations over time in the balance between demand and supply.

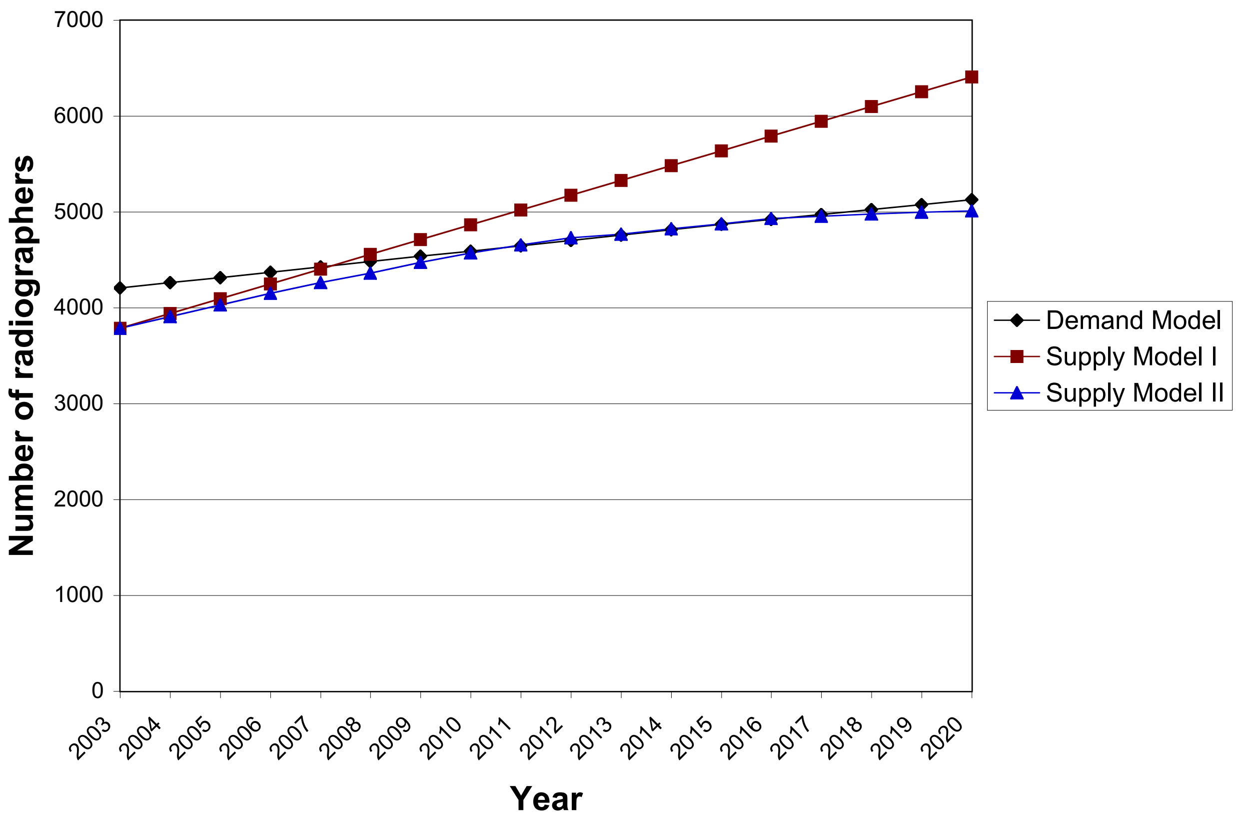
RESULTS

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

Demographics: According to Washington State licensing data in 1998-1999, two-thirds of radiographers in current practice were women, and 86 percent were non-Hispanic white.

Present Shortage of Radiographers May Be Eliminated Around 2010: We created two projection scenarios for this report, shown in Figure 1 (see Appendix for a detailed explanation of methods). Both scenarios assume that demand for services and rates of increase in supply of providers (adjusted for population growth) will continue at current levels. One scenario, based on a 2002 hospital vacancy rate of 10 percent, suggests that the current statewide shortage may be eliminated by 2010. An alternative scenario projects the state to reach equilibrium by 2007, followed by a period of surplus. Recent increases in radiographer education program capacity may cause the supply to meet demand in the relatively near future. If educational output reverts to historical levels, the shortage would likely continue.[4]

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



Projections include the following state-level data:

- Total active professional licenses.
- Hospital radiographer employees and vacancies.
- Total general population projections.
- Radiographer program completions.
- Retirement projections.

Unavailable data that would improve projections:

- Need and distribution of professionals in substate areas.
- Trend data on vacancies/turnover.
- Practice characteristics (e.g., full- v. part-time, career length, specialty practice).
- Job satisfaction and compensation.
- Physician supply trends (e.g., radiology).
- Nonhospital employees/vacancies.
- Demand differentials by demographic group (burden of disease by age, ethnicity, urban/rural, etc.).
- Migration in and out of state.
- Regulation and credentialing changes.
- Scope of practice changes.
- Educational trends (e.g., cost, availability, demand for training).
- Technological change (e.g., productivity, new applications).
- 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 models project an easing of Washington State's radiographer workforce shortage. But these models 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) Can Washington truly meet its radiographer demand by 2010? Is Washington's situation different from that of the rest of the country? How realistic are the future demand estimates in this report, which are based solely on state population growth?

(2) Will Washington's radiologic technology programs continue to graduate about 160 radiographers per year? How many radiographers are trained outside of postsecondary educational institutions (e.g., in hospitals)? What are the pressures facing the educational pipeline to radiography?

(3) How many of Washington's radiographers were trained out of state? How many of those trained in Washington stay here to work? What is the net impact on supply?

(4) This report aggregates all types of imaging professions. How do the prospects for the different branches of radiography and different types of practice (i.e., entry-level v. specialized) differ?

(5) How do the hospital and nonhospital sectors compare? When only hospital vacancy rates are available and these are used to estimate nonhospital vacancies, what kind of error (if any) is introduced?

(6) How equitably are radiographers distributed throughout the state? Are there area shortages or surpluses? What are differences by sector or facility type?

(7) How will new imaging technology affect supply and demand?

(8) How can we obtain more recent and accurate data to assess the current radiographer workforce? What are practical long-term strategies for creating the data needed to monitor radiographer supply and demand?

(9) What new state and federal policies may change radiographer 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 radiographer workforce demand and two alternative methods of projecting radiographer supply. 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 and data on hospital radiographer employees and vacancies. We extrapolated from hospital employment and vacancies to estimate total state employment and vacancies (hospital and nonhospital sectors). This current total demand value was then 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 2003 as the sum of currently practicing (S3, explained below), 3,784, and vacancies (results row 1, explained below), 421. This yields a demand of 69.0 providers per 100,000 population. We assumed this rate of demand through 2020. Thus demand grows in constant proportion to population growth.

(D3) The net annual increase in demand due to population growth, maintaining a ratio of 69 providers per 100,000, ranges from 51 to 56 providers per year through 2020.

SUPPLY MODEL I: LICENSING TRENDS

This model uses recent trends in state licensing of radiographers 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. We derived figures for 2002 and 2003 by adding the mean yearly increase for this five-year period of available data. 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, 172.4, as the estimate for increases from 2001 to 2020.

(S3) Data come from two sources, for two years only: a survey of licensees that accompanied the 1999 professional licensing and license renewal process, and a 2002 survey of hospitals in Washington State (Skillman et al., 2003).

The 1999 value was derived from the licensing data as follows:

— We based all estimates on only active licensees working or living in Washington who were currently practicing, up to age 65, inclusive. All others were excluded from our analysis.

— 2,168 licensees of 2,324 responding to the survey indicated that they were currently engaged in nonvolunteer practice (95.2%).

— 704 active licensees (fitting all other criteria) did not respond to the survey. We assumed that they were in current practice at the same rate as respondents, 95.2 percent, yielding an additional 683 providers.

— Currently practicing survey respondents (2,168) and imputation for missing responses (683) total 2,838. Since nonpracticing licensees may have been more likely not to respond to the survey, this total is likely to be an overestimate.

The 2003 value was derived from hospital survey data as follows:

— The proportion of 1999 licensees indicating employment in hospital inpatient or emergency departments (excluding outpatient care) was 45.1 percent.[5] We assumed that the same proportion of radiographers in 2003 were employed in hospitals to derive the size of the total radiographer workforce as follows:

— There were an estimated 1,939 radiographer positions in nonfederal acute care hospitals in 2003. To adjust for possible overcounting of persons occupying multiple positions in different locations (or more than one type of radiographer position at the same location), we adjusted this value downward based on the fact that 13.6 percent of 1999 licensees giving a work location indicated two different hospital sites. Performing this adjustment yields 1,707 hospital providers. Assuming they constitute 45.1 percent of the total state workforce, as hospital providers did in 1999, the total number of providers is 3,784.

We estimated that the number of licensees in the intervening years (2000-02) increased at a constant rate based on the 1999 to 2003 average yearly change. Using this method, note that the number of providers per 100,000 appears to have increased from about 49 in 1999 to about 62 in 2003.

(S4) We estimated the proportion of active licensees (S1) who are currently practicing (S3) from 1999 through 2003 by dividing (S1) by (S3). This proportion grows from 85 percent to almost 94 percent, averaging 89.7 percent during the period. This change over time may be the result of differences in the data sources used to estimate currently practicing providers for 1999 and 2003 or some other source of error. Alternatively, these numbers may reflect a real growth trend. An increase in the proportion of licensees employed is plausible given the poor economy in recent years that may have pushed inactive radiographers back into the workforce, as has been seen in nursing, another female-dominated profession (Buerhaus et al., 2003). This supposition is entirely speculative in the absence of more data, however.

(S5) For the years 1999 through 2002, the increase in the number of licensees in current practice is derived from the annual increase in total employment estimated in (S3). As explained above, the values in (S3) were based on two different sources of data, one yielding an estimate of employment for 1999, the other for 2003. The average annual increase in currently practicing licensees between these two time points was 236.5. This rate far outpaces the growth in licenses during the same period and, if real, is unlikely to be sustained.

To project future growth in currently practicing licensees from 2003 through 2020, 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 172.4 (S2). We used this historical mean annual growth rate in total licenses to estimate the future annual rate of increase. To obtain estimates of only those radiographers currently practicing, total licensees (which include both radiographers 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 172.4 to reflect that on average, only 59.4 percent of active licensees (estimated in S4 above) were employed as radiographers from 1999 through 2003. This adjustment yields an annual increase of 154.6 providers from 2003 to 2020.

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

(1) Hospital administrators surveyed in 2002-03 (Skillman et al., 2003) reported an estimated 216 vacancies. We adjusted this value to account for possible coverage of more than one position by a single provider and then estimated vacancies in all settings (hospital and nonhospital sectors), as in (S3) above. These adjustments yielded 421 total vacancies. 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 radiographer licensees increased during the years for which we have data (1995 to 2001) at an average rate of 172.4 per year. We were able to derive estimates of the proportion of active licensees in practice during each year from 1999 to 2003. From analysis of state health professions licensing data, we know that an average of 89.7 percent of active licensees were in practice during each year of this period. We applied this proportion to our estimates of future annual increases in licenses. Using this method, we projected increases in employed radiographers of 154 to 155 per year. The annual increase in demand, based on population growth, ranges from the mid- to low-50s through 2020. Beginning with 421 vacancies in 2003, a 10 percent shortfall of radiographers in the state, Supply Model I shows increases in supply relative to demand, with equilibrium around 2007. In this model, supply eventually outstrips demand by 25 percent in 2020. Policy interventions would probably ensure that an impending surplus of this magnitude would never come to pass.

SUPPLY MODEL II: EDUCATIONAL OUTPUT AND RETIREMENTS

This model uses data on educational 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-S8:

(S1) Same as Supply Model I, (S1).

(S2) Same as Supply Model I, (S3).

(S3) Same as Supply Model I, (S4).

(S4) Same as Supply Model I, (S5), years 1999 through 2002, for comparison purposes only. Supply increases based on actual employment estimates are larger than would be expected based merely on educational completions net of retirements, the method we employed in this model.

(S5) We obtained completions data from several sources. Most (but not all) institutions report to NCES IPEDS, data that are publicly available for the years 1996-98 and 2000. We obtained data for 1999 and 2001-03, as well as data from institutions that do not report to IPEDS, directly from individual programs.

A perceived shortage of radiographers in Washington has spurred new short- and long-term strategies to increase supply. These strategies include one-time and permanent increases in capacity in training programs in community and four-year colleges and new programs that train existing health care workers (Health Care Personnel Shortage Task Force, 2004). The full impact of these changes is not yet clear, but we projected educational completions to continue at the higher rates of recent years to take account of capacity increases. The imputed value of 160 completions per year—2004 to 2020—is the mean of the 2002 and 2003 completions.

Ninety percent of all completions are radiologic technologists, and ten percent are radiation therapy technologists. Note that only one institution in Washington, Bellevue Community College, offers nuclear medicine or radiation therapist technologist training. From 1996 to the present, the college has trained no nuclear medicine technologists.

Note also that although passage of a certification exam is required, completion of a formal program is not necessary for licensure in Washington State. We assumed that all formal program completers sit for and pass the ASRT certification exam. This over-estimation compensates in some measure for the inability to account for providers who obtain their license without attending a formal training program.

(S6) 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 89.7 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.

(S7) 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.

(S8) The net annual increase in supply is simply the difference between the gain from completions (S6) less retirements (S7).

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) Hospital administrators surveyed in 2002-03 (Skillman et al., 2003) reported an estimated 216 vacancies. We adjusted this value to account for possible coverage of more than one position by a single provider and then estimated vacancies in all settings (hospital and nonhospital sectors), as in (S3) above. These adjustments yielded 421 total vacancies. 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 completions from 1995 to 2001 averaged 118 radiographers per year. Output increased to a mean of 160 per year in 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 radiography programs would obtain state certification (licensing) to practice. From analysis of the state health professions licensing data we know that an estimated 89.7 percent of active radiographer 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 143 or 144 providers per year. Our projections of retirements, based on ages of licensed providers, result in annual reductions to supply that grow from 21 in 2003 to about 120 approaching 2020. Our estimates of the annual increase in demand, based on population growth, range from the mid- to low-50s through 2020. Beginning with 421 vacancies in 2003, a 10 percent shortfall of radiographers in the state, Supply Model II shows increases in supply relative to demand, with equilibrium around 2010. This equilibrium is maintained for several years until the vacancy rate begins to climb slightly approaching 2020.

Table A1. Projections Using Supply Model I: Radiographer 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	2,822	2,925	3,131	3,338	3,511	3,684	3,856	4,029																	
(S2) Net increase in active licensees	103	206	207	173	173	172	173	172	173	172	173	172	173	172	173	172	173	172	173	172	173	172	173	172	173
(S3) Total currently practicing (per 100,000)				2,838 (49.2)	3,074 (52.5)	3,311 (55.8)	3,547 (58.9)	3,784 (62.1)																	
(S4) Proportion of active licensees currently practicing				85.0%	87.6%	89.9%	92.0%	93.9%																	
(S5) Net increase in currently practicing				236	237	236	237	154	155	154	155	154	155	154	155	154	155	154	155	154	155	154	155	154	155

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 1,000s)	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 (69 per 100,000)								4,205	4,260	4,315	4,370	4,426	4,481	4,536	4,591	4,646	4,701	4,757	4,812	4,867	4,919	4,970	5,022	5,074	5,126
(D3) Annual increase in demand								55	55	55	56	55	55	55	55	55	55	56	55	55	52	51	52	52	52

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								421	322	223	124	25	-74	-174	-273	-373	-472	-572	-670	-770	-869	-972	-1,075	-1,178	-1,280
(2) Vacancies / total demand (%)								10.0	7.6	5.2	2.8	0.6	-1.7	-3.8	-5.9	-8.0	-10.	-12.0	-13.9	-15.8	-17.7	-19.6	-21.4	-23.2	-25.0

Table A2. Projections Using Supply Model II: Radiographer 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	2,822	2,925	3,131	3,338	3,511	3,684	3,856	4,029																	
(S2) Total currently practicing (per 100,000)				2,838 (49.2)	3,074 (52.5)	3,311 (55.8)	3,547 (58.9)	3,784 (62.1)																	
(S3) Proportion of active licensees currently practicing				85.0%	87.6%	89.9%	92.0%	93.9%																	
(S4) Net increase in currently practicing in Model I row S5				236	237	236	237																		
(S5) Educational completions	133	138	122	83	106	126	154	165	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
(S6) New completers currently practicing				73	93	110	135	145	143	144	143	144	143	144	143	144	143	144	143	144	143	144	143	144	143
(S7) Retirements				8	16	7	18	21	22	25	31	42	35	46	59	68	106	86	93	86	117	123	123	130	113
(S8) Net increase in currently practicing				65	77	103	117	124	121	119	112	102	108	98	84	76	37	58	50	58	26	21	20	13	30

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 1,000s)	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 (69 per 100,000)								4,205	4,260	4,315	4,370	4,426	4,481	4,536	4,591	4,646	4,701	4,757	4,812	4,867	4,919	4,970	5,022	5,074	5,126
(D3) Annual increase in demand								55	55	55	56	55	55	55	55	55	55	56	55	55	52	51	52	52	52

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								421	352	286	222	166	119	66	23	-6	-27	-9	-11	-6	-9	17	47	79	118
(2) Vacancies / total demand (%)								10.0	8.3	6.6	5.1	3.8	2.7	1.5	0.5	-0.1	-0.6	-0.2	-0.2	-0.1	-0.2	0.3	0.9	1.6	2.3

NOTES

[1] Supply may have been overestimated because deaths and retirements appear not to have been included in the model.

[2] Ninety-one percent of all practices affiliated with ASTRO—the American Society for Therapeutic Radiology and Oncology—were surveyed; thirty-three practices were surveyed in Washington.

[3] 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 were significantly lower than either the 1999 licensing data or the 2003 survey of acute care hospitals, we did not incorporate its estimates into this analysis.

[4] The current projection assumes continued output of 160 radiographers per year based on the past two years. Prior to 2002, annual output averaged 118 per year.

[5] This value is based on our analysis of the survey that was part of the 1998-99 Washington State licensing process. For comparison, in North Carolina (Dyson et al., 2003), 63.5 percent (and a higher percentage for nuclear medicine and radiation therapy technologists), and in New Jersey (1990), 61 percent of all radiographers worked in hospitals (DiStefano et al., 1990). It is unclear whether the North Carolina and New Jersey figures include hospital outpatient care, excluded here.

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