WHAT IS BEHIND HRSA'S PROJECTED SUPPLY, DEMAND, AND SHORTAGE OF REGISTERED NURSES?

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I. Background

An adequate supply of nurses is essential to achieving the nation's goals of ensuring access to affordable, high-quality healthcare. The adequacy of nurse supply varies geographically throughout the nation, with a general consensus that at the national level currently a moderate shortage of registered nurses (RN) exists. The findings of our analysis suggest that the current RN shortage will continue to grow in severity during the next 20 years if current trends prevail and that some states face a more severe shortage than do others. The growth and aging of the population, along with the nation's continued demand for the highest quality of care, will create a surging demand for the services of RNs over the coming two decades. At the same time, because many RNs are approaching retirement age and the nursing profession faces difficulties attracting new entrants and retaining the existing workforce, the RN supply remains flat.

The mission of the National Center for Health Workforce Analysis (NCHWA) in the Bureau of Health Professions (BHPr), Health Resources and Services Administration (HRSA), is *to collect, analyze, and disseminate health workforce information and facilitate national, state, and local workforce planning efforts*. To meet this mission as it pertains to the nurse workforce, NCHWA collects data on the nurse workforce through its quadrennial Sample Survey of Registered Nurses (SSRN) and maintains two models to project the RN supply and demand: the Nursing Supply Model (NSM) and the Nursing Demand Model (NDM). In this paper, we provide a brief overview of these two models; describe the data, methods, and assumptions used to project RN supply and demand; present findings from the models; and discuss the limitations of these and other models and methods to forecast demand for health workers.[1]

II. Nursing Supply Model

Tracking nurses by age, state, and highest education level attained (i.e., diploma or associate degree, baccalaureate degree, and graduate degree), the NSM produces annual, state-level projections of RN supply through 2020. Starting with the number of licensed RNs in 2000, the NSM adds the estimated number of newly licensed RNs, subtracts the estimated number of separations, and tracks cross-state migration patterns to calculate an end-of-year estimate of licensed RNs by state (Exhibit 1). The end-of-year estimate becomes the starting value for the next year's projections.

To estimate the number of RNs active in the health workforce and the number of fulltime equivalent (FTE) RNs employed in healthcare, the model projects the number of licensed RNs and then applies workforce participation rates. In computing FTE RNs, nurses who work fulltime are counted as one FTE, while nurses who report working part time or for only part of the year are counted as one-half of an FTE.

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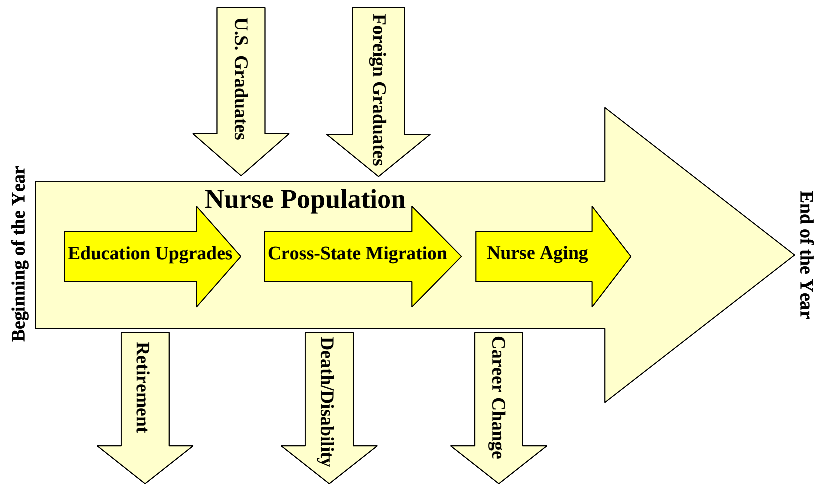
[1] Additional information on these models, projections from these models, and the data and assumptions is available in other reports: *Projected Supply, Demand, and Shortages of Registered Nurses: 2000–2020* (NCHWA, 2002), *NSM: Technical Report and User Guide* (NCHWA, forthcoming), *NDM: Development and Baseline Projections* (NCHWA, forthcoming), and *NDM User Guide* (NCHWA, forthcoming).

Exhibit 1. Overview of the Nursing Supply Model



The NSM contains three major components: (1) modeling new graduates from nursing programs, (2) modeling location and employment patterns of the current licensed nurse population, and (3) modeling separations from the nurse workforce. For each of these components, we describe the data, assumptions, and methods used to project future RN supply.

A. New Graduates from Nursing Programs

RNs typically enter the nurse workforce prepared at the diploma, associate, or baccalaureate level. (Some RNs enter at the master's level but are modeled here as bachelor of science in nursing [BSN] graduates who upgrade their education). Data on the number of first-time candidates taking the National Council Licensure Examination for Registered Nurses (NCLEX-RN examination), as published by the National Council of State Boards of Nursing, suggest that in 2000 approximately 71,100 RNs graduated from U.S. nursing programs (Exhibit 2). Approximately two-thirds of these graduates were prepared at the diploma or associate level, with the remaining one-third prepared at the baccalaureate level or higher. The number of graduates in 2000 shows a continuing decline compared with earlier years (e.g., there were approximately 76,300 graduates in 1999 and 83,000 graduates in 1998). The literature discussing reasons for this trend is extensive (e.g., see Buerhaus et al. [2000] and Seago et al. [2001]) but reflects increasing professional opportunities for women outside nursing, stagnant pay and more onerous working conditions for many in nursing, and a decline in pubic perception of the attractiveness of the nursing profession.

Baseline projections of the number of new nursing school graduates are based on the assumption that the nursing profession will continue to attract its current share of the applicant pool. The population of women ages 20 to 44 is used as a proxy for the size of the applicant pool, and the population projections used in the NSM come from the U.S. Census Bureau's middle series population projections.[2] Combining state-level NCLEX-RN data with state-level estimates of the number of women ages 20 to 44 creates a separate applicant pool share for each state. Over time, each 1% increase (or decrease) in the size of the applicant pool is assumed to cause a 1% increase (or decrease) in the number of RN graduates for that state. Under the baseline scenario, the number of new nurse graduates remains relatively constant through 2020 at the national level. The number of nurse graduates of each education type (E) in each state (S) and year (Y) is expressed mathematically:

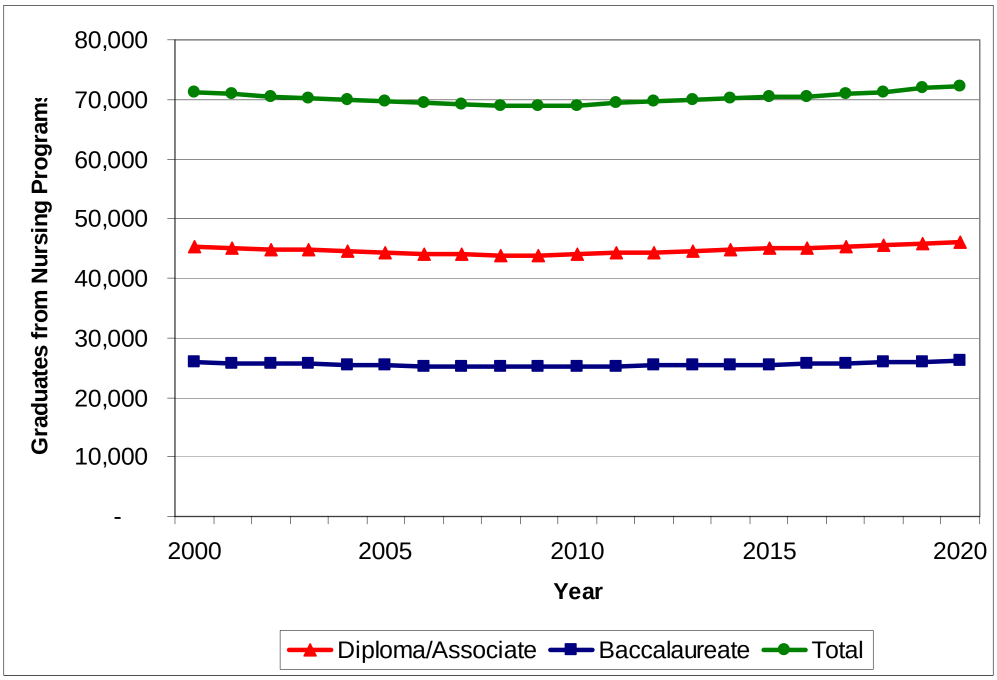
[2] The U.S. Census Bureau's projections were developed before the 2000 Census and underestimated the U.S. population in 2000. Consequently, we adjusted the projections to reflect this undercount. Men continue to constitute a small percentage of the RN workforce, doubling from approximately 2.7% in 1980 to 5.4% in 2000 (BHPr, 2001). As the proportion of RNs who are male grows, the NSM might have to add a gender component to track difference in workforce participation patterns and retirement rates between male and female RNs.

$$Graduates_{E,S,Y} = \left(\frac{PopW_{S,Y}}{PopW_{S,2000}} \right) \times Graduates_{E,S,2000}$$

The NSM software was built with algorithms to model the impact on the number of nursing graduates resulting from changes in RN compensation, working conditions, teaching capacity, and tuition costs. However, the research has yet to be completed for modeling the relationship between the number of nurse graduates and determinants that reflect the attractiveness of nursing as a career.

In addition to graduates from U.S. nursing programs, the NSM assumes net immigration of 3,500 RNs per year from foreign countries.

Exhibit 2. National Baseline Projections of Annual Nursing School Graduates



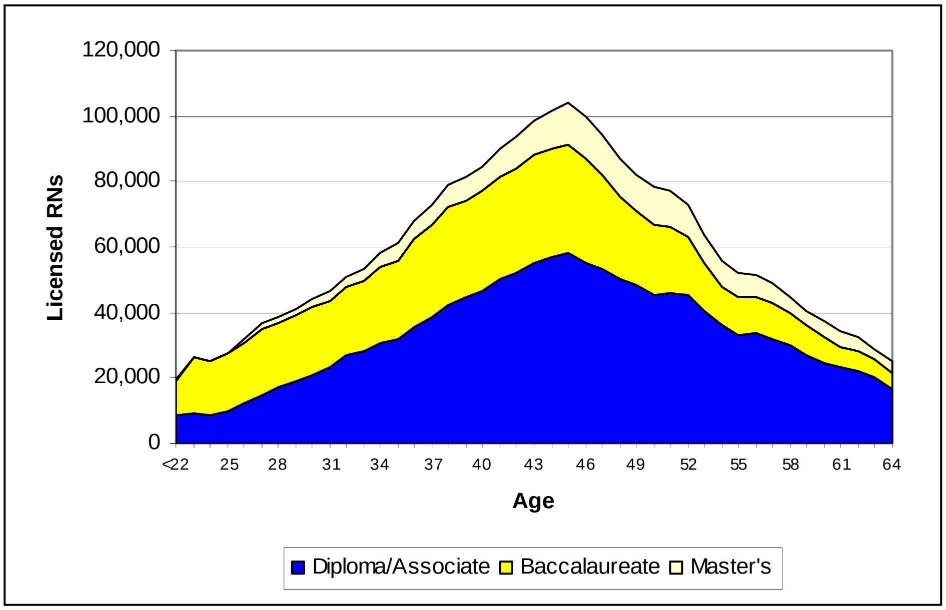
Source: Analysis of the 2000 SSRN.

B. Licensed Nurse Population

The NSM tracks the population of licensed RNs, or "bodies," regardless of whether the RN is providing nursing services. It applies estimated workforce participation rates to the projections of licensed RNs to forecast the active nurse supply (defined as number of nurses employed or seeking employment in nursing) and FTE supply (defined as the FTE number of nurses providing nursing services).

The model starts with the number of licensed RNs in each state, tracked by education level and age, as estimated using the 2000 SSRN (Exhibit 3). The education level and age composition of the licensed RN population has important implications for the current and future RN supply because workforce participation, cross-state migration, and retirement patterns vary systematically by education level and age.

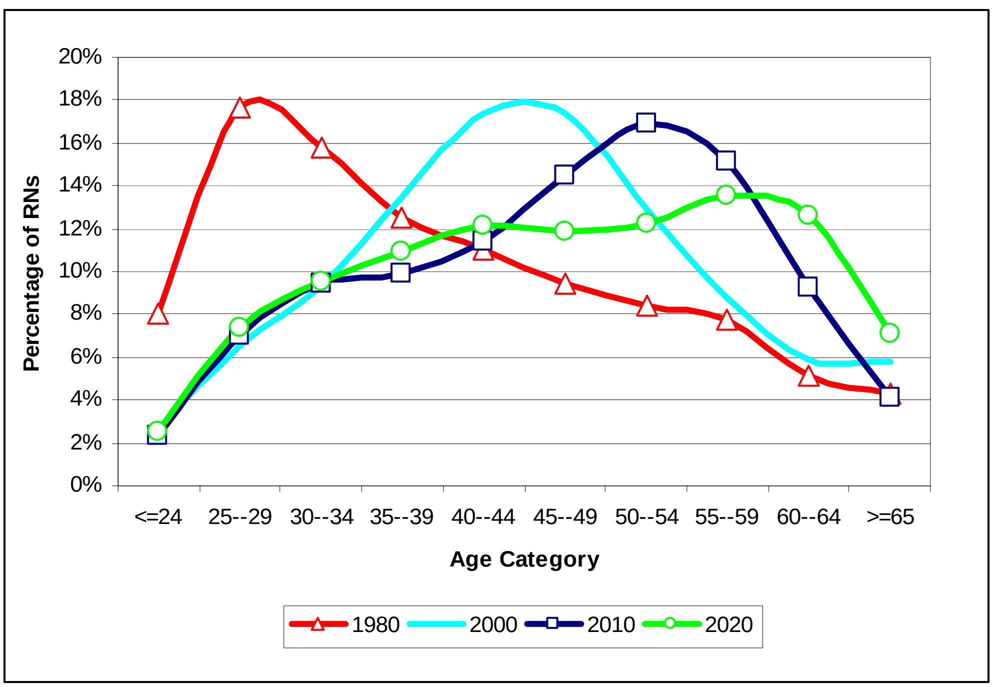
Exhibit 3. RN Licensed Population, by Education Level and Age, 2000



Source: Analysis of the 2000 SSRN

Over time, the nurse population has continued to age due to the large number of baby boom nurses and increasing difficulties in attracting new entrants to the profession. Also, the average age of new entrants is increasing (Exhibit 4).

Exhibit 4. Age Distribution Trend of the RN Population



Sources: 1980 and 2000 SSRN; NSM projections for 2010 and 2020.

1. Workforce Participation

The active RN supply is defined as the licensed RN population who provides nursing services or are seeking employment in nursing. This supply estimate excludes RNs who are licensed but not working in the nursing field (e.g., retired RNs who retain a license, RNs who have temporarily left the workforce, and licensed RNs employed in non-nursing positions). Responses to the SSRN are subjective, with individual respondents determining whether they are employed in a nursing position. The NSM applies national rates of workforce participation, by RN age and education level, to the projected licensed RN population in each state to project active nurse supply (Exhibit 5).

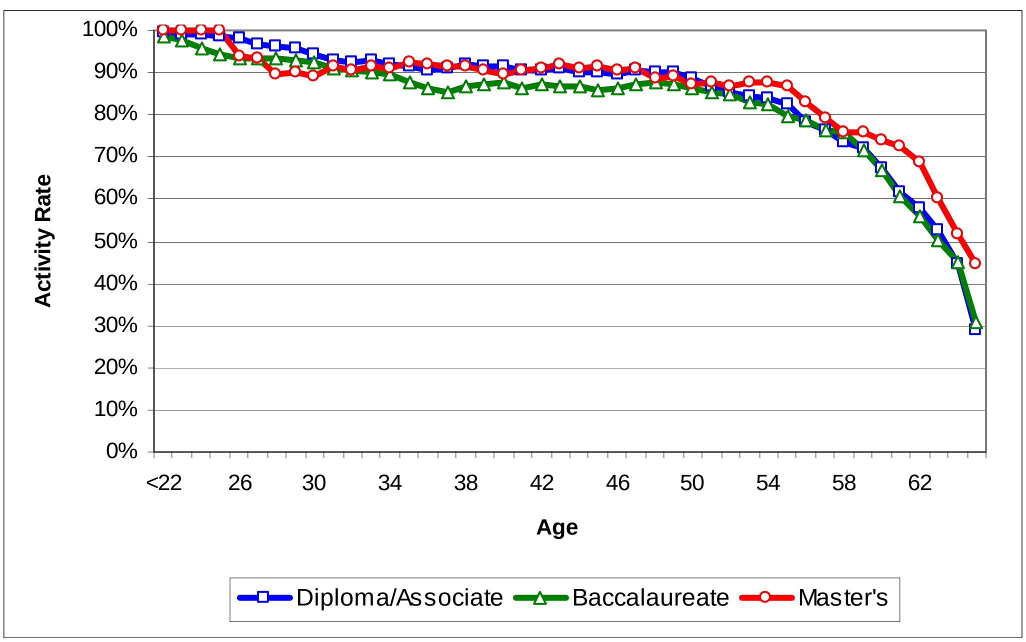
In a recent survey of approximately 7,300 licensed nurses (ANA, 2001), 672 respondents stated reasons for their decision not to work in a nursing position. Approximately 25% found their current position more rewarding professionally, 20% cited better salaries in their current position, 20% reported more convenient work hours in their current position, and 18% cited personal safety concerns with working in a healthcare environment. If these estimates represent the entire licensed nurse workforce, then of the approximately 136,000 licensed RNs in 2000 employed in non-nursing positions (BHPr, 2001), an estimated:

- 34,000 would find their current position more rewarding professionally,
- 27,000 would cite better salaries in their current position,
- 27,000 would report more convenient work hours in their current position, and
- 24,000 would cite personal safety concerns with working in a healthcare environment.

Only 70% of nurses in 2000 report being satisfied in their current position, which is significantly lower than U.S. workers in general (85%) and professionals in particular (90%) (BHPr, 2001). Job satisfaction among RNs was lowest in nursing homes and hospitals and highest in nursing education. Thus, of the approximately 2.2 million RNs employed in nursing in 2000, an estimated 672,000 were dissatisfied with their work.

The NSM software contains algorithms that allow users the potential to model changes in workforce participation rates over time based on projected changes in RN compensation and working conditions. There exists a paucity of research, however, identifying appropriate measures of working conditions and impact of changes in these factors on RN workforce participation.

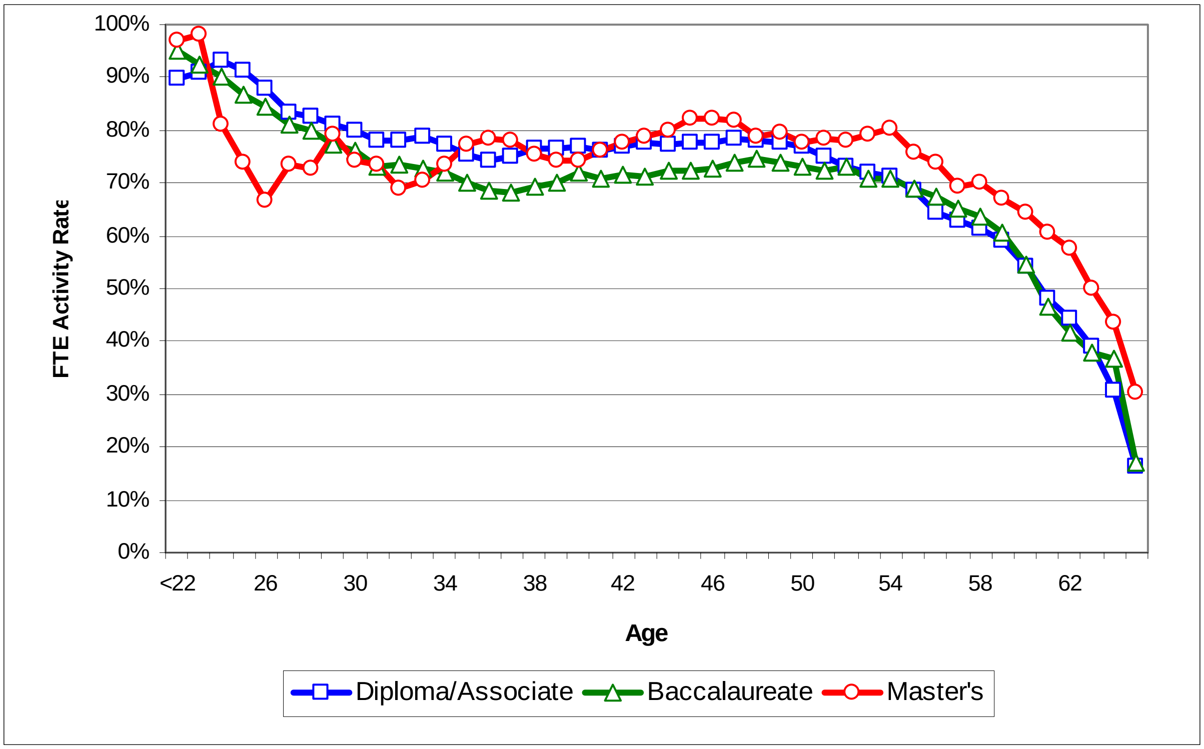
Exhibit 5. Workforce Participation Rates of Licensed RNs, by Age and Highest Education Level Attained



Source: Analysis of the 2000 SSRN.

The NSM also projects the FTE supply of RNs by applying FTE workforce participation rates that vary by RN age and education level (Exhibit 6). The FTE supply counts RNs working fulltime in nursing as one FTE and RNs working part time as one-half of an FTE.

Exhibit 6. FTE Workforce Participation Rates of Licensed RNs, by Age and Highest Education Level Attained



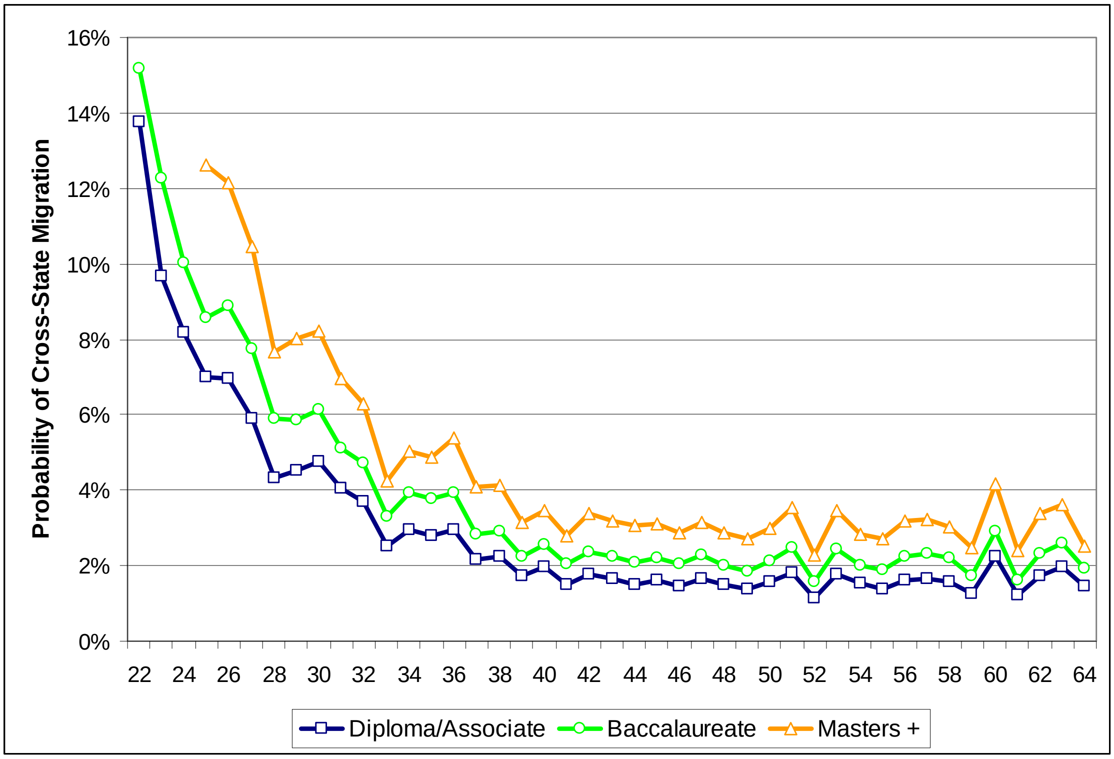
Source: Analysis of the 2000 SSRN.

2. *Cross-State Migration Patterns*

Nurses migrate between states for better career opportunities, because of change in location of spouses' employment, and for many other reasons. Some states are net exporters of RNs (i.e., more RNs leave than enter the state in a given year), while other states are net importers. The NSM estimates the number of RNs who will leave or enter the state each year by applying migration probabilities that vary by RN age, education level, and state. We estimated these migration probabilities by estimating a probit model using data from the 1992, 1996, and 2000 SSRNs. The SSRN asks survey participants in which state they resided at the time of the survey and one year before the survey. Nurses who change states between the survey date and the preceding year are identified as cross-state migrants. The probit model estimates the probability of leaving (or entering) a particular state as a function of RN age, education level, and state of residence. The NSM first estimates the number of nurses leaving each state by age and education level. Then, the NSM allocates this pool of migrating nurses to each state based on immigration probabilities that vary by state, RN age, and RN education level.

RNs prepared at the masters level or higher are more likely to migrate than are RNs prepared at the baccalaureate level, who in turn are more likely to migrate than are RNs with a diploma or associate degree (Exhibit 7). The analysis also shows significant variation across states in migration patterns. Younger RNs are more likely to migrate across states than are older RNs, reflecting factors such as greater transience among professionals early in their career as they seek employment after graduation.

Exhibit 7. Probability of Cross-State Migration, by Age and Education Level

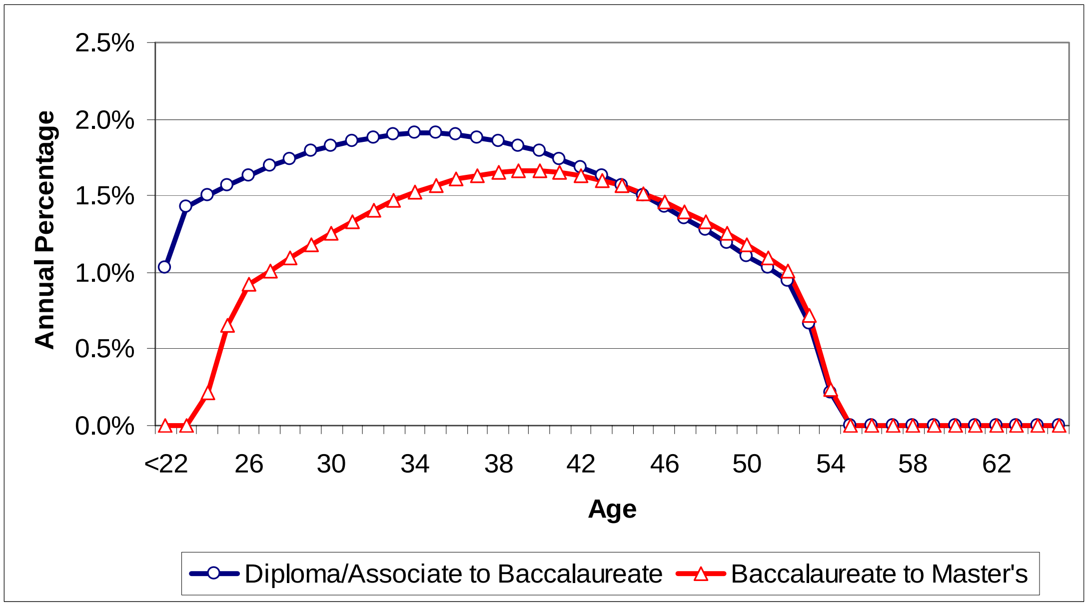


Source: Analysis of the 1992, 1996, and 2000 SSRNs.
Note: Probability of immigration and emigration varies by state.

3. Change in Education Level Attained

Some RNs will continue their schooling and thus move to a higher education category during the year. The NSM tracks two types of education upgrades: RNs prepared at the diploma or associate level who earn a baccalaureate degree and RNs prepared at the baccalaureate level who earn a master's or higher degree (Exhibit 8). The probability that an RN will upgrade his or her education level varies by age and was estimated using a probit model and data from the 1992, 1996, and 2000 SSRNs.

Exhibit 8. Percentage of RNs Who Upgrade Their Education, by Age



Source: Analysis of the 1992, 1996, and 2000 SSRNs.

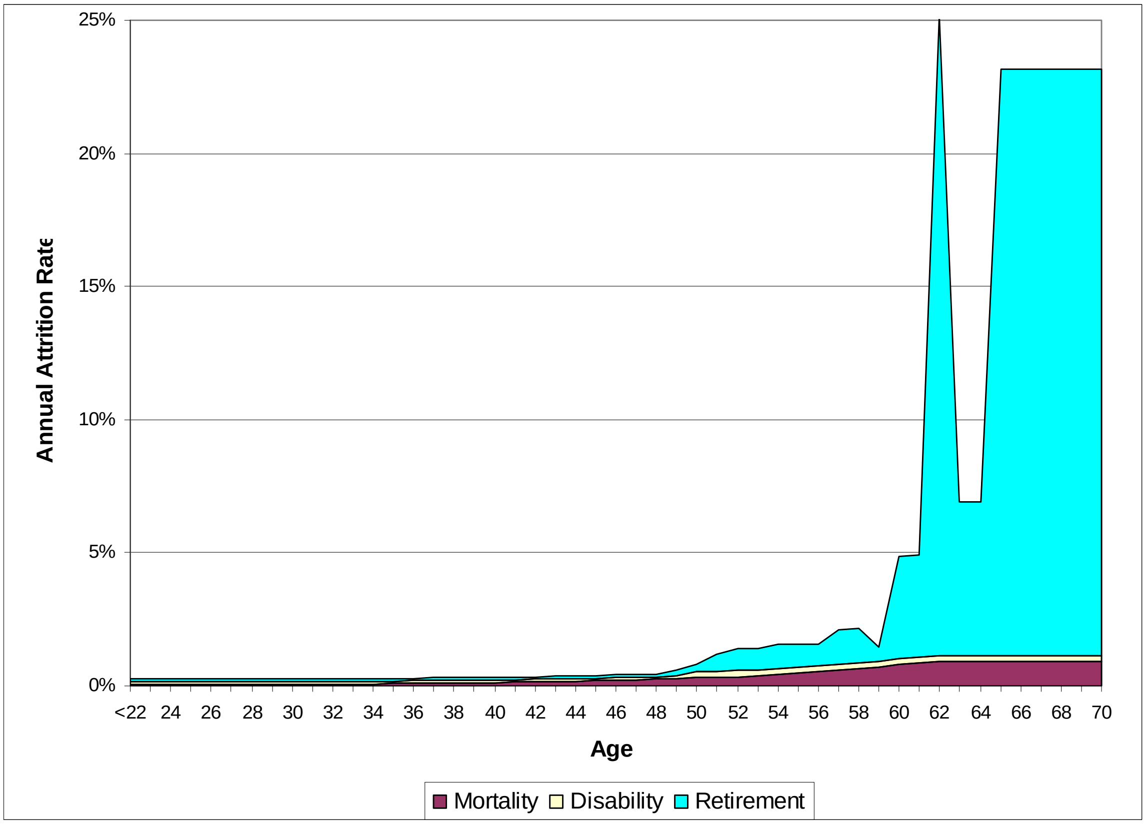
Note: An analysis of the SSRN found that few nurses age 55 and older upgrade their education, and the drop in probability of education upgrade for nurses in their early 50s reflects this transition to a zero probability.

C. Permanent Separation from the Nurse Workforce

Reasons why RNs permanently leave the workforce and do not renew their license include retirement, mortality, disability, and other factors. The NSM contains one set of attrition rates that combines all reasons for failing to renew one's license. These rates do not, however, reflect temporary departures from the nurse workforce captured through the use of workforce participation rates as described previously.

We constructed separation rates (Exhibit 9) by combining mortality rates for women obtained from Minino et al. (2002) and estimated rates of attrition for reasons of disability and retirement using data from the 1998, 1999, 2000, and 2001 March Current Population Survey (CPS). The CPS collects data on respondent age, gender, education level, and workforce participation. These workforce departure rates were constructed based on data for all U.S. college–educated women. There exists a paucity of information on workforce separation rates for RNs, and, in particular, the number of RNs who fail to renew their license after changing careers. (The SSRN surveys only nurses with an active license.) Anecdotal evidence suggests that many RNs who leave nursing retain their license even when they have little intention of returning to nursing. We account for nurses who change careers but continue to renew their license in our workforce participation and FTE supply rates.

Exhibit 9. Workforce Separation Rates for College-Educated Women



Source: Analysis of the 1998–2001 CPS files; mortality rates from Minino et al. (2002).

D. Nursing Supply Projections

Below we present projections from the NSM. The baseline projections assume the status quo, while projections for three alternative scenarios illustrate the supply implications of increasing the number of graduating RNs, increasing RN wages, and improving RN retention in the workforce.

1. Baseline Projections

The NSM baseline projections reflect the level of RN supply most likely to occur if current trends continue (Exhibit 10). At the national level, the number of licensed RNs is projected to remain relatively constant at about 2.7 million nurses between 2000 and 2020. The number of licensed RNs is projected to increase slightly through 2012 but to start declining as the number of retiring RNs exceeds the number of new graduates. The number of RNs active in nursing is projected to remain between 2.1 million and 2.3 million during this period, while the FTE supply of RNs is projected to decrease slightly from 1.89 million in 2000 to 1.81 million in 2020. At the state level, substantial variation occurs in the growth (or decline) of the RN population between 2000 and 2020 based on the number of new RN graduates in each state, net cross-state migration, and attrition from the RN population.

Exhibit 10. Baseline RN Projections, 2000 to 2020

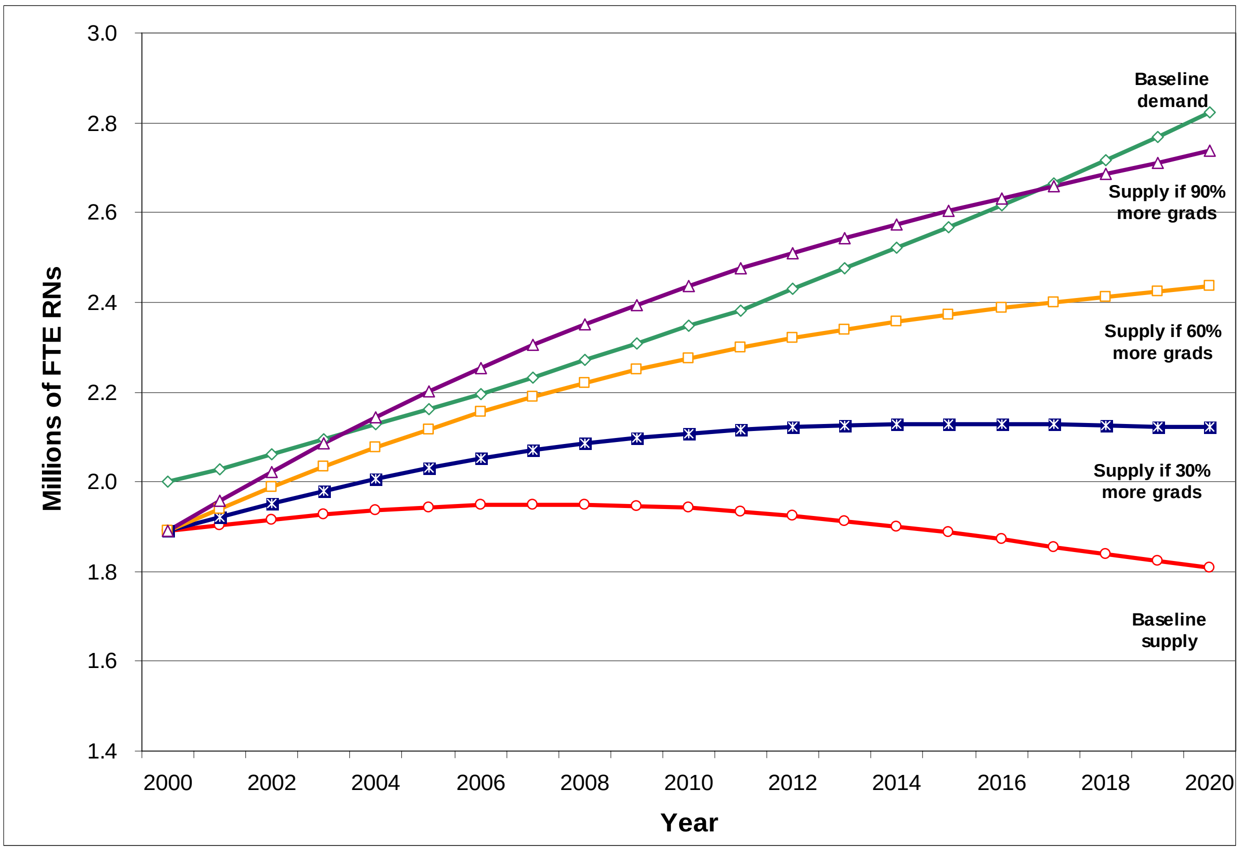
	2000	2005	2010	2015	2020	Change from 2000–2020
Licensed RNs	2,697,000	2,752,000	2,795,000	2,781,000	2,705,000	0%
RNs providing nursing services or seeking employment in nursing	2,249,000	2,303,000	2,305,000	2,250,000	2,163,000	-4%
FTE RNs providing nursing services	1,891,000	1,943,000	1,941,000	1,886,000	1,808,000	-4%

To assess the sensitivity of the model to key determinants of RN supply, we projected supply under alternative scenarios where we vary key assumptions.

2. Scenario 1: Change in Output from Nursing Programs

Under the baseline projections, the year-to-year percentage change in the number of graduates from nursing programs in each state is directly proportional to percentage change in size of the state's female population ages 20 to 44 (which, as discussed previously, is used as a proxy for the size of the pool of nursing school candidates). The NSM uses state-level estimates of new RN graduates in 2000 as the starting point for the projections. Projections of the FTE RN supply increase substantially over time under alternative scenarios where the number of graduates from U.S. nursing programs, relative to the baseline projections, is 30% higher, 60% higher, and 90% higher year after year (Exhibit 11). Over time, the difference in projected total FTE RNs between each scenario grows such that by 2020 the difference in totals FTE RNs, relative to the baseline projections, is +314,000, +628,000, and +929,000 for, respectively, the +30%, +60%, and +90% scenarios. ***To meet projected growth in demand for RN services, the U.S. must graduate approximately 90% more nurses from U.S. nursing programs relative to the baseline graduate projections.***

Exhibit 11. FTE Supply Implications of Changes in Projected Number of New Graduates from U.S. Nursing Programs[3]



[3] The data, methods, and assumptions used to calculate baseline demand projections are described in Section III.

3. Scenario 2: Change in RN Wages

If wages for nursing services increase relative to wages in alternative occupations, then, all else being equal, nursing becomes a more attractive career. In the short run, an increase in wages for nursing services would increase the FTE RN supply by motivating:

- Licensed RNs not practicing nursing to return to nursing,
- Part-time RNs to work more hours, and
- RNs to delay retirement or leave retirement.

The short-term percentage increase in FTE RN supply attributed to each 1% increase in wages for nursing services is referred to as *short-term wage elasticity of supply*.

In the long run, an increase in wages for nursing services will also attract new entrants to the nursing workforce (assuming no constraints on nursing school capacity). Because of the time to recognize an increase in RN wages and the time to train new nurses, a delay of several years is expected between the time that RN wages increase and new entrants to the nursing profession increase. The *long-term wage elasticity of supply*, consequently, is larger than the short-term wage elasticity of supply.

There exists a paucity of research that estimates the wage elasticity of supply for nurses, and the few studies that have been published report a large range of elasticity estimates. One challenge when assessing the validity of these estimates for modeling the supply of RNs is to distinguish between short-term and long-term wage elasticities and to distinguish between market wage elasticities and wage elasticities specific to a particular provider (e.g., if one hospital increases RN wages, then that hospital will draw nurses away from other hospitals). Sloan and Richupan (1975) obtained wage elasticity estimates for RN workforce participation that ranged from 0.18 to 2.82. Using a sample of Norwegian nurses, Askildsen et al. (2002) estimate wage elasticities for workforce participation ranging from 0.253 to 0.843. For comparison, a review of the literature assessing the military's ability to recruit finds most pay elasticity estimates in the 0.5 to 1.5 range (Hogan et al., 1995).

For this scenario, we assume annual growth in RN wages, relative to wage growth in alternative occupations, of 0% (the assumption in the baseline projections), +1%, +2%, and +3% annually between 2000 and 2020[4] (Exhibit 12). The wage growth rates have a compounding effect over time, so a 1% growth rate over a 20-year period means that by 2020 RN wages would have increased, relative to other occupations, by 22%. We assume that each 1% increase in wages increases the number of RN graduates by 0.8% and increases workforce participation rates by 0.3%. By 2020, relative to the baseline projections, the number of FTE RNs is +228,000 (+13%), +518,000 (+29%), and +886,000 (+49%), respectively, for the scenarios with 1%, 2%, and 3% annual growth in real wages.

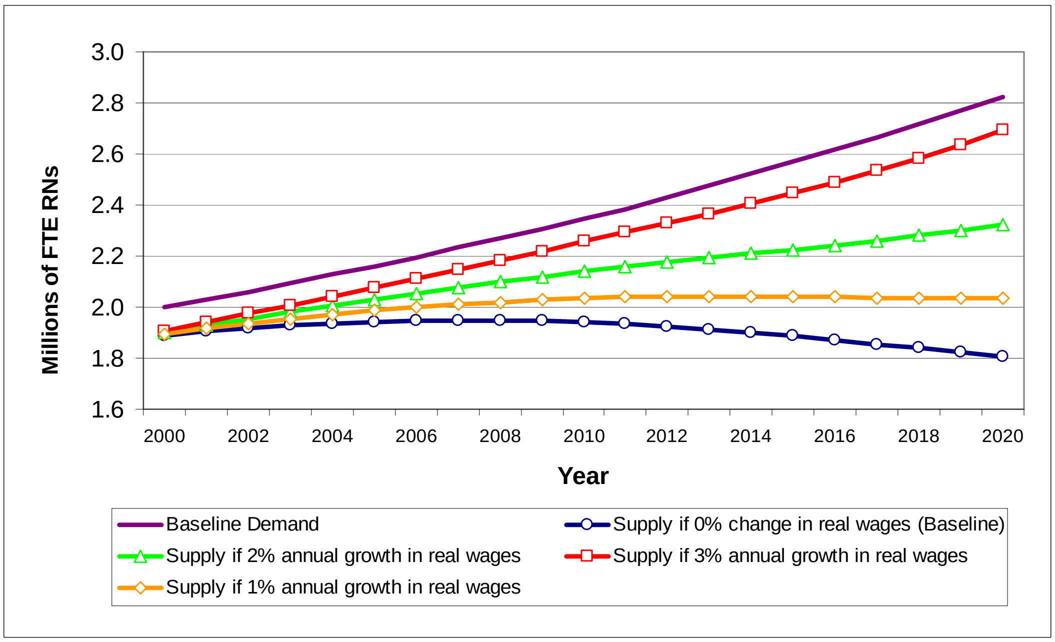
The baseline demand projections, discussed in more detail later, assume that RN wages will grow at the same rate as wages of licensed practical nurses (LPN) and other healthcare occupations. If RN wages were to rise faster than, say, LPNs, then employers of nurses would have a financial incentive to substitute lower-cost LPNs for higher-cost RNs, where feasible. Spetz and Given (2003) estimate that inflation-adjusted wages must increase by between 3% and 4% per year between 2002 and 2016 to bring RN labor markets into equilibrium. ***Assuming each 1% real increase in RN wages increases the number of new RN graduates by 0.8% and increases FTE activity rates by 0.3%, a continuous 3% annual increase in RN wages would still result in a shortfall of approximately 100,000 FTE RNs but would prevent the shortage from growing more severe (Exhibit 13).***

[4] An annual survey of RN salaries finds that RN hourly earnings increased by nearly 7%, on average, between 2002 and 2003 (Robinson and Mee, 2003).

Exhibit 12. Supply Implications of Rising RN Wages, 2020

	Annual Wage Growth (relative to annual wage growth in alternative professions)			
	0% (Baseline)	1%	2%	3%
Cumulative wage growth 2000–2020	0%	22%	49%	81%
Graduates/year 2020 (percentage different from baseline)	72,400	85,500 +18%	102,000 +40%	121,000 +67%
Licensed RNs 2020 (percentage different from baseline)	2,704,000	2,827,000 +5%	2,969,000 +10%	3,130,000 +16%
FTE RNs 2020 (percentage different from baseline)	1,808,000	2,036,000 +13%	2,326,000 +29%	2,694,000 +49%
FTE Rate 2020 (aggregate)	67%	72%	78%	86%

Exhibit 13. Projected FTE RN Supply under Alternative Wage Growth Scenarios

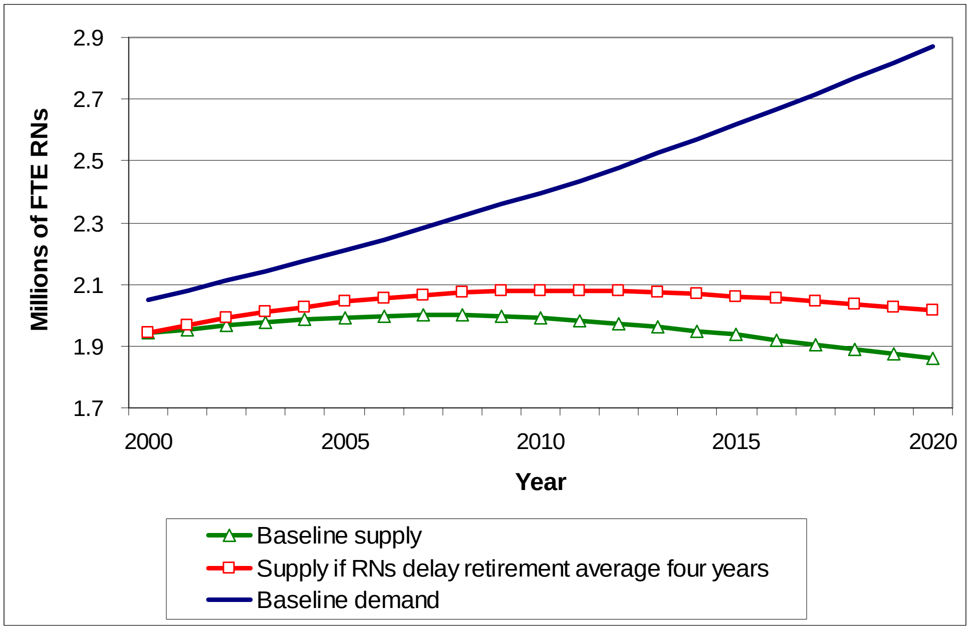


Note: Projections assume wage elasticities of 0.8 for new graduates and 0.3 for FTE workforce participation rates.

4. Scenario 3: Change in RN Retirement Patterns

The rate at which RNs permanently separate from the RN workforce varies by age and education level, with high rates of departure between age 62 and age 65 as nurses qualify for Social Security and Medicare benefits. Using the NSM, we project RN supply if each RN were to work an additional four years before retiring. Delays in average retirement age might occur as a result of (1) government policies delaying eligibility for Social Security and Medicare, (2) a healthier population able to remain longer in the workforce, or (3) improvements to RN working conditions that increase the likelihood that nurses will remain active in the workforce. Compared to the baseline projections, delaying retirement by an average of four years would increase the FTE RN supply by nearly 158,000 (9%) in 2020. Still, such an increase exerts only a modest effect on alleviating the projected growing RN shortage (Exhibit 14).

Exhibit 14. Impact of Changing Retirement Patterns on FTE RN Supply

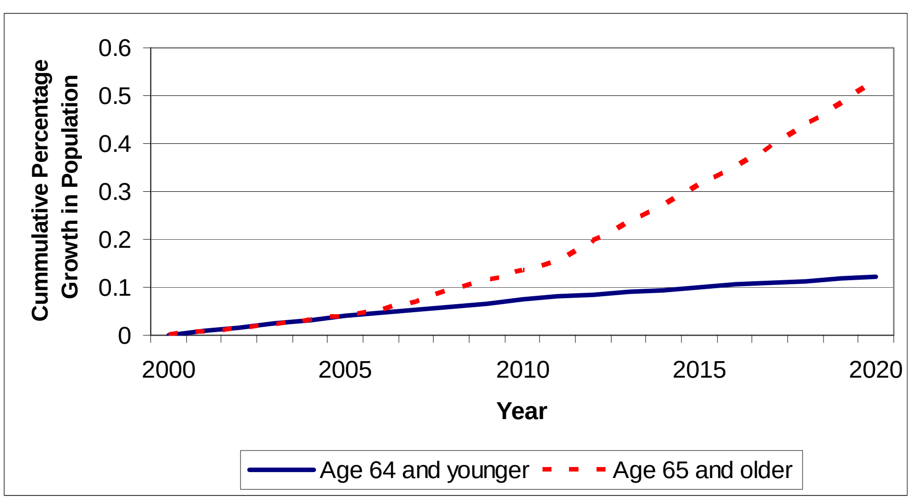


III. Nursing Demand Model

The NDM projects state-level demand for FTE RNs, LPNs and vocational nurses, and nurse aides/auxiliaries and home health aides (NA) through 2020. Moreover, the NDM projects demand for RNs, the focus of this paper, in 12 employment settings. Nurse demand is defined as the number of FTE RNs whom employers are willing to hire given population needs, economic considerations, the healthcare operating environment, and other factors.

Changing demographics constitute a key determinant of projected demand for FTE RNs in the baseline scenario. The U.S. Census Bureau projects a rapid increase in the elderly population starting around 2010 when the leading edge of the baby boom generation approaches age 65 (Exhibit 15). Because the elderly have much greater per capita healthcare needs compared with the non-elderly, the rapid growth in demand for nursing services is especially pronounced for long-term care settings that predominantly provide care to the elderly.

Exhibit 15. Population Growth, 2000 to 2020

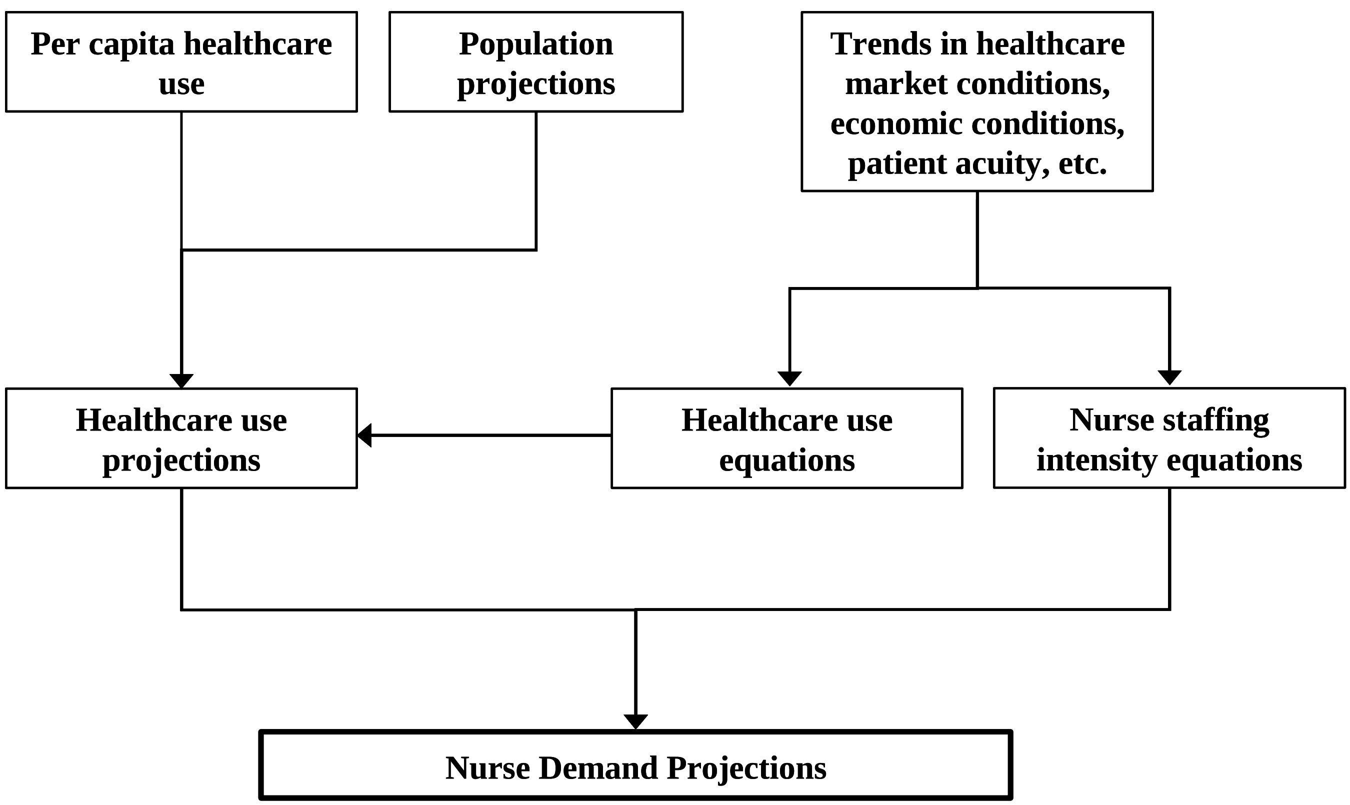


In addition to state-level U.S. Census Bureau projections of changing demographics, the NDM projects nurse demand as a function of changing patient acuity, economic factors, and various characteristics of the healthcare operating environment.

The NDM (Exhibit 16), which combines input databases and projection equations to project demand, contains two major components: (1) the data and equations to project future demand for healthcare services and (2) the data and equations to project future nurse staffing intensity. It first extrapolates expected use of healthcare services by combining national healthcare use patterns and state population projections by age and gender. Then, the model adjusts the healthcare use extrapolations for each state to account for factors that cause healthcare use to deviate from expected levels (e.g., state-level variation in managed care enrollment rates).

The model next projects nurse staffing intensity (e.g., FTE RNs per hospital inpatient days) as a function of current staffing intensity and trends in major determinants of nurse staffing intensity (e.g., average patient acuity). Combining projected healthcare use (e.g., inpatient days) with projected nurse staffing intensity (e.g., FTE RNs per inpatient day) produces projections of demand for FTE RNs by setting, state, and year. We describe the data, assumptions, and methods used to estimate demand for healthcare services and nurse staffing intensity, and we present our findings. A more complete description of the NDM is available in other reports.[5]

Exhibit 16. Overview of the Nursing Demand Model



[5] *NDM Development and Baseline Projections* (NCHWA, forthcoming), *NDM User's Guide* (NCHWA, forthcoming), and *The Nursing Demand–Based Requirements Forecasting Model* (Fritz, 1999).

A. Modeling Demand for Healthcare Services

The demand for nurses derives from the demand for healthcare services. To accurately project the demand for nurses, therefore, one must first project the demand for healthcare services. The NDM projects demand for healthcare services for half of the 12 employment settings in the NDM (Exhibit 17). (For five settings, demand for RNs is projected using RN-per-population ratios. Demand for nurse educators is projected assuming that nurse educators remain a fixed proportion of total RN demand in each state). Measures of demand for NDM-projected healthcare services include inpatient days, outpatient visits, and emergency visits to short-term hospitals; inpatient days at long-term hospitals (e.g., psychiatric, rehabilitation, and all other hospitals); nursing facility residents; and home health visits.

Exhibit 17. Overview of the Nursing Demand Model

Setting	Healthcare Use Measure Projected	Staffing Intensity Measure Projected
Short-term hospitals:		
Inpatient	Inpatient days	FTE RNs/1,000 inpatient days
Outpatient	Outpatient visits	FTE RNs/1,000 outpatient visits
Emergency	Emergency visits	FTE RNs/1,000 emergency visits
Long-term hospitals	Inpatient days	FTE RNs/1,000 inpatient days
Nursing facilities	Residents	FTE RNs/resident
Physician offices	NA	FTE RNs/10,000 population
Home health	Home health visits	FTE RNs/1,000 home health visits
Occupational health	NA	FTE RNs/10,000 population ages 18–64
School health	NA	FTE RNs/10,000 population ages 5–17
Public health	NA	FTE RNs/10,000 population
Nurse education	NA	FTE RN educators/total FTE RNs
Other healthcare	NA	FTE RNs/10,000 population

The NDM employs a two-step process to make state-level projections of demand for healthcare services for each of the six settings modeled. Step 1 applies national per capita use rates for 32 population subgroups to U.S. Census Bureau population projections for each state and year.[6] The 32 population subgroups are defined by eight age categories (ages 0–4, 5–17, 18–24, 25–44, 45–64, 65–74, 75–84, and 85 and older), gender, and metropolitan or non-metropolitan location.

Multiplying each per capita use rate by its respective state-level population projection creates a state-level extrapolation of the *expected* demand for healthcare services that controls for differences across states and over time in demographics. (Step 2 adjusts these extrapolations based on trends in the healthcare operating system and other factors.)

The following equation describes this step, where $\mathbf{EU_{S,H,Y}}$ is the expected level of healthcare use in state **S** in healthcare setting **H** in year **Y**. The variables **P** and **R** are, respectively, the size of the population in state **S** and the national per capita healthcare use for each age category (**a**), by gender (**s**) and by metropolitan or nonmetropolitan location (**l**). The first component of this equation is a calibration factor to ensure that base year estimates of *expected* healthcare use equal estimates of *actual* use.[7]

[6] To estimate per capita use of healthcare services, we use the 1996 Health Cost Utilization Project (HCUP) database for hospital inpatient services, 1996 National Hospital Ambulatory Care Survey (NHAMCS) for hospital outpatient and emergency services, 1997 National Nursing Home Survey (NNHS) for nursing facilities, and 1995 National Home and Hospice Care Survey (NHHCS) for home health. See Section 0 for a discussion of the choice of 1996 as the base year.

[7] Estimates of actual use of healthcare services come from multiple sources. The American Hospital Association (AHA) provides state-level estimates of inpatient days, outpatient visits, and emergency visits. The American Health Care Association (AHCA) provides state-level estimates of residents in nursing facilities. State-level estimates of home health visits were constructed using data from the Centers for Medicaid and Medicare Services (CMS) and other sources.

$$EU_{S,H,Y} = \left(\frac{AU_{S,H,1996}}{\sum_{l=urban}^{rural} \sum_{s=female}^{male} \sum_{a=1}^{8} P_{a,s,l,S,1996} \times R_{a,s,l,H}} \right) \times \left(\sum_{l=urban}^{rural} \sum_{s=female}^{male} \sum_{a=1}^{8} P_{a,s,l,S,Y} \times R_{a,s,l,H} \right)$$

Step 2 adjusts up or down these initial extrapolations of healthcare use in each state and year based on projected changes in the healthcare operating environment, economic considerations, and other factors. The use adjustment factor differs by state, year, and setting and is calculated using projection equations whose parameters describe the relationship between healthcare use and exogenous variables.

$$\begin{aligned} Projected\ \ Utilization &= EU_{S,H,Y} \times Adjustment_{S,H,Y} \\ &= EU_{S,H,Y} \times (\beta_0 + \beta_1 \times X_1 + ... + \beta_k \times X_k) \end{aligned}$$

We estimated the parameters in the projection equations (βs) (Exhibit 18) using multiple regression analysis and a panel data set consisting of state-level data for the period 1996 to 2000. The dependent variable in the regression equations, measures the degree to which actual use (AU) of healthcare services deviate from expected use (EU) in a given state and setting during the period included in the regression analysis as described in Step 1.

$$Adjustment_{S,H,Y} = \left(\frac{AU}{EU} \right)_{S,H,Y}$$

The actual regression equations contain the logged form of the dependent and many of the exogenous variables. Taking the logged form of these variables has two major advantages over the unlogged form. One, using a logged form ensures that the model will not project a negative value of the dependent variable. Two, the coefficients of logged exogenous variables can be interpreted as elasticities that represent the percentage change in the dependent variable for each 1% change in the exogenous variables (holding constant the other variables in the model). Having the coefficients in a common metric (e.g., elasticities) allows easier comparison of the magnitude and precision of coefficients between variables, across regression equations, and with empirical findings in the literature. The health maintenance organization (HMO) variable and the region dummy variables are the only variables not in log form.

Selection of the exogenous variables employed in the healthcare use regressions, as well as those employed in the staffing intensity regressions, was based on both theory and empirical analysis. We considered three criteria when determining which variables to include in the regression equations.

(1) **Theory-based model specification**. A logical relationship should exist between the exogenous variable and the dependent variable. That is, there should be a priori expectations of the direction of the relationship between the exogenous variable and the dependent variable based on theory and prior empirical evidence.

(2) **Identification of major determinants**. We used stepwise regression to identify factors that exert a statistically significant effect on either demand for healthcare services or nurse staffing intensity. Stepwise regression considers the pool of potential exogenous variables—the pool consisted of only exogenous variables that logically would affect the dependent variable—and adds or subtracts variables based on the predictive power of each variable. One result of using this approach is that nearly all the exogenous variables in the final regression equations are statistically significant. Unfortunately, another result of using stepwise regression is that the statistical significance of the regression equations and the predictive power of the equation are overstated.

(3) **Reliable extrapolations of future values**. We considered for inclusion in the final regression equations only variables whose future values can be extrapolated with some degree of reliability or that are important for policy modeling.

Several factors complicated the selection of exogenous variables in the regressions. First, in a few cases an exogenous variable is not statistically significant, though the factor that this variable reflects is presumed essential for developing a dynamic model (e.g., the HMO variable in the equation to estimate RN staffing patterns in hospital inpatient settings). We had to determine whether to include these variables with low statistical significance. In a few cases, variables deemed important that had a level of statistical significance between 0.05 and 0.2 were included in the final regressions. The coefficients on these variables are unbiased, despite the lack of precision. We closely scrutinized these coefficients and compared them with other findings from this analysis and from the literature to help ensure their reasonableness.

A second complication is that some of the exogenous variables that theory suggests are determinants of the dependent variable—and thus should be considered for inclusion in the equation—are correlated. For example, HMO enrollment rate is correlated with population density, and both HMO enrollment rates and population density might affect healthcare use and staffing intensity. (An example of how population density might affect nurse-staffing patterns is that healthcare providers in metropolitan areas might benefit from economies of scale that rural areas might not realize.) Multicollinearity among the exogenous variables means that their independent effects might not be precisely estimated even though the estimated effects are unbiased. Also, the stepwise regression approach might result in one variable forcing a correlated variable from the equation. Preliminary regressions were estimated to test the robustness of the regressions with respect to the inclusion or exclusion of correlated variables, and the results helped determine which variables to include or exclude from the final regression specifications.

A third complicating factor is that some regressions contain data from multiple years, and observations from the same state are not completely independent, meaning some heteroskedasticity occurs in the data. Heteroskedasticity can result in underestimates of the coefficient standard errors, which in turn overstates the statistical significance of the coefficients.[8]

The dependent and exogenous variables in the equations are estimates based on hospital census data and surveys of patients and healthcare providers. The concern that estimates for smaller states are less precise than estimates for larger states led to the decision to weight each observation in the regression by the square root of the state's population.

Multiple regression analysis provides estimates of the relationship between healthcare use and its determinants. Note that the regressions predict the relationship between healthcare use and its determinants *after* adjusting for differences in the demographic composition by age category, gender, and urban or rural location.

Consistent with other studies, this analysis finds that HMOs decrease the number of inpatient days at short-term hospitals (Exhibit 18). The number of emergency department visits and nursing facility residents also decline as HMO enrollment rates rise. The baseline scenario assumes a 0.5 percentage point increase annually in enrollment rates, which equates to a 10 percentage point increase between 2000 and 2020.[9] Consequently, the NDM projects that, in 2020, inpatient days at short-term hospitals will decline by 3%, emergency department visits will decline by 2.8%, and the number of nursing facility residents will decline by 3.6% relative to the levels that would exist if no change in HMO enrollment rates occurred. State-level estimates of HMO enrollment rates for 1996 through 2000 come from the Interstudy Competitive Edge.

As improvements in technology and cost pressures shift more surgeries from an inpatient to an outpatient setting, the number of inpatient days at short-term hospitals will fall and the number of outpatient visits and home health visits is expected to rise. The baseline scenario assumes that per capita inpatient surgeries will decline by 2% annually from 2000 to 2020 and that these surgeries will instead be performed on an outpatient basis. For every 1% increase in the proportion of hospital-based surgeries performed on an outpatient basis, the regression findings suggest that inpatient days will decline by 0.47%, outpatient visits will increase by 1.66%, and home health visits will increase by 0.86%. State-level estimates of the proportion of hospital surgeries performed on an outpatient basis were obtained from American Hospital Association (AHA) annual *Hospital Statistics* publications.

An increase in the percentage of population uninsured decreases demand for healthcare services in long-term hospitals and nursing facilities. The baseline scenario assumes a modest decline in the percentage of population uninsured due to changing demographics. The variable was primarily included to increase the NDM's policy analysis capabilities. A 1% increase in the proportion of the population that is uninsured decreases inpatient days at long-term hospitals by

[8] Preliminary analyses to control for heteroskedasticity included the estimation of "difference-in-differences" models, using regression analysis, to control for state fixed effects. In these regressions, both the dependent and exogenous variables are transformed so the estimate for each state in a particular year is that year's deviation from the state's multiyear average. One important limitation of the difference-in-differences approach is that it eliminates cross-state variation in the dependent and exogenous variables, which is an important source of information for estimating the relationship between healthcare use and its determinants. For example, HMO enrollment rates vary substantially across states, but in a given state might change little over the few years included in the regression analysis. Many of the exogenous variables that were statistically significant in the difference-in-differences models are the same variables used in the NDM's final projection equations.

[9] The HMO variable (and assessment trend) is included as a proxy for factors that make clinicians and consumers more cost-conscious, whether that be through the application of managed care principles or out-of-pocket costs such as co-pay and deductibles.

0.38% and decreases nursing facility residents by 0.16%.

The percentage of population enrolled in Medicaid is positively correlated with higher use of healthcare services in five settings. Given that Medicaid enrollment is generally associated with higher need for healthcare services, access to medical services, and lower income (which some studies have found to be correlated with greater healthcare needs), this positive relationship is not surprising. The baseline scenario assumes a modest change in the percentage of population enrolled in Medicaid due to changing demographics. A 1% increase in the proportion of the population enrolled in Medicaid increases demand for inpatient days, outpatient visits, and emergency department visits at short-term hospitals by 0.26%, 0.17%, and 0.29%, respectively; increases demand for inpatient days at long-term hospitals by 0.26%; and increases demand for home health services by 0.34%.

An increase in the proportion of the population that is non-white is associated with a slight increase in the use of short-term hospital outpatient services and long-term hospital inpatient days. An increase in the proportion of the population that is Hispanic is associated with a slight decrease in emergency department visits. These demographic variables might be capturing differences across racial and ethnic groups in healthcare needs, behavior that affects healthcare use, or access to care via insurance and local availability of services.

Population density, as measured by percentage of population living in an urban area, is negatively correlated with use of inpatient services at short-term hospitals and nursing facilities. The reader will recall that the approach already controls for urban or rural location of the states' population before estimating the regressions. Consequently, these findings are difficult to interpret. Population density is also correlated with HMO enrollment rates. When the population density variable is omitted from the short-term hospital inpatient day and nursing facility regressions, the coefficients on the HMO variable grow more negative.

The inclusion of regional dummy variables in the regressions improves the overall fit of many of the equations and helps estimate more precisely the relationship between the dependent and exogenous variables in the model. Over time, the values of these dummy variables remain constant. After controlling for differences in demographics and the exogenous variables in the model, the regressions show significant regional variation in demand for healthcare services.

Exhibit 18. Healthcare Use Regression Results

	Short-Term Hospitals			**Long-Term/ Psych/Other Hospital Inpatient Days**	**Nursing Facility Residents**	**Home Health Visits**
	Inpatient Days	**Outpatient Visits**	**Emergency Department Visits**			
Intercept	0.30[a,] (0.127)	1.39 (0.162)	0.50 (0.080)	0.24 (0.173)	-4.62 (1.151)	0.85 (0.267)
Healthcare Operating Environment						
Percentage of population in an HMO	-0.30 (0.105)		-0.28 (0.075)		-0.36 (0.138)	
Percentage of hospital-based surgeries performed in an outpatient setting	-0.47 (0.143)	1.66 (0.206)				0.86 (0.345)
Economic Conditions						
Percentage of population uninsured				-0.38 (0.069)	-0.16 (0.051)	
Percentage of population Medicaid eligible	0.26 (0.040)	0.17 (0.054)	0.29 (0.032)	0.26 (0.073)		0.34 (0.098)
Per capita personal income					0.40 (0.116)	
Demographics						
Percent of population non-white		0.06 (0.023)		0.27 (0.029)		
Percentage of population Hispanic			-0.05 (0.008)			

Exhibit 18. Healthcare Use Regression Results (continued)

	Short-Term Hospitals			Long-Term/ Psych/Other Hospital Inpatient Days	Nursing Facility Residents	Home Health Visits
	Inpatient Days	Outpatient Visits	Emergency Department Visits			
Geographic Location						
Percentage of population in urban area	-0.25 (0.062)				-0.17 (0.089)	
East-North-Central Region				-0.35 (0.054)		
East-South-Central Region	0.09 (0.038)	-0.25 (0.054)				0.58 (0.095)
Mid-Atlantic Region	0.24 (0.031)	0.15 (0.045)			0.35 (0.051)	0.26 (0.077)
Pacific Region	-0.35 (0.033)		-0.17 (0.028)	-0.54 (0.057)		-0.56 (0.079)
New England Region	-0.19 (0.034)		0.10 (0.030)	0.30 (0.072)	0.45 (0.055)	0.79 (0.085)
South-Atlantic Region		-0.26 (0.038)				
West-North-Central Region			-0.16 (0.027)			
West-South-Central Region		-0.17 (0.047)				0.83 (0.080)
Mountain Region	-0.27 (0.031)					
Central Regions					0.39 (0.032)	
R-Squared	0.7659	0.4679	0.6299	0.5559	0.6061	0.7125
Years Included in Regression	1996–1999	1996–1999	1996–1999	1996–1999	1996–2000	1996–1998

[a] Regression coefficients with standard errors in parentheses.
Note: The projection method already controlled for population age, gender, and urban or rural location distribution before estimating the regression equations. Also, the use of stepwise regression to determine which exogenous variables to include inflates the statistical significance of the results.

Modeling Nurse Staffing Intensity

Nurse staffing intensity is defined as the number of FTE RNs divided by some measure of workload specific to the setting being modeled (e.g., FTE RNs per 1,000 inpatient days at short-term hospitals). The NDM calculates base year values of nurse staffing intensity for each state and setting by dividing estimates of RN employment by estimates of healthcare use. Thus, in nursing facilities, base year estimates of employed FTE RNs per resident are used as the staffing intensity measures.

We use 1996 as the base year for several reasons. First, the importance of the SSRN in estimating base-year RN supply and demand limits the base year to a year in which the SSRN was conducted (e.g., 1992, 1996, 2000). Second, indications that the nurse shortage has grown more severe in recent years suggests that an earlier year (e.g., 1996 versus 2000) might produce nurse staffing intensity estimates that reflect a market where a relative equilibrium existed between nurse supply and demand. We make one exception to the argument that nurse employment in a setting is the best measure of nurse requirements. In hospitals, we estimate that RN demand was approximately 7% higher than RN employment in 1996. The lower-thandemanded number of RNs employed in hospitals reflects the rapid and significant changes taking place in the hospital sector during the early and middle 1990s when hospitals were downsizing in response to the rapid rise in managed care and hospital consolidations. We arrive at this 7% estimate by comparing RN staffing intensity in hospitals using SSRN and AHA data for 1992, 1996, and 2000.

After establishing base year nurse staffing intensity, the NDM then projects future nurse staffing intensity. For four employment settings, nurse staffing intensity is measured as a nurse-to-population ratio (because of data limitations) that is assumed constant over time. Demand for nurse educators is calculated as a constant fraction of total demand for RNs. For 7 of the 12 employment settings modeled, future nurse staffing intensity is projected as a function of changes in exogenous variables (X) such as average patient acuity levels, economic considerations, and characteristics of the healthcare operating environment. The projection formula is specified as

$$\frac{\text{FTE RNs}_{\text{S,H,Y}}}{\text{Workload Measure}_{\text{S,H,Y}}} = \delta_{S,H}\left(\beta_0 + \beta_1 \times X_1 + \ldots + \beta_k \times X_k\right)$$

where the parameters β represent the estimated relationship between nurse staffing intensity and its determinants and δ is an adjustment factor so the base year projections equal actual nurse staffing intensity in the base year. We estimated the parameters using multiple regression analysis with state-level data from 1996 through 2000 (although most regression equations were estimated using a subset of these years based on data availability).

Both theory and empirical analysis helped determine the exogenous variables to employ in the projection equations. As with the healthcare use regressions, the dependent variable and most of the exogenous variables enter into the regression equation in a log form. Also, we estimated the equations using a stepwise regression that results in a parsimonious model but that overstates the significance statistics often used to assess how robust the regression findings are.

1. Nurse Wages

The ratio of RN to LPN wages is used to estimate the degree to which employers substitute lower-cost LPNs for higher-cost RNs as RN wages rise relative to LPN wages.[10] In the baseline projections, we assume that this ratio stays constant over time. The regressions do not simultaneously control for nursing supply, which could bias the wage elasticities (ε) towards zero. The size of the estimated elasticities, however, appears reasonable based on a priori expectations and a comparison with the literature. Demand for RNs is less responsive to changing relative wages in physicians' offices (ε=-0.64) and inpatient settings at short-term hospitals (ε=-0.65) compared with home health (ε=-1.06) and long-term hospitals (ε=-1.20).

The wages elasticity estimates from this analysis are comparable to the few studies in recent literature that report wage elasticities. Lane and Gohmann (1995), in their analysis of nurse shortages, estimate the wage elasticity of nurse demand by simultaneously estimating a supply and demand equation.[11] The authors combine both RNs and LPNs in their analyses. They estimate nurse own-wage elasticity in short-term hospitals to be approximately -0.9.

Spetz (1999) estimates a demand equation for RNs using hospital-level data for short-term, general hospitals in California during the period 1976 to 1994. To control for the endogeneity of nurse wages, Spetz uses an instrumental variables approach to estimate the RN demand curve, which she compares to a demand curve estimated using the ordinary least squares (OLS) regression. As expected, her estimate of wage elasticity from the OLS regression (ε=-0.194) is less elastic than the estimate obtained using the instrumental variables approach (ε=-2.778) when she models the daily services units of California hospitals. Similarly, when she estimates demand equations for the medical-surgical units of California hospitals, the wage elasticity estimates are less elastic from the OLS regression (ε=-0.342) than from the instrumental variables regression (ε=-3.653). Spetz also finds that an increase in LPN wages is associated with a statistically significant rise in RN employment in daily services units of hospitals, but the converse is untrue.

As discussed previously in the context of RN supply, the short-term wage demand elasticities are typically smaller than long-term wage elasticities. In the short term, employers might have few options to replace RNs

[10] The ability of healthcare providers to substitute lower-cost nurses for higher-cost nurses is more than simply an economic phenomenon; rather, it also reflects legal and quality considerations. RNs receive special training that enables them to provide certain services that LPNs cannot provide. Thus, in only a limited range could substitution be made without jeopardizing healthcare delivery quality.

[11] Lane and Gohmann estimate nurse supply and demand simultaneously using two approaches: (1) a two-stage least squares model and (2) a "switching" model that relaxes the assumption that the market for hospital nurses is in equilibrium. The authors report an own-wage elasticity of demand of -1.14 when using the two-stage least squares model, but they believe the estimate of -0.92 from the switching model to be more accurate.

as they become relatively more expensive. In the long term, employers can change nurse staffing practices and adopt new technologies that alter how RNs are used.

2. HMO Enrollment Rates

An increase in HMO enrollment rates produces mixed effects on staffing intensity. The HMO variables in the regressions are not logged, so the interpretation of the coefficients is different from the other variables. An increase in the HMO enrollment rate by one percentage point increases RN staffing intensity in short-term hospital inpatient, short-term hospital outpatient, and home health by 0.30%, 0.67%, and 0.97%, respectively. An increase in the HMO enrollment rate by one percentage point decreases RN staffing intensity in physician offices by 0.51%.

HMO enrollment rates affect nurse-staffing patterns for two possible reasons. One, HMOs decrease inpatient days in short-term hospitals through efforts at preventive care and efforts to channel patients with less-severe problems to less-expensive settings. This reduction in inpatient days might be raising the average acuity level of patients admitted to the hospital, which results in higher RN staffing per 1,000 inpatient days. Two, the efforts of HMOs to reduce costs could contribute to their adopting technologies or substituting between different types of healthcare professionals. As discussed previously, HMO enrollment rates are correlated with other variables such as percentage of population in urban area. Consequently, the coefficient on the HMO enrollment rate variable could be capturing some of the relationship between staffing intensity and other factors correlated with HMO enrollment rates. In both regressions where HMO enrollment rate affects staffing intensity, the variable percentage of population in urban area is also included.

3. Hospital Inpatient and Outpatient Surgeries

Changes in technology can exert a mixed effect on the demand for healthcare services and staffing intensity. One measure used in the NDM that reflects, in part, technological advances is the percentage of hospital-based surgical procedures performed on an outpatient basis. Improvements in technology and medical procedures that shift some surgical procedures from an inpatient to an outpatient setting could affect nurse-staffing intensity in both inpatient and outpatient settings. If patients with less-severe health problems are shifted from an inpatient to an outpatient setting, then average patient acuity in both settings could rise. This situation could result in greater staffing intensity per inpatient day and per outpatient visit while decreasing overall nurse demand. Each 1% increase in the proportion of hospital surgeries performed in an outpatient setting increases staffing intensity for FTE RNs per 1,000 short-term hospital inpatient days by 0.64%. As discussed previously, a 1% increase in the proportion of hospital-based surgeries performed on an outpatient basis reduces short-term hospital inpatient days by 0.47%, increases outpatient visits by 1.64%, and increases home health visits by 1.86%. Surprisingly, a 1% increase in this surgery variable causes virtually no change in overall demand for RNs—it just shifts where the RNs are providing services.

4. Healthcare Reimbursement Rates

A rise in average Medicare and Medicaid payments for services is associated with greater staffing intensity. Part of this increase might be due to greater patient acuity, and part might be due to the ability of healthcare providers to purchase nursing services. A 1% increase in average Medicare payments per home health visit increases demand for RNs by 1%. A 1% increase in average Medicaid daily rates for nursing facilities increases staffing intensity of RNs in nursing facilities by 0.34%.

5. Percentage of Population Uninsured

The rate of uninsured in the population could increase the level of uncompensated care provided by healthcare providers. A 1% increase in the proportion of the population that is uninsured decreases RNs per 1,000 short-term hospital inpatient days by 0.37% and decreases RNs per 1,000 visits to physician offices by 0.21%. RN per 1,000 inpatient days in long-term hospitals rises by 0.3% for each 1% increase in the rate of uninsured, although the reason for this positive relationship is not readily surmised.

6. Percentage of Population Medicaid Eligible

A 1% rise in the proportion of population that is Medicaid eligible decreases RN staffing per 1,000 emergency department visits by 0.19%. As discussed in the previous section, a 1% rise in percentage of population that is Medicaid eligible increases demand for emergency department services by 0.29%, so the net effect of a 1% rise in this variable is to increase demand for RNs in emergency departments by 0.05%.

7. Per Capita Personal Income

As the population grows wealthier, the demand for higher-quality healthcare services likely will rise. A 1% rise in per capita income increases RN staffing intensity in physician offices by 0.33%.

8. *Patient Acuity Levels*

A population with greater healthcare needs requires greater levels of services as measured by both the quantity of services provided and staffing intensity per unit of service provided. The NDM contains two measures that are proxies of population health status: (1) population mean age and (2) average number of activities of daily living (ADL) limitations of nursing facility residents. (In addition, the Medicare and Medicaid reimbursement rate variables discussed previously might also be capturing variation in average patient acuity across states and over time.) A 1% increase in population mean age increases RN staffing intensity in physician offices by 1.52%. A 1% increase in average number of ADL limitations of nursing facility residents increases demand for RNs per nursing facility resident by 0.63%.

9. *Geographic Location*

The percentage of population living in urban areas exerts a mixed impact on nurse staffing intensity. A 1% increase in this variable decreases RN staffing per 1,000 inpatient days at long-term hospitals by 0.60%. In short-term hospitals, a 1% increase in this variable increases RN staffing intensity in inpatient settings and outpatient settings by 0.16% and 0.39%, respectively. As discussed previously, this variable is correlated with HMO enrollment rates; consequently, the precise relationship among HMO enrollment rate, percentage of population living in urban areas, and nurse staffing intensity is unclear. Significant regional variation occurs in nurse staffing intensity, but few visible patterns emerge in the findings (Exhibit 19). Changes in staffing intensity will vary by state depending on the projected values for exogenous variables and changing demographics.

Between 2000 and 2020, staffing intensity is projected to increase 34% in home health, from approximately 2.8 FTE RNs per 1,000 home health visits to approximately 3.8 FTE RNs per 1,000 visits (Exhibit 20). In short-term hospital inpatient settings, FTE RNs per 1,000 inpatient days is projected to increase by 18% at the national level (from 6.5 to 7.7). For nursing facilities and physician offices, we project a 13% increase in staffing intensity, while for short-term hospital outpatient settings we project a 6% increase in staffing intensity. In short-term hospital emergency settings and in long-term hospitals, we project virtually no change in staffing intensity. The staffing intensity measures for RNs in occupational health, school health, public health, nurse education, and "other" healthcare settings is assumed constant over time at their 1996 levels. To fully comprehend the magnitude of additional FTE RNs required, the overall impact of staffing intensity must be considered in conjunction with healthcare use projections.

Exhibit 19. Nurse Staffing Intensity Regressions

	Short-Term Hospitals			Long-Term Hospitals	Nursing Facilities	Home Health	Physician Offices
	Inpatient	**Outpatient**	**ED**				
Intercept	1.62[a] (0.247)	-1.7 (0.122)	-0.53 (0.177)	2.69 (0.462)	-5.15 (0.922)	-5.16 (0.787)	-7.13 (3.593)
Healthcare Operating Environment							
Ratio of RN to LPN hourly wage	-0.65 (0.258)			-1.20 (0.671)		-1.06 (0.537)	-0.64 (0.391)
Percentage of population in an HMO (variable not logged)	0.30 (0.202)	0.67 (0.389)				0.97 (0.316)	-0.51 (0.230)
Percentage of hospital surgeries performed in outpatient setting	0.64 (0.255)						
Average Medicare payment per home health visit						1.00 (0.198)	
Average Medicaid NF daily rate					0.34 (0.153)		

Exhibit 19. Nurse Staffing Intensity Regressions (continued)

	Short-Term Hospitals			Long-Term Hospitals	Nursing Facilities	Home Health	Physician Offices
	Inpatient	**Outpatient**	**ED**				
Economic Conditions							
Percentage of population uninsured	-0.37 (0.069)			0.30 (0.147)			-0.21 (0.091)
Percentage of population Medicaid eligible			-0.19 (0.091)		-0.19 (0.103)		
Per capita personal income							0.33 (0.202)
Population Health/Patient Acuity							
Population mean age							1.52 (0.761)
Average number of ADL limitations of nursing facility residents					0.63 (0.444)		
Geographic Location							
Percentage of population in urban area	0.16 (0.114)	0.39 (0.201)		-0.60 (0.206)			
East-South-Central region	-0.11 (0.066)				-0.5 (0.098)	-0.22 (0.139)	
East-North-Central region	-0.23 (0.054)						
Mid-Atlantic region	-0.34 (0.057)		0.15 (0.077)	-0.43 (0.138)		0.23 (0.119)	
South-Atlantic region					-0.24 (0.067)		
New England region				-0.41 (0.166)			
West-South-Central region		-0.19 (0.111)			-0.91 (0.091)	-0.62 (0.123)	
Western regions	0.20 (0.045)	-0.40 (0.076)		0.26 (0.103)			0.16 (0.072)
Coastal regions		-0.40 (0.076)					
R-squared	**0.7988**	**0.4544**	**0.1365**	**0.5217**	**0.5664**	**0.7121**	**0.3869**
Years included in regression	**1996**	**1996**	**1996**	**1996**	**1996, 1999, 2000**	**1996**	**1996**

[a] Regression coefficients with standard errors in parentheses.

Exhibit 20. National Measures of Projected Nurse Staffing Intensity

		Baseline	Projected					
Setting	**Staffing Intensity Measure**	**1996**	**2000**	**2005**	**2010**	**2015**	**2020**	**Increase from 2000–2020**
Short-term hospitals:								
Inpatient	FTE RNs/1,000 inpatient days	6.16	6.54	6.81	7.12	7.42	7.69	18%
Outpatient	FTE RNs/1,000 outpatient visits	0.18	0.19	0.19	0.19	0.20	0.20	6%
Emergency	FTE RNs/1,000 emergency visits	0.93	0.94	0.94	0.94	0.95	0.94	0%
Long-term hospitals	FTE RNs/1,000 inpatient days	5.31	5.25	5.28	5.29	5.28	5.27	0%
Nursing facilities	FTE RNs/resident	0.09	0.10	0.10	0.11	0.11	0.11	13%
Physician offices	FTE RNs/10,000 population	5.50	5.51	5.69	5.88	6.04	6.20	13%
Home health	FTE RNs/1,000 home health visits	2.59	2.87	3.08	3.31	3.57	3.84	34%
Occupational health	FTE RNs/10,000 population ages 18–64	Constant at 1996 levels						
School health	FTE RNs/10,000 population ages 5–17	Constant at 1996 levels						
Public health	FTE RNs/10,000 population	Constant at 1996 levels						
Nurse education	FTE RN educators/total FTE RN demand	Constant at 1996 levels						
Other healthcare	FTE RNs/10,000 population	Constant at 1996 levels						

B. Nursing Demand Projections

Below, we present projections from the NDM. We present projections for alternative scenarios that use different assumptions about the trends in the major demand determinants.

1. Baseline Projections

Under the baseline scenario, demand for FTE RNs is projected to increase 41% between 2000 and 2020 at the national level (Exhibit 21). As shown in the appendix, the projected change in demand varies substantially by state. In percentage terms, the fastest growth will occur in settings that predominantly serve the elderly (e.g., home health and nursing facilities) and in hospital outpatient settings.

Exhibit 21. Baseline Projections of Demand for FTE RNs

Setting	2000	2005	2010	2015	2020	Increase from 2000–2020
Total [a]	**2,001,500**	**2,161,300**	**2,347,100**	**2,569,800**	**2,824,900**	**41%**
Hospitals [a]	1,239,500	1,324,800	1,427,900	1,555,600	1,698,900	37%
Short-term hospital, inpatient	874,700	930,200	999,100	1,086,800	1,187,000	36%
Short-term hospital, outpatient	83,500	95,900	110,400	126,400	142,000	70%
Short-term hospital, emergency	90,300	92,200	94,500	97,300	100,400	11%
Long-term hospitals	191,000	206,500	223,900	245,100	269,400	41%
Nursing facilities	172,800	197,200	224,500	253,600	287,300	66%
Physician offices	155,000	166,400	178,800	191,600	204,700	32%
Home health	132,000	157,300	187,500	226,200	275,600	109%
Occupational health	20,200	21,000	22,000	23,100	23,900	18%
School health	57,600	59,700	60,400	61,100	62,200	8%
Public health	99,800	103,500	107,300	111,500	115,800	16%
Nurse education	45,900	49,600	53,800	58,800	64,500	41%
Other healthcare	78,500	81,700	84,900	88,400	92,000	17%

[a] Due to rounding, category totals might fail to equal the sum across component settings.

2. Alternative Scenarios

Nurse demand will be determined, in part, by political decisions, changes in technology, changes in the healthcare operating environment, and changes in other factors difficult to predict. In addition, projection models such as the NDM are relatively simplistic simulations of a complex healthcare system that try to capture the major trends affecting demand for nurses, so the RN demand projections are made with some level of imprecision. The degree of imprecision is difficult to determine. A sensitivity analysis shows how the projections change as we change key assumptions in the model. We present projections under four alternative scenarios (Exhibit 22):

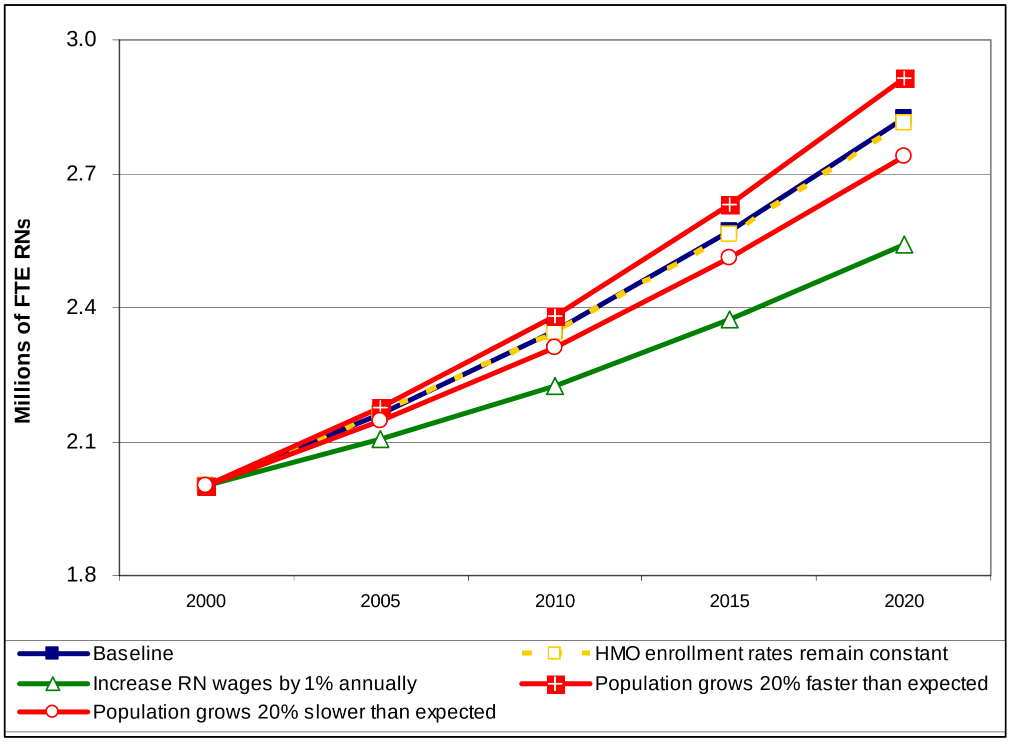
(1) Scenario 1 assumes no changes in managed care enrollment rates (compared to the baseline that assumes an annual 0.5 percentage point increase). At the national level across all settings, this modest change in the growth rate of managed care enrollment has virtually no effect on demand for RNs. However, substantial changes occur at the setting level. Managed care growth simply shifts care from inpatient to outpatient settings, and the decline in projected inpatient days is offset by a likely increase in staffing intensity as the average level of patient acuity increases.

(2) Scenario 2 assumes that RN wages increase 1% annually compared to LPN wages. (The baseline assumes that RN and LPN wages grow at the same rate.) Under this scenario, a rise in RN wages gives employers greater financial incentive to substitute lower-cost LPNs for higher-cost RNs, where possible. Between 2000 and 2020, the compounding effect of a 1% annual growth in relative wages for RNs results in a real increase of 22% relative to wages of LPNs. By 2020, demand for FTE RNs would be approximately 10% lower (or 285,000 FTE RNs) relative to the baseline.

(3) Scenario 3 assumes that the U.S. population grows 20% faster than projected by the U.S. Census Bureau. By 2020, this accelerated growth results in demand for 88,000 additional FTE RNs (or 3%) relative to the baseline.

(4) Scenario 4 assumes that the U.S. population grows 20% slower than projected by the U.S. Census Bureau. By 2020, this decelerated growth results in the demand for 85,000 fewer FTE RNs (or 3%) relative to the baseline.

Exhibit 22. Projected Demand for FTE RNs under Alternative Scenarios



IV. Assessing the Adequacy of Future Supply

Comparing the baseline supply and demand projections suggests that the U.S. had a shortage of approximately 168,000 FTE RNs in 2003, implying that the current supply would have to increase by 9% to meet estimated demand. By 2020 the national shortage is projected to increase to more than 1 million FTE RNs (Exhibit 23), if current trends continue, suggesting that only 64% of projected demand will be met (Exhibit 24).

The supply and demand projections most likely bound the range of the actual number of FTE RNs who will be employed over the projection horizon. As the nursing shortage becomes more severe, market and political forces will create pressures that will increase supply, decrease demand, or both.

As illustrated in the appendix, state-level shortages will vary substantially over time and across states. As the nurse shortage in any particular state becomes too severe, market forces will create financial incentives for nurses to migrate to states with more severe shortages.

> ***"Labor shortages are sometimes characterized by a tendency to define a shortage in terms that are independent of demand. According to our definition a shortage exists if, at the prevailing wage rate for a given occupation, demand exceeds supply. Frequently, however, actual demand is ignored and a shortage is defined with reference to what someone thinks society 'needs.'"***
>
> ***Ronald Ehrenberg and Robert Smith***

Exhibit 23. Projected U.S. FTE RN Shortages, 2000 to 2020

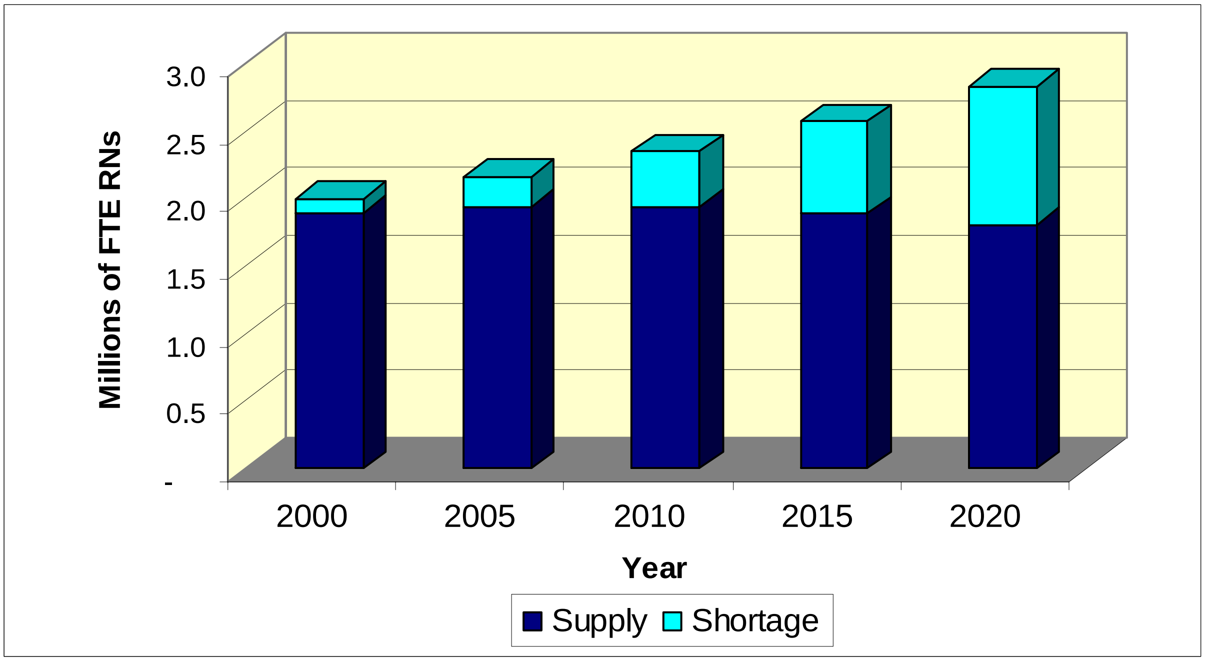


Exhibit 24. Projected U.S. FTE RN Supply, Demand, and Shortages

	2000	2005	2010	2015	2020
Supply	1,890,700	1,942,500	1,941,200	1,886,100	1,808,000
Demand	2,001,500	2,161,300	2,347,000	2,569,800	2,824,900
Shortage	(110,800)	(218,800)	(405,800)	(683,700)	(1,016,900)
Supply ÷ Demand	94%	90%	83%	73%	64%
Demand Shortfall	6%	10%	17%	27%	36%

V. Limitations of the Models and Areas for Future Research

The NSM and NDM are built on a theoretical foundation supported by empirical research. Still, efforts to update and enhance both models faced numerous challenges—many due to data limitations. Below, we describe limitations of the two models and suggest areas for research that could address these limitations. Such research could improve the theoretical underpinnings of the models and improve the precision of key parameters in the model.

The NSM and the NDM are independent models. The NDM makes projections without considering the potential supply of nurses and vice versa. The future nurse workforce, in reality, will be influenced by the combination of supply and demand. A rising demand for nursing services at a time when supply is flat or falling will place upward pressures on nurse wages. This rise in wages would increase the number of new graduates, increase employment participation rates, and delay retirement for some nurses—all actions that will increase supply. Local shortages, on the other hand, could increase nurse wages locally contributing to local increases in the number of nurse graduates and an increase in the number of nurses migrating to that locality. Rising nurse wages will also place downward pressures on demand for nurses.

Both models use the SSRN to estimate the number of RNs employed in the base year. The NSM uses the 2000 SSRN to estimate supply of RNs by age, education level, and state. The NDM uses the 1996 SSRN to estimate number of FTE RNs by setting and state. Because the precision of estimates is proportional to sample size, the RN supply and employment estimates for the base year become less precise the smaller the unit of aggregation. Consequently, the base year starting values and projections for future years are less precise the smaller the unit of analysis. For example, estimates of demand for RNs in a particular setting within a state likely will be less precise than the state-level estimates, which in turn likely will be less precise than the national-level estimates.

One criticism of many attempts to model nurse demand is the limited consideration of important determinants of nursing demand (e.g., see Dumpe, Hermon, and Young [1998] and Prescott [2000]). Projections models such as the NDM and NSM are scaled-down versions of complex systems. Data and resource limitations prevented building models that include a wider array of determinants to better model the complexities of RN supply and demand. Consequently, many determinants of RN supply and demand are excluded from these models. Still, these models attempt to account for the major trends affecting RN supply and demand and project future supply and demand under a set of assumptions that constitutes an educated guess at whether current trends will continue.

Regarding the NDM, we use state-level data to estimate the relationship between demand for RNs and its determinants. One consequence of using state-level data is that relatively few degrees of freedom exist for estimating the regression equations. Future efforts might investigate the use of alternative approaches or lower levels of data aggregation to estimate the relationship between healthcare use and its determinants and between staffing intensity and its determinants.

Additional research could provide estimates of key parameters that improve the accuracy of the models and make the models more flexible policy tools. The NSM, for example, was built with the capacity to model the RN supply implications of changes in nurse wages, working conditions, tuition costs, and number of nursing school faculty. The empirical research has yet to be conducted to estimate the parameters necessary to use these features.

The NSM models only the supply of RNs and, unlike the NDM, fails to consider LPNs and nurse aides. The adequacy of the LPN supply holds implications for both the supply of and demand for RNs. On the demand side, employers have some ability to substitute between RNs and LPNs—taking into consideration legal and practical constraints. On the supply side, some LPNs seek further training to become RNs. Using the 2000 SSRN, we estimate that approximately 9.5% of the RN workforce, or 257,784 RNs, were employed as LPNs before starting their basic nurse education. The RN and LPN workforces are competing for the same candidates, many of whom could become either RNs or LPNs. Consequently, policies designed to recruit more RNs could have the unintended consequence of reducing the LPN supply.

Parts of both models are static. In the NSM, for example, the probability of cross-state migration is based on historical patterns that fail to consider the current shortage of RNs in each state. The NDM has limited ability to model substitution between types of nurses and between nurses and other healthcare workers. The NDM does model substitution between RNs and LPNs if their relative wages change, but future research might look at other ways to incorporate substitution effects. Similarly, the NDM has limited ability to capture the interaction of healthcare settings. For example, some settings might be viable substitutes (e.g., home health versus nursing facilities), while other settings might be complementary (e.g., increased use of outpatient services leading to increased use of home health services).

In summary, the NSM and NDM constitute powerful tools for projecting RN supply and demand under alternative sets of assumptions. The models help quantify the growing shortage of RNs as an aging population increases demand for nursing services at the same time an aging RN workforce and difficulties attracting new entrants to the nursing profession portend relatively little growth in the national RN supply.

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Appendix: State-Level Supply, Demand, and Shortage Projections

Exhibit A-1. Baseline FTE RN Supply, by State and Year, 2000 to 2020

STATE	SSRN Estimate	Projection				Change from 2000–2020
	2000	2005	2010	2015	2020	
AK	4,200	3,800	3,200	2,500	2,000	-52%
AL	29,900	33,700	36,600	38,200	39,100	31%
AR	16,400	18,100	19,300	19,800	19,900	21%
AZ	29,000	30,100	30,700	30,500	30,100	4%
CA	155,500	156,200	153,300	148,200	144,300	-7%
CO	28,100	28,300	27,200	25,100	23,000	-18%
CT	28,000	25,400	22,900	19,900	17,200	-39%
DC	7,300	6,900	6,500	5,900	5,400	-26%
DE	6,100	6,300	6,300	6,100	5,800	-5%
FL	108,100	111,100	112,000	110,200	106,600	-1%
GA	49,400	49,500	48,200	45,300	41,800	-15%
HI	7,200	7,700	7,900	8,100	8,200	14%
IA	25,200	26,300	26,600	26,000	25,000	-1%
ID	7,000	7,300	7,400	7,300	7,100	1%
IL	88,100	88,000	85,600	81,900	77,100	-12%
IN	41,400	41,800	41,600	40,400	38,500	-7%
KS	20,600	21,600	22,100	21,800	21,100	2%
KY	28,800	32,300	34,700	35,500	35,300	23%
LA	30,200	34,100	37,200	39,100	39,800	32%
MA	63,600	62,700	60,100	56,000	51,400	-19%
MD	36,400	36,500	35,600	33,800	31,800	-13%
ME	11,200	11,600	11,600	11,100	10,500	-6%
MI	70,000	72,400	72,000	68,900	66,000	-6%
MN	39,200	41,000	41,800	41,200	39,700	1%
MO	44,400	45,600	45,700	44,200	42,800	-4%
MS	18,400	20,900	22,600	23,600	23,800	29%
MT	6,400	6,500	6,500	6,300	5,900	-8%
NC	59,900	64,500	67,400	68,600	68,000	14%
ND	5,400	5,700	5,800	5,800	5,600	4%
NE	13,300	14,100	14,700	14,900	14,900	12%
NH	9,300	9,500	9,300	8,800	8,100	-13%
NJ	60,400	58,200	55,000	50,500	44,900	-26%
NM	9,600	10,500	11,000	11,300	11,500	20%
NV	9,000	9,300	9,200	8,700	8,100	-10%
NY	138,100	142,600	142,300	137,400	131,500	-5%
OH	86,900	89,300	88,900	85,500	79,700	-8%
OK	18,900	20,600	21,500	22,100	22,500	19%
OR	21,800	22,600	22,400	21,100	19,800	-9%
PA	111,800	105,900	99,200	90,600	80,400	-28%
RI	9,300	9,300	9,000	8,400	7,900	-15%
SC	23,400	25,100	25,900	26,200	26,000	11%
SD	7,000	7,600	7,900	7,900	7,800	11%
TN	40,900	42,700	42,800	41,800	40,100	-2%
TX	107,600	115,300	118,700	119,000	118,500	10%
UT	11,400	12,900	14,100	14,900	15,400	35%
VA	46,300	47,600	47,600	46,300	44,000	-5%
VT	4,900	5,000	4,800	4,400	4,000	-18%
WA	37,900	38,100	37,300	35,100	33,000	-13%
WI	41,300	42,900	43,300	42,200	40,100	-3%
WV	13,200	14,200	14,600	14,600	14,000	6%
WY	3,200	3,300	3,300	3,300	3,300	3%
U.S. [a]	**1,890,700**	**1,942,500**	**1,941,200**	**1,886,100**	**1,808,000**	**-4%**

[a] Due to rounding, national totals might fail to equal the sum across states.

Exhibit A-2. Baseline FTE RN Demand, by State and Year, 2000 to 2020

State	SSRN Estimate	Projection					Change from 2000–2020
	1996	2000	2005	2010	2015	2020	
AK	4,400	4,300	4,900	5,500	6,100	6,700	56%
AL	30,900	31,400	33,900	36,800	40,300	44,400	41%
AR	16,100	18,500	20,200	22,000	24,300	26,900	45%
AZ	28,900	34,000	38,700	43,200	48,500	54,700	61%
CA	159,500	165,500	178,700	200,900	228,900	260,900	58%
CO	27,500	30,000	34,000	38,100	42,500	47,500	58%
CT	28,200	30,200	31,800	34,000	36,600	39,600	31%
DC	8,500	8,800	8,900	9,500	10,200	11,000	25%
DE	5,800	6,400	7,000	7,600	8,100	8,800	38%
FL	107,300	115,500	129,300	144,700	164,300	187,800	63%
GA	48,700	52,800	58,400	64,600	71,600	79,500	51%
HI	8,200	10,000	11,100	12,400	13,900	15,700	57%
IA	24,400	27,100	28,600	30,000	31,800	34,100	26%
ID	6,000	6,200	7,300	8,200	9,200	10,500	69%
IL	88,400	85,200	89,600	94,900	101,300	109,000	28%
IN	40,800	43,000	46,600	49,800	53,500	57,400	33%
KS	19,000	20,200	21,500	23,100	24,900	27,000	34%
KY	26,900	29,200	31,200	33,500	36,300	39,400	35%
LA	30,700	31,800	34,200	37,100	40,600	44,600	40%
MA	59,900	68,300	71,700	76,200	81,700	87,800	29%
MD	38,300	36,800	39,400	42,600	46,100	50,000	36%
ME	11,400	12,400	13,100	14,100	15,300	16,800	35%
MI	69,100	67,700	71,300	75,100	79,600	84,300	25%
MN	35,400	39,200	42,600	46,200	50,400	55,300	41%
MO	45,000	51,600	54,900	58,600	63,100	68,200	32%
MS	18,700	19,900	21,400	23,100	25,400	28,000	41%
MT	5,800	5,500	6,300	7,000	7,800	8,800	60%
NC	54,400	61,500	68,400	75,500	83,700	92,900	51%
ND	5,900	5,800	6,200	6,700	7,300	8,000	38%
NE	13,400	14,800	15,900	17,100	18,500	20,200	36%
NH	9,800	10,500	11,500	12,600	13,800	15,100	44%
NJ	59,700	65,600	69,700	74,600	80,400	87,300	33%
NM	10,200	11,000	12,500	14,100	15,900	18,000	64%
NV	8,800	10,200	12,100	13,300	14,700	16,200	59%
NY	148,100	151,000	156,000	163,800	174,000	185,700	23%
OH	86,400	90,500	95,700	101,000	107,300	113,700	26%
OK	18,400	18,400	20,000	22,000	24,300	27,000	47%
OR	21,100	22,000	24,800	27,700	31,100	35,100	60%
PA	107,100	110,200	115,000	120,300	127,200	135,200	23%
RI	9,300	10,900	11,400	12,000	12,800	13,800	27%
SC	24,200	25,700	28,300	31,100	34,400	38,100	48%
SD	7,000	6,900	7,500	8,100	8,700	9,500	38%
TN	43,100	50,600	55,800	61,300	67,800	75,400	49%
TX	117,000	129,100	143,800	160,600	179,900	202,100	57%
UT	11,000	12,000	13,800	15,600	17,500	19,600	63%
VA	47,800	49,200	53,600	58,600	64,300	70,300	43%
VT	4,300	4,600	5,000	5,400	5,800	6,300	37%
WA	34,400	36,300	40,800	46,100	52,100	59,100	63%
WI	37,200	37,000	39,800	42,800	46,300	50,300	36%
WV	13,500	12,600	13,200	13,900	14,700	15,700	25%
WY	3,500	3,500	4,000	4,500	5,100	5,800	66%
U.S.[a]	**1,889,300**	**2,001,500**	**2,161,300**	**2,347,000**	**2,569,800**	**2,824,900**	**41%**

[a] Due to rounding, national totals might fail to equal the sum across states.

Exhibit A-3. Baseline FTE RN Supply and Demand, 2000 and 2005

State	2000				2005			
	Supply	Demand	Supply - Demand	Supply ÷ Demand	Supply	Demand	Supply - Demand	Supply ÷ Demand
AK	4,200	4,300	-100	98%	3,800	4,900	-1,100	78%
AL	29,900	31,400	-1,500	95%	33,700	33,900	-200	99%
AR	16,400	18,500	-2,100	89%	18,100	20,200	-2,100	90%
AZ	29,000	34,000	-5,000	85%	30,100	38,700	-8,600	78%
CA	155,500	165,500	-10,000	94%	156,200	178,700	-22,500	87%
CO	28,100	30,000	-1,900	94%	28,300	34,000	-5,700	83%
CT	28,000	30,200	-2,200	93%	25,400	31,800	-6,400	80%
DC	7,300	8,800	-1,500	83%	6,900	8,900	-2,000	78%
DE	6,100	6,400	-300	95%	6,300	7,000	-700	90%
FL	108,100	115,500	-7,400	94%	111,100	129,300	-18,200	86%
GA	49,400	52,800	-3,400	94%	49,500	58,400	-8,900	85%
HI	7,200	10,000	-2,800	72%	7,700	11,100	-3,400	69%
IA	25,200	27,100	-1,900	93%	26,300	28,600	-2,300	92%
ID	7,000	6,200	800	113%	7,300	7,300	0	100%
IL	88,100	85,200	2,900	103%	88,000	89,600	-1,600	98%
IN	41,400	43,000	-1,600	96%	41,800	46,600	-4,800	90%
KS	20,600	20,200	400	102%	21,600	21,500	100	100%
KY	28,800	29,200	-400	99%	32,300	31,200	1,100	104%
LA	30,200	31,800	-1,600	95%	34,100	34,200	-100	100%
MA	63,600	68,300	-4,700	93%	62,700	71,700	-9,000	87%
MD	36,400	36,800	-400	99%	36,500	39,400	-2,900	93%
ME	11,200	12,400	-1,200	90%	11,600	13,100	-1,500	89%
MI	70,000	67,700	2,300	103%	72,400	71,300	1,100	102%
MN	39,200	39,200	0	100%	41,000	42,600	-1,600	96%
MO	44,400	51,600	-7,200	86%	45,600	54,900	-9,300	83%
MS	18,400	19,900	-1,500	92%	20,900	21,400	-500	98%
MT	6,400	5,500	900	116%	6,500	6,300	200	103%
NC	59,900	61,500	-1,600	97%	64,500	68,400	-3,900	94%
ND	5,400	5,800	-400	93%	5,700	6,200	-500	92%
NE	13,300	14,800	-1,500	90%	14,100	15,900	-1,800	89%
NH	9,300	10,500	-1,200	89%	9,500	11,500	-2,000	83%
NJ	60,400	65,600	-5,200	92%	58,200	69,700	-11,500	84%
NM	9,600	11,000	-1,400	87%	10,500	12,500	-2,000	84%
NV	9,000	10,200	-1,200	88%	9,300	12,100	-2,800	77%
NY	138,100	151,000	-12,900	91%	142,600	156,000	-13,400	91%
OH	86,900	90,500	-3,600	96%	89,300	95,700	-6,400	93%
OK	18,900	18,400	500	103%	20,600	20,000	600	103%
OR	21,800	22,000	-200	99%	22,600	24,800	-2,200	91%
PA	111,800	110,200	1,600	101%	105,900	115,000	-9,100	92%
RI	9,300	10,900	-1,600	85%	9,300	11,400	-2,100	82%
SC	23,400	25,700	-2,300	91%	25,100	28,300	-3,200	89%
SD	7,000	6,900	100	101%	7,600	7,500	100	101%
TN	40,900	50,600	-9,700	81%	42,700	55,800	-13,100	77%
TX	107,600	129,100	-21,500	83%	115,300	143,800	-28,500	80%
UT	11,400	12,000	-600	95%	12,900	13,800	-900	93%
VA	46,300	49,200	-2,900	94%	47,600	53,600	-6,000	89%
VT	4,900	4,600	300	107%	5,000	5,000	0	100%
WA	37,900	36,300	1,600	104%	38,100	40,800	-2,700	93%
WI	41,300	37,000	4,300	112%	42,900	39,800	3,100	108%
WV	13,200	12,600	600	105%	14,200	13,200	1,000	108%
WY	3,200	3,500	-300	91%	3,300	4,000	-700	83%
U.S.[a]	**1,890,700**	**2,001,500**	**-110,800**	**94%**	**1,942,500**	**2,161,300**	**-218,800**	**90%**

[a] Due to rounding, national totals might fail to equal the sum across states.

Exhibit A-4. Baseline FTE RN Supply and Demand, 2010 and 2015

State	2010				2015			
	Supply	Demand	Supply - Demand	Supply ÷ Demand	Supply	Demand	Supply - Demand	Supply ÷ Demand
AK	3,200	5,500	-2,300	58%	2,500	6,100	-3,600	41%
AL	36,600	36,800	-200	99%	38,200	40,300	-2,100	95%
AR	19,300	22,000	-2,700	88%	19,800	24,300	-4,500	81%
AZ	30,700	43,200	-12,500	71%	30,500	48,500	-18,000	63%
CA	153,300	200,900	-47,600	76%	148,200	228,900	-80,700	65%
CO	27,200	38,100	-10,900	71%	25,100	42,500	-17,400	59%
CT	22,900	34,000	-11,100	67%	19,900	36,600	-16,700	54%
DC	6,500	9,500	-3,000	68%	5,900	10,200	-4,300	58%
DE	6,300	7,600	-1,300	83%	6,100	8,100	-2,000	75%
FL	112,000	144,700	-32,700	77%	110,200	164,300	-54,100	67%
GA	48,200	64,600	-16,400	75%	45,300	71,600	-26,300	63%
HI	7,900	12,400	-4,500	64%	8,100	13,900	-5,800	58%
IA	26,600	30,000	-3,400	89%	26,000	31,800	-5,800	82%
ID	7,400	8,200	-800	90%	7,300	9,200	-1,900	79%
IL	85,600	94,900	-9,300	90%	81,900	101,300	-19,400	81%
IN	41,600	49,800	-8,200	84%	40,400	53,500	-13,100	76%
KS	22,100	23,100	-1,000	96%	21,800	24,900	-3,100	88%
KY	34,700	33,500	1,200	104%	35,500	36,300	-800	98%
LA	37,200	37,100	100	100%	39,100	40,600	-1,500	96%
MA	60,100	76,200	-16,100	79%	56,000	81,700	-25,700	69%
MD	35,600	42,600	-7,000	84%	33,800	46,100	-12,300	73%
ME	11,600	14,100	-2,500	82%	11,100	15,300	-4,200	73%
MI	72,000	75,100	-3,100	96%	68,900	79,600	-10,700	87%
MN	41,800	46,200	-4,400	90%	41,200	50,400	-9,200	82%
MO	45,700	58,600	-12,900	78%	44,200	63,100	-18,900	70%
MS	22,600	23,100	-500	98%	23,600	25,400	-1,800	93%
MT	6,500	7,000	-500	93%	6,300	7,800	-1,500	81%
NC	67,400	75,500	-8,100	89%	68,600	83,700	-15,100	82%
ND	5,800	6,700	-900	87%	5,800	7,300	-1,500	79%
NE	14,700	17,100	-2,400	86%	14,900	18,500	-3,600	81%
NH	9,300	12,600	-3,300	74%	8,800	13,800	-5,000	64%
NJ	55,000	74,600	-19,600	74%	50,500	80,400	-29,900	63%
NM	11,000	14,100	-3,100	78%	11,300	15,900	-4,600	71%
NV	9,200	13,300	-4,100	69%	8,700	14,700	-6,000	59%
NY	142,300	163,800	-21,500	87%	137,400	174,000	-36,600	79%
OH	88,900	101,000	-12,100	88%	85,500	107,300	-21,800	80%
OK	21,500	22,000	-500	98%	22,100	24,300	-2,200	91%
OR	22,400	27,700	-5,300	81%	21,100	31,100	-10,000	68%
PA	99,200	120,300	-21,100	82%	90,600	127,200	-36,600	71%
RI	9,000	12,000	-3,000	75%	8,400	12,800	-4,400	66%
SC	25,900	31,100	-5,200	83%	26,200	34,400	-8,200	76%
SD	7,900	8,100	-200	98%	7,900	8,700	-800	91%
TN	42,800	61,300	-18,500	70%	41,800	67,800	-26,000	62%
TX	118,700	160,600	-41,900	74%	119,000	179,900	-60,900	66%
UT	14,100	15,600	-1,500	90%	14,900	17,500	-2,600	85%
VA	47,600	58,600	-11,000	81%	46,300	64,300	-18,000	72%
VT	4,800	5,400	-600	89%	4,400	5,800	-1,400	76%
WA	37,300	46,100	-8,800	81%	35,100	52,100	-17,000	67%
WI	43,300	42,800	500	101%	42,200	46,300	-4,100	91%
WV	14,600	13,900	700	105%	14,600	14,700	-100	99%
WY	3,300	4,500	-1,200	73%	3,300	5,100	-1,800	65%
U.S.[a]	**1,941,200**	**2,347,000**	**-405,800**	**83%**	**1,886,100**	**2,569,800**	**-683,700**	**73%**

[a] Due to rounding, national totals might fail to equal the sum across states.

Exhibit A-5. Baseline FTE RN Supply and Demand, 2020

State	2020			
	Supply	Demand	Supply - Demand	Supply ÷ Demand
AK	2,000	6,700	-4,700	30%
AL	39,100	44,400	-5,300	88%
AR	19,900	26,900	-7,000	74%
AZ	30,100	54,700	-24,600	55%
CA	144,300	260,900	-116,600	55%
CO	23,000	47,500	-24,500	48%
CT	17,200	39,600	-22,400	43%
DC	5,400	11,000	-5,600	49%
DE	5,800	8,800	-3,000	66%
FL	106,600	187,800	-81,200	57%
GA	41,800	79,500	-37,700	53%
HI	8,200	15,700	-7,500	52%
IA	25,000	34,100	-9,100	73%
ID	7,100	10,500	-3,400	68%
IL	77,100	109,000	-31,900	71%
IN	38,500	57,400	-18,900	67%
KS	21,100	27,000	-5,900	78%
KY	35,300	39,400	-4,100	90%
LA	39,800	44,600	-4,800	89%
MA	51,400	87,800	-36,400	59%
MD	31,800	50,000	-18,200	64%
ME	10,500	16,800	-6,300	63%
MI	66,000	84,300	-18,300	78%
MN	39,700	55,300	-15,600	72%
MO	42,800	68,200	-25,400	63%
MS	23,800	28,000	-4,200	85%
MT	5,900	8,800	-2,900	67%
NC	68,000	92,900	-24,900	73%
ND	5,600	8,000	-2,400	70%
NE	14,900	20,200	-5,300	74%
NH	8,100	15,100	-7,000	54%
NJ	44,900	87,300	-42,400	51%
NM	11,500	18,000	-6,500	64%
NV	8,100	16,200	-8,100	50%
NY	131,500	185,700	-54,200	71%
OH	79,700	113,700	-34,000	70%
OK	22,500	27,000	-4,500	83%
OR	19,800	35,100	-15,300	56%
PA	80,400	135,200	-54,800	59%
RI	7,900	13,800	-5,900	57%
SC	26,000	38,100	-12,100	68%
SD	7,800	9,500	-1,700	82%
TN	40,100	75,400	-35,300	53%
TX	118,500	202,100	-83,600	59%
UT	15,400	19,600	-4,200	79%
VA	44,000	70,300	-26,300	63%
VT	4,000	6,300	-2,300	63%
WA	33,000	59,100	-26,100	56%
WI	40,100	50,300	-10,200	80%
WV	14,000	15,700	-1,700	89%
WY	3,300	5,800	-2,500	57%
U.S.[a]	**1,808,000**	**2,824,900**	**-1,016,900**	**64%**

[a] Due to rounding, national totals might fail to equal the sum across states.