Department of Health Professions

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Healthcare Workforce Data Center

Forecasting Nurse Supply and Demand in Virginia 2008 - 2028

For their efforts in the establishment of the Department of Health Professions Healthcare Workforce Data Center, special appreciation is extended to Governor Tim Kaine; the Governor's 2007 Health Reform Commission; Marilyn B. Tavenner, Secretary of Health and Human Resources; Sandra Whitley Ryals, Director of the Department of Health Professions; Beverly Beck, Project Manager; and to the members of the Healthcare Workforce Data Center's Advisory Council; Physician Workforce Committee; Nursing Workforce Committee; and the Healthcare Workforce Information Network Committee.

January 2010

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Healthcare Workforce Data Center

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Preface

In August 2006, the Governor issued Executive Order 31 to create a Health Reform Commission charged with recommending ways to improve Virginia's healthcare system. The Commission addressed key issues relating to access to care; quality, transparency and prevention; long-term care; and healthcare workforce. In its September 2007 report, the Commission projected a shortage of approximately 22,600 nurses and 1,500 physicians in Virginia by 2020 and indicated that Virginia would be experiencing a growing need for direct support professionals, physician extenders, and other healthcare providers to address the requirements of the elderly, disabled, and others in long-term settings. They recommended the formation of the Healthcare Workforce Data Center within the Department of Health Professions (DHP). DHP was considered a natural repository of the Center because it maintains Virginia's licensure database for almost 100 health professions and approximately 350,000 practitioners. In the spring of 2008, the Governor designated Workforce Investment Act (WIA) discretionary funds for the Center's establishment, and in FY 2010, supplemental WIA funds were awarded to the Center for continued data collection and analysis activities.

The Center's mission is to:

improve the healthcare system in the Commonwealth by improving data collection and measurement of the Commonwealth's healthcare workforce through regular assessment of workforce supply and demand.

The Center's focus for FY2009 was to define the chief nursing and physician supply and demand issues. Also during FY2009, the Center's administrative structure was established, its website was instituted, and the Healthcare Workforce Advisory Council (the "Advisory Council") and three committees were formed. The Advisory Council, comprised of approximately 20 stakeholders, included representatives from state agencies, members of the General Assembly, and constituent organizations knowledgeable about healthcare workforce issues in Virginia and nationally. Specific expertise was provided by the: (1) Physicians Workforce Committee, (2) Nursing Workforce Committee, and (3) Healthcare Workforce Information Network.

During the Center's first full year beginning in FY2009, the Department's in-house research capabilities were determined and consultant research partners selected. Data from existing licensure renewal surveys for physicians and nurses and nursing education program survey information were made available for consultant analysis and reporting. Subsequently, DHP's existing nursing and physician surveys have been revised to better ensure that the data gathered would be of most direct relevance to workforce. The new workforce surveys will become part of the on-line licensure renewals process for calendar year 2010 and 2011. Further, an initial application workforce survey for all professions has been developed and is slated to launch with the DHP new online application process.

Forecasting Nurse Supply and Demand in Virginia 2008 - 2028 the first in a series of reports from the DHP Healthcare Workforce Data Center (the Center) designed to forecast the future workforce status of Virginia's licensed nurses (registered nurses and licensed practical nurses). This report was prepared on behalf of the DHP Healthcare Workforce Data Center by Lacey Research Associates under contract HWDC-2008 with the Virginia Department of Health Professions, and evaluative and technical assistance from the Department of Health Administration and Policy at George Mason University, Fairfax, Virginia under a memorandum of understanding.

Forecasting Nurse Supply and Demand in Virginia: 2008 - 2028

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Executive Summary

Over the next two decades, Virginia's population is anticipated to grow by a million. It will also be aging. By then approximately 16% of citizens in Virginia will be aged 65 or older. Long-range supply and demand estimates have been developed to provide insight into the future nursing workforce and to help determine whether there will be an adequate supply of nurses to meet Virginia's needs.

Future Virginia nursing supply was projected by applying the Nurse Supply Model (NSM) developed by the U.S. Health and Resource Services Administration (HRSA). This national workforce supply model enables state-level supply estimates of the Registered Nurse (RN) workforce. This same model was modified to estimate Virginia's potential future supply of Licensed Practical Nurses (LPNs).

Virginia's future nursing demand was estimated using the Nurse Demand Model, also developed by HRSA. It is an econometric model that forecasts demand for RNs, LPNs and nurse aides, based on population and healthcare service demand trends.

The models, the adjustments made to incorporate recent trends in Virginia, and the outcomes of each model for each profession are detailed in this report. The chief findings related to future supply and demand are summarized as follows.

Future RN Supply and Demand Estimates

A slow but steady increase in the RN workforce between 2008 and 2028 is anticipated across three workforce measures: (1) the entire population of all RNs expected to be licensed in the state in a given year, (2) the number of licensed RNs expected to be actively employed in nursing-related positions or seeking a nursing position in a given year, and (3) the number of full-time equivalents (FTEs) expected to be actively employed in the nursing workforce in a given year. However, when comparing the RN growth rate with that of the general population, the number of RNs per 10,000 persons is expected to *decline* over time. Long-range forecasts of supply and demand for RNs in Virginia over the next 20 years show the likelihood of a worsening shortage beginning to develop around 2015 and rapidly become more severe over time. RN supply relative to demand is favorable until 2015 when age related retirements increase and demand grows due to population aging, resulting in an RN shortage. Recent RN supply growth is the result of nursing education program growth/productivity and increased RN workforce participation due to high full-time employment and deferred retirement. Current, economic conditions have contributed to higher than expected levels of workforce participation.

To address the impending shortage issue, two policy options were examined: increase the number of new entrants and delay retirement. Approximately 10,000 more RN FTE's are projected to be needed in 2017 compared with 2008, and an additional 30,000 by 2028. A 10%increase per year in the number of new entrants could bridge the earlier gap, however, it is insufficient to address the 2028 level of demand. The recent severe economic downturn, which began in 2007, has lead to the retention of nurses in the workforce who might have retired from or otherwise left nursing or reduced their participation. The current Virginia RN supply and demand are at equilibrium. However, this is only in the short-term. The long-range problems of

an aging population and the mass retirement expected within an aging RN nursing workforce point to a sharply increasing shortage within the next few years and thereafter. The effect of delaying retirement by one-, two- and four-years, respectively, was determined. If RNs delay retirement by one year, according to the model, the supply increases by over 800 FTEs in just two years. If retirement is delayed by two years, an increase of over 1,100 FTEs can be expected. Although the gap between supply and demand is essentially bridged in the early years, again, it merely postpones the shortage. By 2028, even a four-year retirement delay yields too few FTEs to meet Virginia's growing demand when over 100,000 RN FTEs will be needed.

Not all settings are expected to experience the same rapid growth in demand due to the differences in the patient populations they tend to serve. Skilled nursing facilities are expected to grow the most rapidly because of the services they provide to the elderly. Similarly, home health services and hospital outpatient care services are also anticipated to experience a large growth in demand when compared with occupational health, school health, and other settings.

LPN Supply and Demand Estimates

A steady increase in the LPN workforce is also anticipated between 2008 and 2028. However, contrary to the RN findings, the LPN workforce is estimated to grow *faster* than the general population. The supply is predicted to exceed demand by 2012 and continue to do so through 2028. A note of caution is in order; however, because HRSA supply and demand models do not take the each other's forecast into account for their own predictions. So, comparing the long-range estimates of supply and demand can be problematic. In a free market economy, when labor supply exceeds demand, the wages of oversupplied workers tend to fall or stagnate, prompting them to look in a different segment of the economy for a job and/or reducing the number of new entrants. Thus, LPNs may leave the nursing workforce or move up the career ladder and go into RN education programs to help address the shortage of RNs.

Although LPNs tend to work in fewer types of settings than RNs, future demand for their services is affected by setting. Because of the aging population, the greatest growth is expected in resident nursing facilities and home health care settings.

Conclusions

Overall, long-range supply and demand forecasts predict a growing need for RNs and a surplus of LPNs. RNs are in greater demand because patient care needs are becoming more acute and complex as the patient population ages. Additionally, the overall population is becoming larger. Although the recent severe economic downturn has contributed to the current balance in supply and demand, the long-range problems of an increasing and aging population and aging nursing workforce will create a rapid and severe RN shortage in Virginia in just a few years. Increasing the number of new entrants and delaying retirement should help to postpone shortages, but because each has practical limitations, additional solutions should be developed.

Forecasting Nurse Supply and Demand in Virginia: 2008 - 2028

According to the U.S. Census Bureau, the population of Virginia is expected to grow by 12.6% between 2009 and 2020 which translates into almost 1 million additional people in the state.[1] During that same time period the number of Commonwealth citizens age 65 and over is expected to grow by 45.2%, changing from 12.2% of the total population in 2009 to about 16% of the total population in 2020 - just 11 years from now. All of those Virginia citizens will need healthcare services, and nursing services will be a large portion of that care.

In order to understand what the nursing workforce might look like in years to come, and whether there will be an adequate nursing workforce to meet the needs of Virginia citizens, a long-range estimation forecast of both the supply of nurses and the demand for nurses has been completed. Future nurse supply has been estimated using the Nurse Supply Model (NSM) developed by the U.S. Health and Resource Services Administration (HRSA). This stock and flow model of the nursing workforce allows state-level planners to estimate changes in the Registered Nurse (RN) workforce within their states. We are using it to estimate the potential future supply of both RNs and Licensed Practical Nurses (LPNs) by making some adjustments to the model. The future demand for nurses has been estimated using the Nurse Demand Model, also developed by HRSA. It is an econometric model that forecasts demand for RNs, LPNs and nurse aides, based on population and healthcare service demand trends. Both models, the adjustments made to incorporate recent trends in Virginia, and the outcomes are reviewed within the body of this report.

Nurse Supply Model Overview

The Nurse Supply Model (NSM) estimates the future supply of licensed RNs, RNs actively employed in nursing positions or seeking nursing positions (i.e. a head count of the workforce), and the number of full-time equivalents (FTEs) in the RN workforce. The model can be used to estimate these numbers over a period of up to 20 years. As with any long-range forecasting model the estimates in the years close to the baseline (beginning) year are likely to be more accurate than those 10 years or more beyond the baseline. However, even though the specific counts generated by the model may be questionable, the trend identified by the estimation process is of great value to workforce planners, policy makers, and others concerned about having an adequate number of nurses in the future.

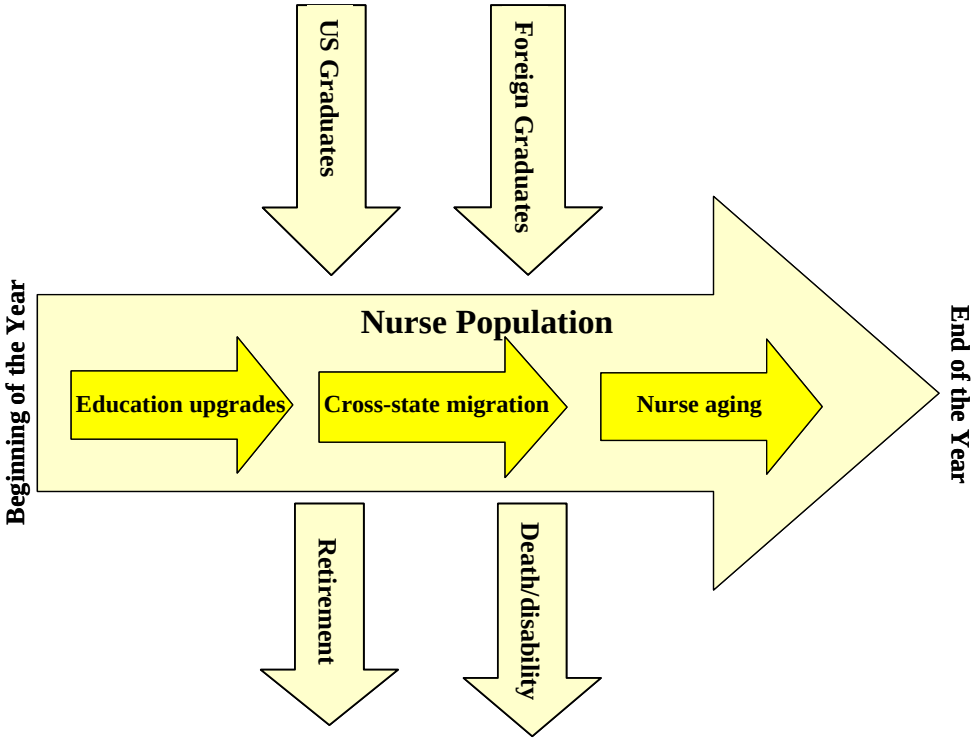
The NSM uses a stock-and-flow process to create the projected annual change in the size of the nurse supply. The supply of nurses is made up of all those currently licensed in a state and those that enter or depart over the course of a year. Nurses enter into the supply when they:

- graduate from a nursing education program in Virginia or some other state or foreign country and pass the national licensing exam (NCLEX),
- get endorsed into Virginia from another state,
- or immigrate into Virginia from a foreign country.

Nurses leave the supply when they:

- migrate out of Virginia to another state or country,
- retire
- become disabled or die.

Within that year some nurses are also upgrading their education, and each of them is aging. The total number of nurses expected to be in the supply at the end of a given year is the result of the starting number at the beginning of the year plus the additions and minus the subtractions occurring during the year. The graphic below illustrates the process.



Source: Technical Report: Use of HRSA Forecasting Models in Florida, July 2008. Florida Center for Nursing

Much of the data used within the Nurse Supply Model is based on information from the National Sample Surveys of Registered Nurses (NSSRN). This national survey of RNs occurs every four years and reaches approximately 30,000 – 35,000 RNs using a complex sampling strategy to achieve a geographically representative sample that can be used to estimate state-level RN populations. The NSM was developed to produce estimates for the period 2000 – 2020. As a result, the data underlying the estimation models are drawn primarily from the 2000 and earlier national surveys. Counts of nurses by state, age and education were estimated from the 2000 SSRN for the model's baseline year of 2000. More complex estimation equations within the model were developed by using multiple waves of the NSSRN.

The NSM uses a fine-grained analysis of nurses by their age and education to apply workforce behavior metrics to estimate not only the number of licensed nurses, but also the number that can be expected to be actively engaged in the nursing workforce in a given year, and how the count of the active workforce can be expected to translate into a measure of full-time equivalents. Age is measured in 44 categories ranging from "22 and under" to "65 and older." Education is measured in three groupings: Diploma and Associate Degree, Baccalaureate Degree, and Master's Degree or Higher. The cross-tabulation of age and education results in a total of 132 cells of information for the Virginia estimation model. This level of detail is important when estimating total workforce supply because work behaviors differ greatly by both age and education. Younger and older nurses both tend to be more engaged in the workforce and work more hours per week than those in their middle years. Nurses with advanced degrees tend to work fewer hours per week but retire from the workforce much later than nurses with less education.

The Nurse Supply Model makes a few assumptions about how nurses move into or out of the workforce and/or how work behavior differs by age or over time. A few of these assumptions are relevant to this analysis:

- the number of "new graduates" each year will change based on changes in the size of the potential applicant pool, which is defined in the model as the number of women in Virginia aged 20-44, but the age distribution within that pool will remain constant
- the rates at which licensed nurses participate in the workforce, by age and education, remains stable over time
- the age distribution of foreign immigrants moving to the state remains constant over time
- rates of attrition from the workforce by age will remain constant over time

Many of these assumptions can be changed by using the policy scenario feature in the NSM. However, in many cases doing so demands evidence of a more appropriate assumption. For instance, there is a wide spread belief that nurses and others are working at older ages than they used to, but there is little information about how age-specific attrition rates are actually changing. The model's assumption about the number of new graduates covarying with the size of the female population age 20 to 44 cannot take into account the fact that 45% of Virginia nursing education programs turned away qualified applicants in 2008. Future changes in the number of new graduates is more likely to be affected by the expansion of nursing education opportunities and the relative attractiveness of the nursing profession than by the number of the females age 20 to 44 living in the state. The model's assumptions about new graduate numbers can be adjusted within the policy scenario feature.

Table 1 lists all of the data fields in the Nurse Supply Model that can be adjusted by the user, a brief description of the field, the data source for the values that come as the default data in the model, and the data source that we were able to identify for more current information based on Virginia's licensed RNs. When we were not able to find current information for Virginia we used the default values supplied with the model.

Table 1. Nurse Supply Model Data Elements and Substitutions for RN Projections

Variable	Variable Description	Default Data Source (Baseline Year = 2000)	New Data Source (Baseline Year = 2008)
Nurse Population in the Base Year			
RN_AD	Nurse population in base year trained a diploma or associate level	NSSRN	VA Board of Nursing count of RNs licensed adjusted by the NSM (NSSRN) proportions by age and education
RN_BA	Nurse population in base year trained at baccalaureate level	NSSRN	
RN_MA	Nurse population in base year trained at masters or higher level	NSSRN	
New Graduates			
Grad_DIPAD	Base year number of new RN graduates at the diploma or associate degree level	National Council of State Boards of Nursing – first time NCLEX candidates who passed in 2000	First time test-takers passing NCLEX in Virginia + 50% of the people who failed on the assumption they will pass in the future and become licensed in Virginia
Grad_BA	Base year number of new RN graduates at the baccalaureate level	National Council of State Boards of Nursing – first time NCLEX candidates who passed in 2000	
%DIPAD	Age distribution of new RNs graduating with diplomas or associate degrees	NSSRN – national rates	New graduates in 2006 and 2007 responding to the Virginia Nursing Workforce Survey were used to create age distribution proportions
%BA	Age distribution of new RNs graduating with a baccalaureate degree	NSSRN – national rates	
Foreign Nurse Graduates			
FNGRADS	Proportion of new foreign nurses migrating into individual states	NSSRN	Virginia was set to 100% and all other states to 0
Foreign	Age distribution of all foreign trained RNs	NSSRN – national rates	NSM default
FGRADS	Total number of foreign trained RNs immigrating into the US each year	assumed to be 3500 (note: NCSBN reports over 20,000 in 2008)	VA Board of Nursing 2007-2008 Report of Statistics, # of foreign trained RNs passing the NCLEX in Virginia

Table 1 continued

Variable	Variable Description	Default Data Source (Baseline Year = 2000)	New Data Source (Baseline Year = 2008)
General Population			
POPULATION	State level population forecasts for the period 2000 – 2020	U.S. Census Bureau – based on adjustments to the 1990 Census	U.S. Census Bureau – based on the 2000 Census and adjustments made through 2005
WNPOP	State level population forecasts of women ages 20-44	U.S. Census Bureau	
ATTRITION	Loss rate by age from the licensed population of RNs based on general population death and retirement rates	Current Population survey data, U.S. Centers for Disease Control	NSM default
Educational Upgrades			
POSTRN	Base year number of RNs upgrading from diploma or associate to baccalaureate	NSSRN	NSM default
MSGRADS	Base year number of RNs upgrading from baccalaureate to Masters or higher level	NSSRN	NSM default
%POSTRNBA	Age distribution of diploma and associate RNs who upgrade to a baccalaureate	NSSRN – national rates	NSM default
%MA	Age distribution of baccalaureate RNs who upgrade to Masters or higher level	NSSRN – national rates	NSM default
RN Immigration and Emigration			
PEMIG_AD	Probability that an RN prepared at the diploma or associate levels will emigrate this year	NSSRN	NSM default
PEMIG_BA	Probability that an RN prepared at the baccalaureate level will emigrate this year	NSSRN	NSM default
PEMIG_MA	Probability that an RN prepared at the Masters or higher level will emigrate this year	NSSRN	NSM default
PIMMIG_AD	Probability that an RN prepared at the diploma or associate levels immigrated last year	NSSRN	NSM default
PIMMIG_BA	Probability that an RN prepared at the baccalaureate level immigrated year	NSSRN	NSM default
PIMMIG_MA	Probability that an RN prepared at the Masters or higher level immigrated year	NSSRN	NSM default

Table 1 continued

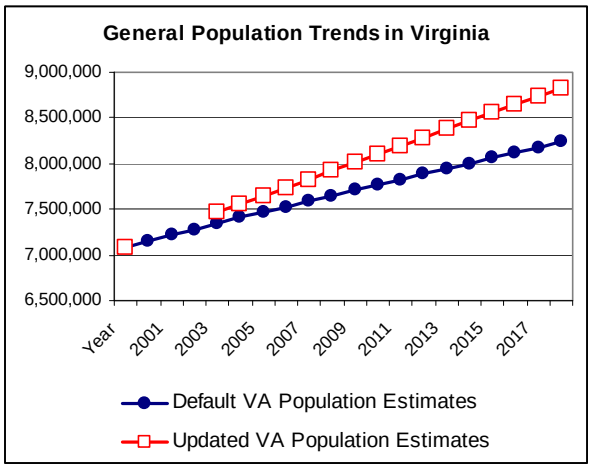
Variable	Variable Description	Default Data Source (Baseline Year = 2000)	New Data Source (Baseline Year = 2008)
Workforce Participation Rates			
ACTIVITY_AD	Workforce participation rates (% in the workforce) for RNs prepared at the diploma or associate level	NSSRN – national rates	2007 and 2008 Virginia Nursing Workforce Survey data was used to calculate the percentage of each age/education group employed in nursing or seeking a nursing job.
ACTIVITY_BA	Workforce participation rates (% in the workforce) for RNs prepared at the baccalaureate level	NSSRN – national rates	
ACTIVITY_MA	Workforce participation rates (% in the workforce) for RNs prepared at the Masters or higher level	NSSRN – national rates	
FTE Participation Rates			
FTE_AD	FTE workforce participation rates for RNs prepared at the diploma or associate level	NSSRN – national rates	2007 and 2008 Virginia Nursing Workforce Survey data was used to calculate the FTE weight for each age/education group. Full-time = 1.0 FTE. Part-time = 0.5 FTE.
FTE_BA	FTE workforce participation rates for RNs prepared at the baccalaureate level	NSSRN – national rates	
FTE_MA	FTE workforce participation rates for RNs prepared at the Masters or higher level	NSSRN – national rates	

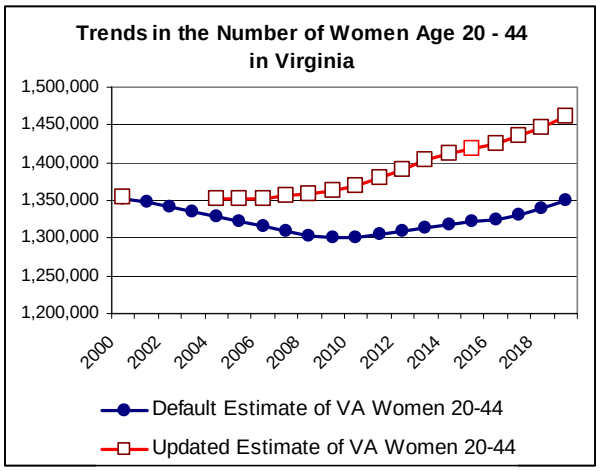
Data Substitutions in the Nurse Supply Model

General Population Statistics

HRSA used projections generated by the U.S. Census Bureau of each state's total population and of women aged 20-44. When the NSM was being built, the population estimates available were based on 1990 census projections and adjusted for early results from the 2000 census. We have replaced these projections with figures released by the U.S. Census Bureau, Interstate Population Projections, 2005 which are based on the 2000 census and the subsequent adjustments that were made up until 2005.

The updated Virginia figures show the state's general population growing at a faster rate than the default values in the model, and the number of women age 20 – 44 with a consistent upward growth rate rather than the decline and increase pattern seen in the default data. This trend in the size of the female workforce (women age 20 – 44) is extremely important for the model estimates, since the model uses this pattern to project the number of new graduates expected to join the workforce.





Baseline RN Counts by Age and Education

The NSM draws the number of RNs at baseline in each state from the NSSRN data in 2000, based on where those nurses worked. This subset of data is then used to determine nurse age and education proportions within each state. We are using the year 2008 as our baseline year. The NSM estimates that in 2008 Virginia would have approximately 68,245 RNs in the population of licensed RNs employed in the state. That count is substantially lower than the 91,239 actively licensed RNs as of June 30, 2008, as reported by the Virginia Board of Nursing. However, the Board's figures do not break down by age and education.

The NSM default data estimates that about 55% of RNs in Virginia hold an ADN/Diploma as their highest educational degree, 33% a baccalaureate, and 11% a Masters degree or higher. Using the 2007 and 2008 Nursing Workforce Survey data for RNs to examine this same information, that data revealed the following proportions: 42% with an ADN or Diploma, 40% baccalaureate, and 18% Masters or doctorate. This difference between the two data sources is larger than expected and may be due, at least in part, to a bias toward higher education among the Virginia Nursing Workforce survey respondents. This would not be surprising as it is widely found that more educated persons are more likely to participate in all types of survey studies. Because this baseline count of the RN population by age and education underlies all of the NSM forecast equations, the model outcomes are very sensitive to these baseline values. Interstate migration patterns, workforce participation rates and FTE rates also vary by education levels, so the effects of any errors in our baseline age/education proportions could be profound.

The solution applied in this analysis was to: 1) keep the proportions generated from the NSSRN data that comes with the NSM, but apply those proportions to the total number of licensed RNs in 2008. This results in a baseline count of the licensed population of RNs by age and education

that reflects the true size of the RN population in Virginia in 2008 but does not incorporate the age bias error that appears to be in the data drawn from the 2007 and 2008 Nursing Workforce Surveys.

Baseline Year RN Graduates

Newly graduated RNs generally take the licensing examination for entry into practice within a short time after graduation and can take the exam (referred to as NCLEX) in any state they choose since the results are recognized throughout the United States. It is common for new nurses to take the exam in the state they intend to practice. Within the NSM new graduates are defined as the number of first-time NCLEX test takers. However, not all nurses who take the NCLEX exam pass the first time. The National Council of State Boards of Nursing, the creators of the exam, report that about 87% of U.S.-educated first-time RN test takers pass. For those that repeat the exam the pass rate is about 53%.[2] Pass rates are lower for RNs educated outside of the United States.

We calculated the number of "graduates" in the baseline year of 2008 by using the count of new graduates that passed the exam given in Virginia during 2008. The majority of those test-takers were graduates of Virginia nursing education programs, but not all. In 2008 a total of 3,572 new RNs took the NCLEX in Virginia and 3,162 of them passed: 2,722 of those who passed were graduates of Virginia schools of nursing. Virginia-educated test-takers were identified by their degree program, but those educated elsewhere were not. We used the degree-type proportions from the Virginia graduates to apportion the 440 RNs that passed the NCLEX in Virginia but were educated elsewhere. In that way we could include them in the total count of "new graduates" required by the model which is a critical part of the in-flow to the supply of nurses in the state each year. If we had left out the RNs who passed the exam but whose educational background was unknown, we would have undercounted that in-flow not only in the baseline year, but every year thereafter since the NSM assumes that the pool of new graduates will change from baseline counts by 1% for each 1% change in the size of the population of women age 20 to 44. For that reason, having an accurate baseline measure of the "new graduate" pool is extremely important.

Foreign-Educated RNs

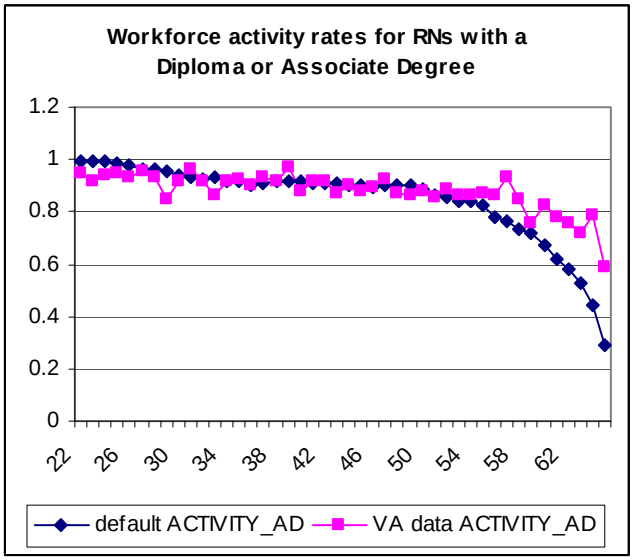
HRSA's Nurse Supply Model assumes that 3,500 foreign-educated RNs will become licensed in the United States each year and be distributed throughout the states, based on information gleaned from the 2000 National Sample Survey of RNs. Under the default assumptions of the model, Virginia would be expected to license approximately 56 foreign-educated RNs each year. However, figures published by the National Council of State Boards of Nursing in 2008 show that more than 20,000 foreign-educated RNs passed the NCLEX-RN exam in 2008 – a substantial increase over the 3500 assumed in the Nurse Supply Model.

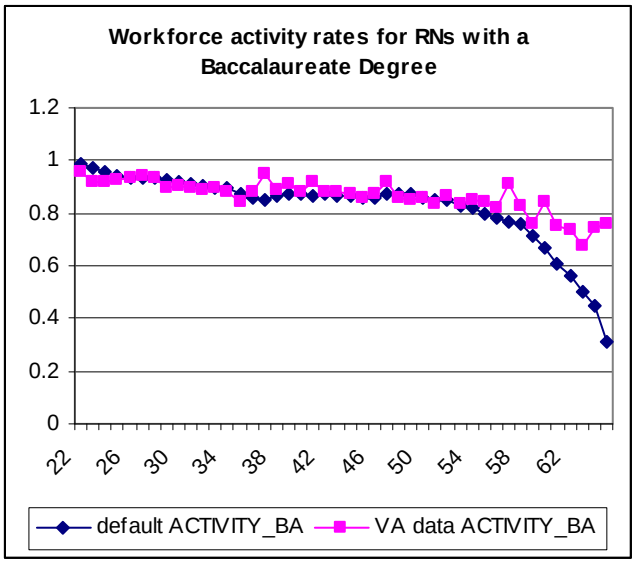
In Virginia the number of foreign-educated RNs that sat for and passed the exam in 2008 was 99 – also a larger number than the 56 that would be assigned to Virginia by using the NSM default

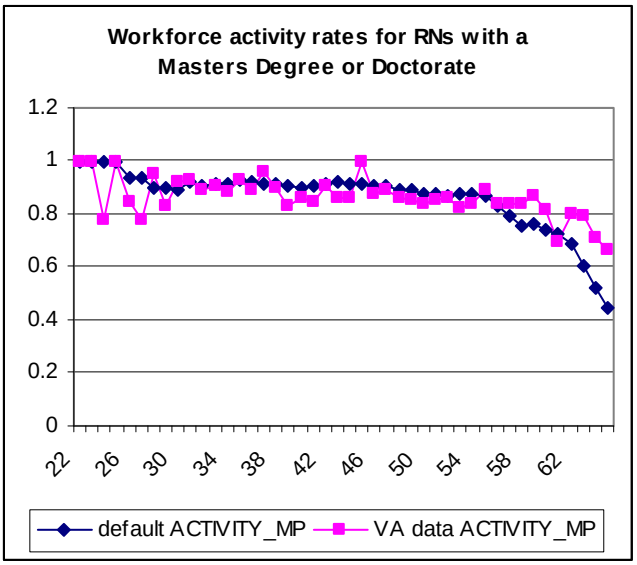
values. We have corrected this issue by setting the total number of foreign-educated graduates to 99 and ensuring that all of them are allocated to Virginia in the model.[3] We applied the age distribution of licensed Virginia RNs who had graduated in 2006 and 2007, gathered from the 2007 and 2008 Virginia Nursing Workforce Survey, to these foreign-educated nurses.

RN Workforce Activity Rates by Age and Education

Information from the 2007 and 2008 Nurse Workforce Survey was used to calculate workforce activity rates. There were slight differences between the NSM default data values and the ones generated from Virginia nurses. The charts on this page make it clear that the default values in the NSM underestimate the proportion of older nurses that remain active in the nursing workforce (i.e., are employed in nursing or are seeking nursing employment), regardless of their education level. At younger ages the Virginia RN workforce is very similar to the national trends that are the basis of the NSM estimates. The workforce activity rates based on Virginia RNs were substituted into the model to ensure a more accurate forecast.

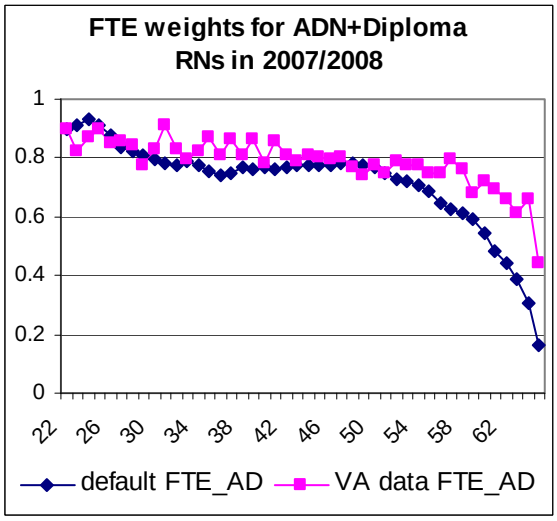


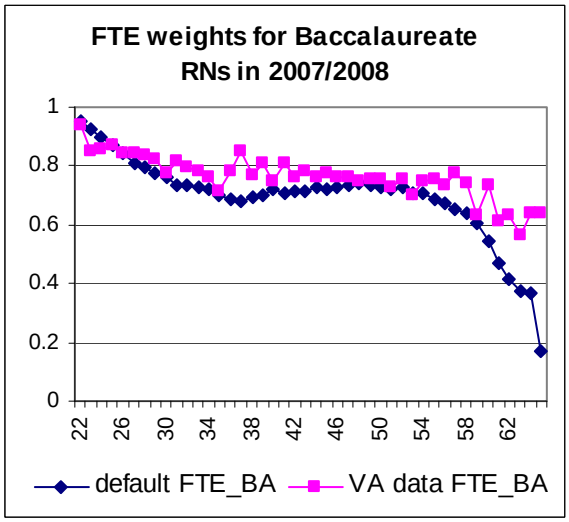




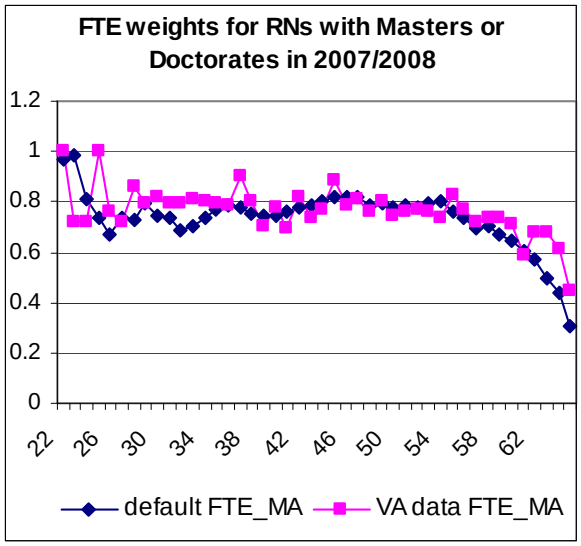
RN FTE Workforce Participation Rates

We were able to use the 2007 and 2008 Nursing Workforce Survey data to calculate full-time equivalent (FTE) weights for each of the age and education cells in the Nurse Supply Model. That survey measured both employment status (in or outside of the nursing workforce) and the hours worked per week (Full-time - 32 hours or more per week or Part-time – less than 32 hours





per week). We assigned a value of 1.0 to RNs reporting full-time employment in nursing, and a value of 0.5 to those reporting part-time employment. This Virginia-specific information shows an overall higher level of workforce activity than the default data supplied with the NSM, as well as higher rates for older nurses. Both of these findings are consistent with studies done in North Carolina and Florida using the same version of the NSM. It is possible that the economic climate in 2007 and 2008 has something to do with the differences, or it may be that Virginia nurses work a bit more than the national patterns in effect in 2000. It is those 2000 national work patterns that underlie the NSM FTE participation rates that are supplied with the model. The result of modifying the model with our Virginia-based data is a slightly larger RN FTE supply at baseline and throughout the projection period than what would be predicted by using the default data in the model.



Attrition from the Workforce

At the time when the current HRSA Nurse Supply Model was being developed, there was very little research into attrition from the nursing workforce. There is more now, but it is still a difficult and complex issue to measure. The NSM constructed age-specific attrition rates based on information about women's mortality rates published by the Centers for Disease Control in 2002 and data on women's retirement and disability rates gathered from the 1998, 1999, 2000 and 2001 Current Population Surveys (March Panel). These constructed rates are intended to capture permanent departures from the workforce, not temporary ones which might occur during a working lifetime. Those temporary departures are captured through the workforce participation rate measures.

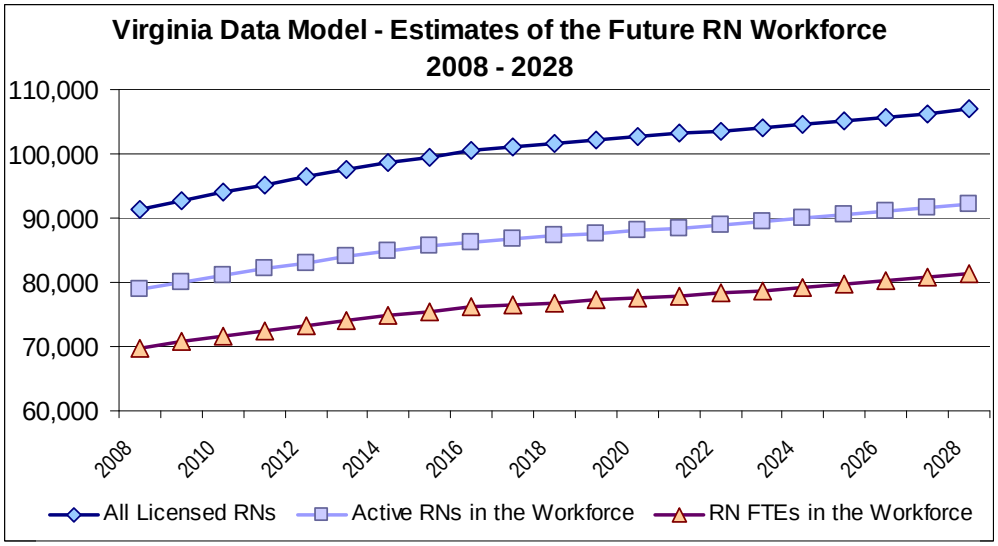
Although there is some data available through the Virginia Board of Nursing regarding the number of nurses that fail to renew their license each year, it is not published in a form that would allow for the construction of age-specific rates. As more demographic information is linked to licensure information it may become possible in future years to measure the attrition rate of nurses in Virginia. In the meantime, we will use the attrition rates provided in the NSM for both RN and LPN projections, in spite of the fact that these rates have probably changed somewhat over the past 10 years.

In and Out Migration

We did not have the information needed to verify the rates at which RNs move into or out of Virginia each year, so the default rates in the NSM were used. Those default rates show that in 2000 Virginia was likely to gain slightly more nurses than were lost through interstate migration – a net gain of 31 in the baseline year of the model. This number is so low relative to the size of the entire workforce that the net migration rate for Virginia in the NSM is essentially zero. As a result we can expect that the impact of migration to and from other states will be zero over the estimation period.

Future RN Supply Estimates

When all available data elements based on RNs licensed in the state of Virginia were added into the model, forecast estimates of the RN workforce were calculated. The model produces estimates for three different measures of the workforce: the entire population of all RNs expected to be licensed in the state in a given year; the number of licensed RNs expected to be actively employed in nursing-related positions or seeking a nursing position in a given year; and the number of RN full-time equivalents (FTEs) expected to be actively employed in the nursing workforce in a given year.



The charts on this page and the numbers in Table 2 report the trends expected for the RN workforce in Virginia from 2008 to 2028. The general trend is one of slow but steady increase in all aspects of the RN workforce.

However, when the growth rate of RNs is compared to that of the general population in Virginia over the same time period it is clear that the supply of RNs is not expected to grow as quickly as the general population. The number of RNs per 10,000 persons in Virginia is expected to decline over time. This means that the ways in which nursing services are currently organized and delivered will be inadequate to meet the future needs of Virginia's citizens at the same level of service being provided in 2008.

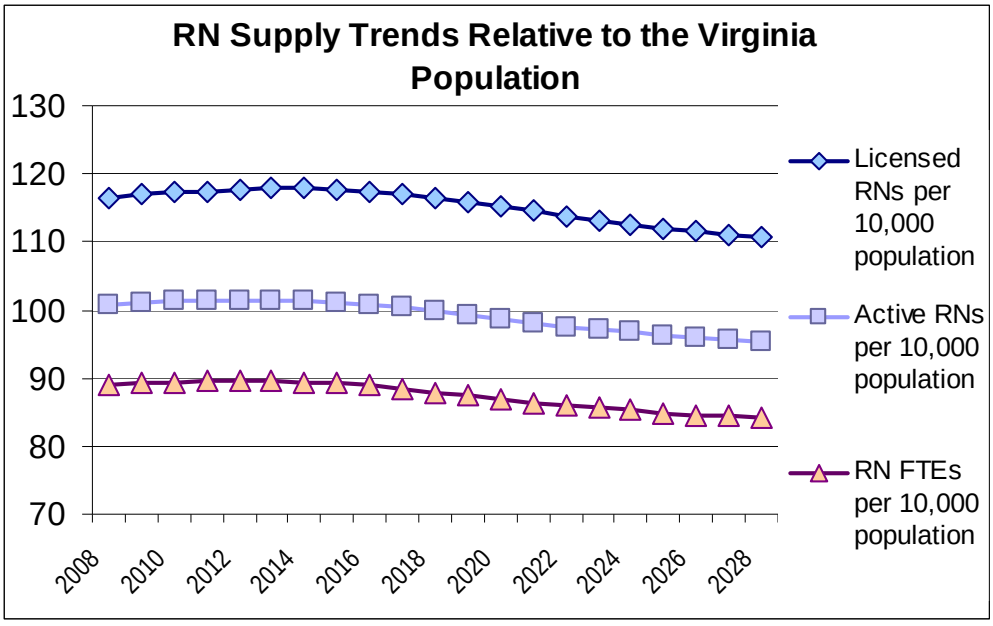
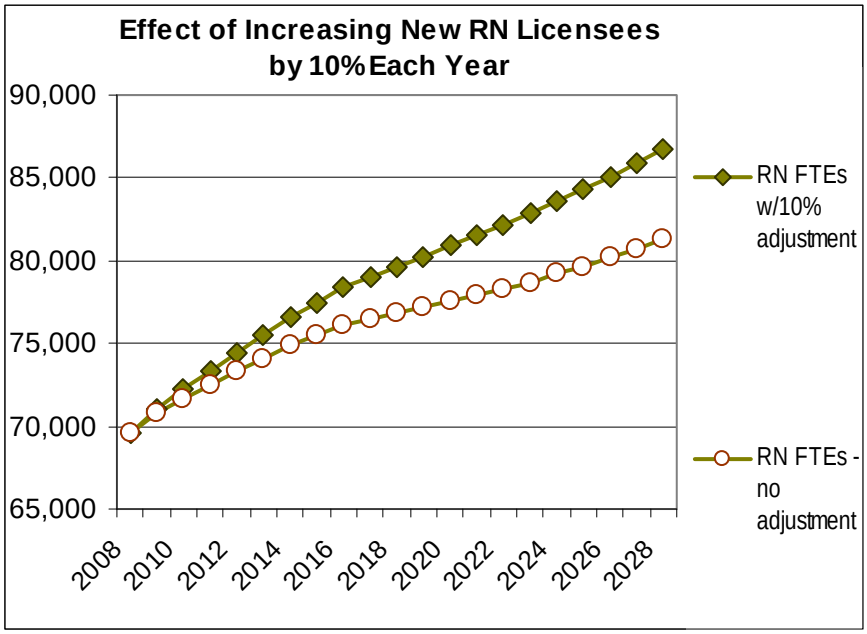


Table 2. Forecast Estimates of the RN Workforce in Virginia

Year	Licensed RNs	RNs Active in the Workforce	RN FTEs in the Workforce	General Population in Virginia	Licensed RNs per 10,000 Population	RN FTEs per 10,000 Population
2008	91,239	78,830	69,627	7,827,657	116.56	88.95
2009	92,639	80,083	70,754	7,919,021	116.98	89.35
2010	93,930	81,097	71,626	8,010,245	117.26	89.42
2011	95,154	82,131	72,498	8,101,489	117.45	89.49
2012	96,355	83,051	73,304	8,192,854	117.61	89.47
2013	97,584	83,967	74,110	8,284,309	117.79	89.46
2014	98,675	84,776	74,875	8,375,648	117.81	89.40
2015	99,592	85,568	75,518	8,466,864	117.63	89.19
2016	100,406	86,273	76,116	8,557,758	117.33	88.94
2017	101,111	86,770	76,501	8,648,333	116.91	88.46
2018	101,728	87,184	76,830	8,738,451	116.41	87.92
2019	102,271	87,657	77,189	8,828,145	115.85	87.43
2020	102,809	88,121	77,595	8,926,113	115.18	86.93
2021	103,237	88,465	77,905	9,017,970	114.48	86.39
2022	103,619	88,871	78,307	9,109,828	113.74	85.96
2023	104,033	89,341	78,704	9,201,685	113.06	85.53
2024	104,537	89,915	79,212	9,293,542	112.48	85.23
2025	105,076	90,442	79,657	9,385,399	111.96	84.87
2026	105,651	90,965	80,178	9,477,256	111.48	84.60
2027	106,271	91,544	80,720	9,569,114	111.06	84.35
2028	106,982	92,220	81,337	9,659,128	110.76	84.21

Scenarios Affecting the RN Forecast for Virginia

Increasing RN Production



A common policy solution for increasing the size of the nursing workforce is to increase the number of new entrants into the workforce. Generally we think of this in terms of new graduates, but migration into a state can also play a role in this regard. The NSM includes a policy scenario option that allows the user to increase or decrease the number of new entrants. Called 'new graduates' in the model, the figures used in the calculations are actually the number of new RNs that pass the NCLEX exam each year within the state. We ran a scenario in which the number of NCLEX passers increased by 10% each year. The resulting impact on the size of the RN workforce in Virginia – measured in full-time equivalents (FTEs) is illustrated in the chart above. Although the impact is slow to develop, over time this small increase in the number of 'new graduates' each year results in a significant increase in the RN workforce: an additional 1,130 RN FTEs by 2012 and more than 4,000 additional RN FTEs by 2023. See Table 3 for the estimation figures.

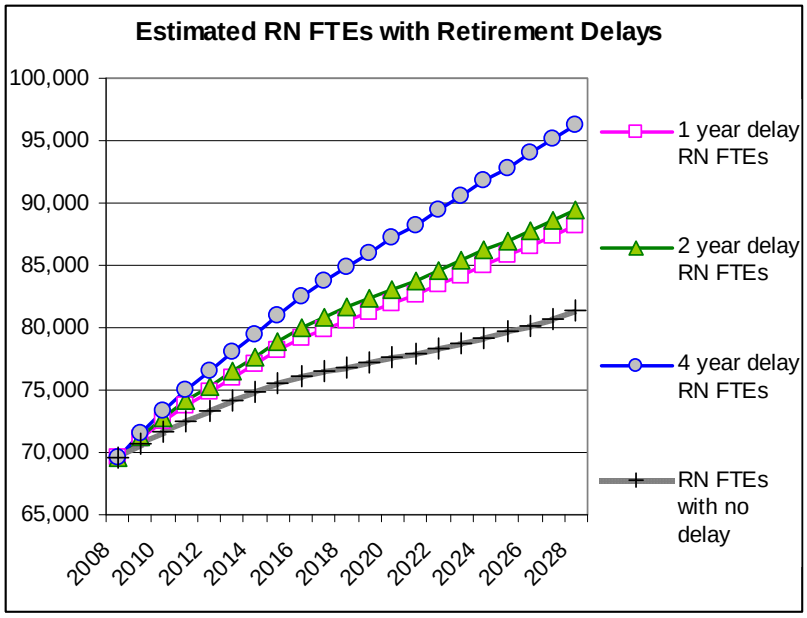
Given the current constraints on nursing education in terms of available faculty, the cost of adding physical resources such as classroom space and learning equipment, and the difficulty of developing additional clinical sites for students, an annual 10% increase in productivity may be a tall order. However, some of that productivity could come from improving the retention and passing rate of students in nursing programs as they are currently configured. Maintaining an on-going increase of 10% annually would become more difficult over time as nursing programs reach their maximum retention and passing rates.

Table 3. Virginia RN Workforce Forecast if New Graduates are Increased 10% Each Year

Year	Licensed RNs w/10% adjustment	Active RNs w/10% adjustment	RN FTEs w/10% adjustment	Additional Licensed RNs	Additional Active RNs	Additional RN FTEs
2008	91,239	78,830	69,627	0	0	0
2009	92,983	80,396	71,037	344	313	283
2010	94,618	81,723	72,193	688	625	568
2011	96,186	83,069	73,346	1,032	938	848
2012	97,731	84,302	74,434	1,377	1,250	1,130
2013	99,307	85,530	75,518	1,723	1,563	1,408
2014	100,745	86,650	76,564	2,070	1,873	1,689
2015	102,009	87,752	77,482	2,417	2,184	1,964
2016	103,170	88,767	78,360	2,764	2,494	2,243
2017	104,221	89,572	79,018	3,110	2,801	2,517
2018	105,183	90,293	79,622	3,456	3,109	2,792
2019	106,072	91,073	80,251	3,802	3,415	3,063
2020	106,957	91,843	80,931	4,148	3,722	3,336
2021	107,725	92,486	81,506	4,488	4,022	3,601
2022	108,444	93,195	82,176	4,825	4,324	3,870
2023	109,194	93,959	82,834	5,160	4,619	4,130
2024	110,030	94,829	83,603	5,493	4,914	4,391
2025	110,898	95,644	84,302	5,822	5,202	4,644
2026	111,799	96,453	85,075	6,149	5,489	4,898
2027	112,743	97,315	85,866	6,472	5,771	5,146
2028	113,772	98,267	86,725	6,790	6,046	5,389

Delaying RN Retirement

To what extent would retention of experienced RNs for a few more years beyond traditional retirement points impact the supply of RNs into the future? This question was translated into a planning scenario within the Nurse Supply Model. The results are shown in the chart to the left. Within the model a delay of 1 year is simulated by shifting the age-specific attrition rates forward one year, so that the attrition rate that previously applied to 45 year old RNs is now applied to 46 year old RNs, the attrition rate that previously applied to 46 year-olds is now applied to 47 year-olds, etc.



We chose to simulate 3 different scenarios: a 1 year delay in retirement for all RNs; a 2 year delay; and a 4 year delay. The assumption of the model is that this change in workforce behavior would be consistent across the years of the forecast. Given the current age of the nursing workforce, that assumption may lead to exaggerated estimates in later years of the forecast.

The short-term effects of delays in retirement or work reduction seen among older RNs due to the economic downturn of the past 2 years are currently being felt in the work place. The impact of those changes in behavior can be seen more clearly in the chart to the right which focuses on just a six year period of time, with 2008 as the baseline year. Even a 1 or 2 year delay in retirement has an immediate impact on the size of the RN workforce as measured in FTEs. Within 2 years the supply increases by 861.4 FTE with a 1 year delay, and by 1,128.4 FTEs when RNs delay retirement by 2 years. See Table 4 below for the annualized effects.

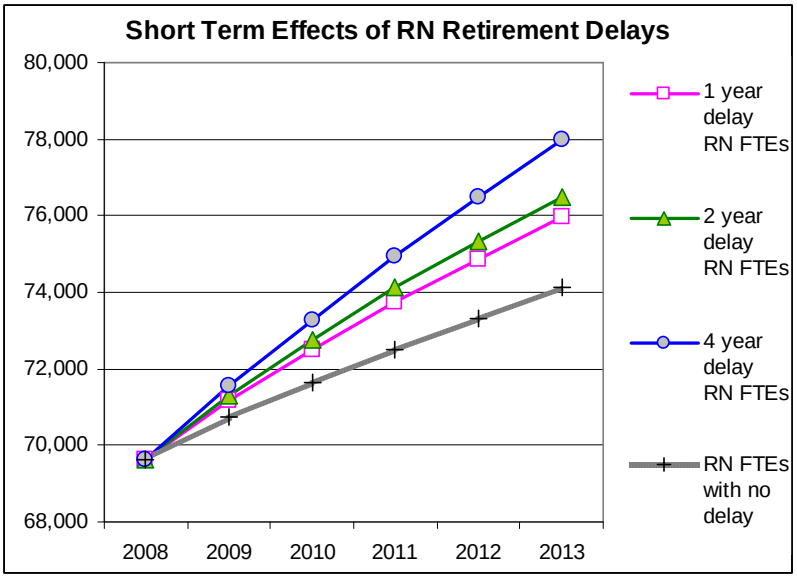


Table 4. Effect of RN Retirement Delays on Future Supply of Virginia RN FTEs

Year	No Delay	1 Year Delay	2 Year Delay	4 Year Delay
2008	69,626.8	69,626.8	69,626.8	69,626.8
2009	70,753.5	71,165.4	71,309.7	71,569.5
2010	71,625.7	72,487.1	72,754.1	73,287.7
2011	72,498.5	73,722.1	74,112.4	74,946.8
2012	73,303.5	74,863.3	75,333.5	76,501.2
2013	74,109.8	75,961.1	76,492.4	77,993.8
2014	74,874.7	77,125.8	77,671.5	79,492.7
2015	75,517.7	78,201.2	78,870.0	80,987.7
2016	76,116.4	79,187.5	80,004.3	82,457.7
2017	76,501.3	79,920.5	80,863.5	83,691.4
2018	76,830.1	80,565.8	81,606.5	84,833.7
2019	77,188.7	81,247.4	82,344.1	85,997.3
2020	77,595.3	81,968.6	83,097.9	87,165.2
2021	77,905.1	82,646.6	83,766.5	88,228.0
2022	78,306.6	83,436.6	84,582.7	89,402.9
2023	78,704.2	84,195.2	85,386.6	90,560.1
2024	79,212.4	85,009.7	86,228.8	91,757.0
2025	79,657.2	85,769.6	86,980.8	92,837.2
2026	80,177.6	86,588.8	87,818.2	93,968.8
2027	80,720.0	87,406.7	88,651.2	95,083.4
2028	81,336.8	88,241.0	89,510.6	96,212.3

Forecast of the LPN Workforce in Virginia

Adjusting the Nurse Supply Model for LPNs

At this point in time there is no estimation model for LPN workforce that has been verified through wide spread use. And, although the Nurse Supply Model was developed with only Registered Nurses in mind, it can be adapted to create forecast estimations for Licensed Practical Nurses (LPNS) as well. The adjustments made to the NSM in order to produce LPN estimates are reviewed below:

- Because LPNs have only a single level of education, the NSM conventions of breaking out baseline counts and age distributions by education level are not necessary when forecasting the LPN workforce. The relevant data for LPNs was entered into the cells reserved in the NSM tables for RNs with a diploma or associate degree education; all other education-related fields were disabled. Fields related to educational upgrades were also disabled since this is not relevant within the LPN workforce.

- Age distribution of LPNs was constructed from data in the 2007 and 2008 Virginia Nursing Workforce Survey and those proportions were applied to the total number of LPNs licensed as of June 30, 2008 to get the count of LPNs by age at baseline required by the model.

- The number of new licensees (called new graduates within the NSM) entering into the workforce was also constructed in a manner consistent with the Virginia RN data. The total count at baseline is the sum of the number of LPNs passing the NCLEX-PN in Virginia in 2008 plus 42% of the number that failed at the first sitting. That 42% figure is based on the statistics reported by the Virginia Board of Nursing[4] regarding the percentage of LPN students who fail the first time, but subsequently pass the NCLEX-PN. There are also a small number of foreign-educated LPNs that receive a license to practice in Virginia each year. In 2008 that number was 12. These were counted in the appropriate place in the model and become incorporated into the long range estimates.

- The interstate migration patterns of LPNs are currently unknown and probably would not be much like the migration patterns of RNs due to differences in their education level and in their job opportunities. Therefore, the assumption in the LPN forecasting model is that the number of LPNs migrating into and out of the state are in balance at baseline (that is, equal to zero) and in all future years.

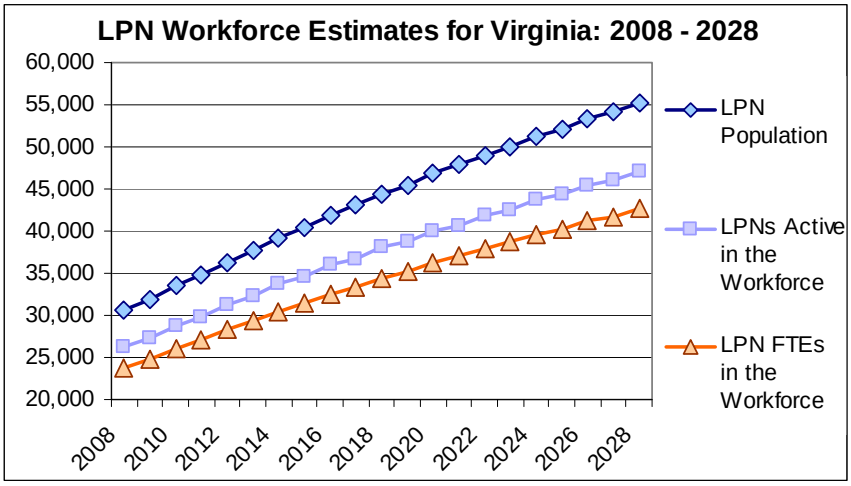
- The NSM uses general population retirement, disability and death rates by age to model when RNs can be expected to permanently leave the workforce. Since we have no evidence that these rates would be different for LPNs we have kept the NSM default values in the model when estimating the future LPN workforce for Virginia.

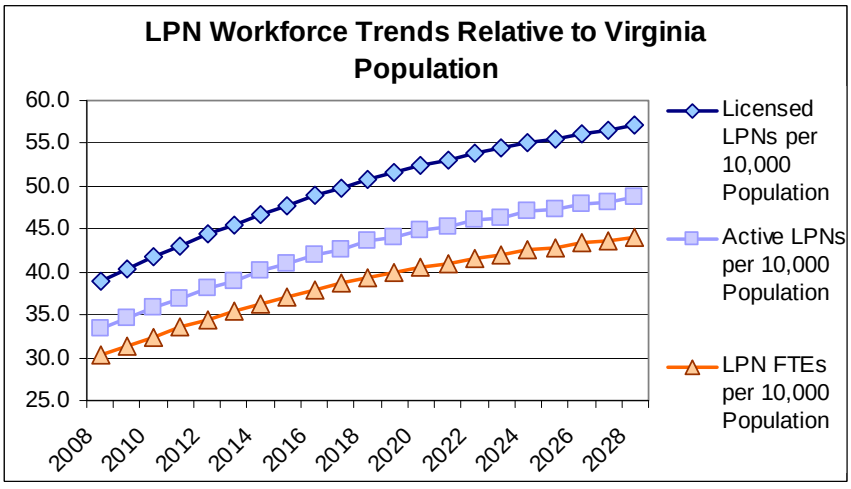
- Work activity rates (the proportion of LPNs engaged in a nursing job or seeking nursing employment) and work participation rates (the number of full-time equivalent LPNs in the

workforce based on hours worked per week) were calculated in the same manner as in the RN forecast model. Employment and hours worked per week information was drawn from data in the 2007 and 2008 Virginia Nursing Workforce Survey, and age specific rates were calculated.

Future LPN Supply Estimates

The model's estimates of future supply for all aspects of the LPN workforce in Virginia shows a steady increase over the period from 2008 to 2028. The total number of licensed LPNs in the state is expected to increase by 45% between 2008 and 2018, and by a total of 81% by 2029 over the number licensed in 2008 (see Table 5 for annual estimates of the LPN workforce). This strong rate of growth may be due, at least in part, to the attrition rates in the model. Those rates are an amalgam of general mortality rates of women by age, and rates of departure from the workforce due to disability or retirement based on information from the 1998, 1999, 2000 and 2001 March waves of the Current Population Survey. The departure rates constructed by the creators of the NSM were based on data for all college-educated women in the United States. This means that the attrition rates in the LPN forecasting model are based on a more educated workforce than would be common among licensed LPNs. This may be inflating the number of LPNs that remain in the workforce over time, and thus our future supply estimates. Unfortunately, without detailed information about when LPNs permanently separate from the workforce it is not possible to judge the size of this effect.





Another factor that may be at play in the different patterns forecast for RNs and LPNs in the state is a previous finding that the LPN workforce is younger than the RN workforce in Virginia.[5] A

younger workforce would be expected to grow faster than an older workforce since the rate of attrition is usually lower among younger worker than older workers.

Contrary to the finding that the RN workforce will grow slower than the general population in Virginia, our forecast of the LPN workforce suggests it will grow faster than the general population. If true, this bodes well for the long term care industry which will struggle to provide care for a rapidly increasing number of older Virginians in the next 20 years.

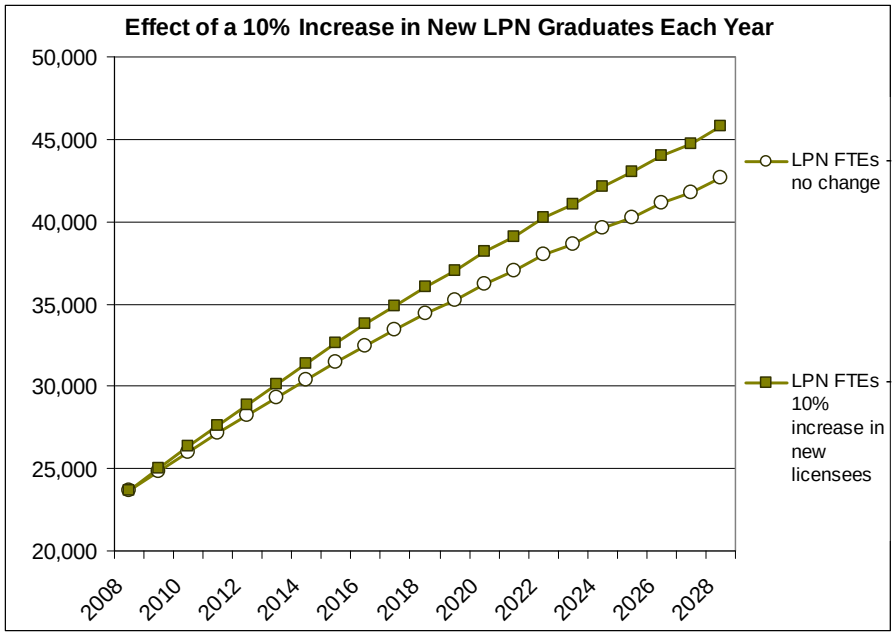
Table 5. Forecast Estimates of the LPN Workforce Supply in Virginia: 2008 - 2028

Year	Licensed LPNs	LPNs Active in the Workforce	LPN FTEs in the Workforce	General Population in Virginia	Licensed LPNs per 10,000 Population	LPN FTEs per 10,000 Population
2008	30,535	26,199	23,682.2	7,827,657	39.0	30.3
2009	31,973	27,389	24,858.4	7,919,021	40.4	31.4
2010	33,479	28,765	25,989.6	8,010,245	41.8	32.4
2011	34,850	29,874	27,157.8	8,101,489	43.0	33.5
2012	36,353	31,265	28,246.9	8,192,854	44.4	34.5
2013	37,696	32,297	29,324.6	8,284,309	45.5	35.4
2014	39,166	33,672	30,415.4	8,375,648	46.8	36.3
2015	40,447	34,650	31,458.2	8,466,864	47.8	37.2
2016	41,854	35,949	32,489.6	8,557,758	48.9	38.0
2017	43,030	36,761	33,399.6	8,648,333	49.8	38.6
2018	44,374	38,071	34,423.3	8,738,451	50.8	39.4
2019	45,511	38,791	35,223.0	8,828,145	51.6	39.9
2020	46,792	40,069	36,248.5	8,926,113	52.4	40.6
2021	47,848	40,726	36,983.4	9,017,970	53.1	41.0
2022	49,043	41,946	37,970.0	9,109,828	53.8	41.7
2023	50,042	42,545	38,646.5	9,201,685	54.4	42.0
2024	51,188	43,716	39,588.5	9,293,542	55.1	42.6
2025	52,157	44,342	40,268.3	9,385,399	55.6	42.9
2026	53,257	45,436	41,146.1	9,477,256	56.2	43.4
2027	54,164	46,002	41,748.5	9,569,114	56.6	43.6
2028	55,219	47,066	42,628.3	9,659,128	57.2	44.1

Scenarios affecting the LPN Forecast for Virginia

Increasing LPN Production

Following the same analysis strategy used for RNs, we tested a scenario in which the production of new LPNs is increased by 10% each year, beginning in 2009. The chart shows the results of that analysis.



A 10% increase in the number of new LPNs passing the NCLEX-PN exam and becoming licensed in Virginia would, over time, result in an additional 1,800 LPN FTEs in the workforce by 2019 and more than 3,000 additional LPN FTEs by the year 2028. See Table 6 for the annual estimates of LPN supply under this scenario of a 10% increase in new licensees (called "new graduates" in the context of the Nurse Supply Model).

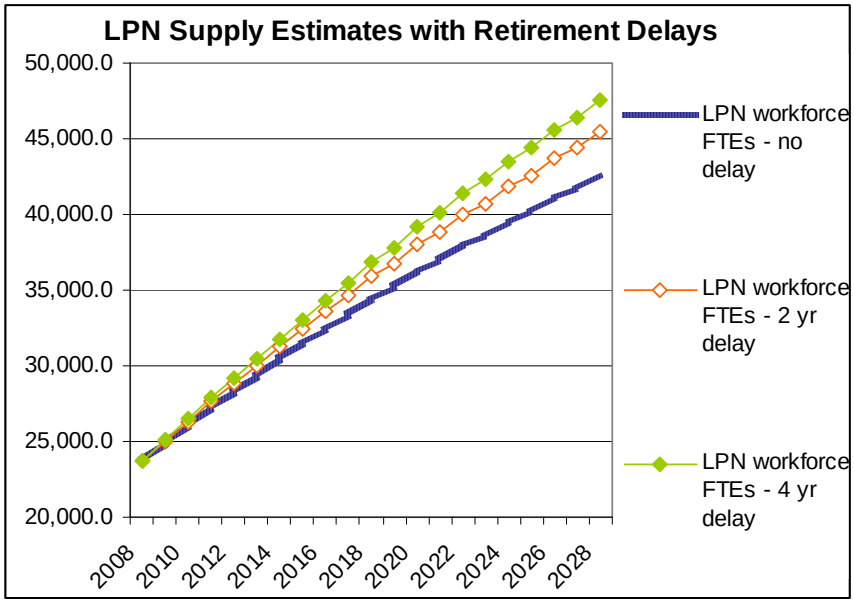
Consistently increasing the production of new LPNs by 10% each year would have to address the same problems noted earlier in regard to increasing the production of RNs: the limited number of qualified faculty; the cost of additional classroom space and learning equipment; and limited clinical practice sites for students. However, there is a high attrition (loss) rate of students within practical nursing education programs. If more students can be retained and graduated, and pass the licensing examination, then some of the growth in this scenario could be derived with current resources.

Table 6. LPN Workforce Forecast if New Graduates are Increased 10% Each Year

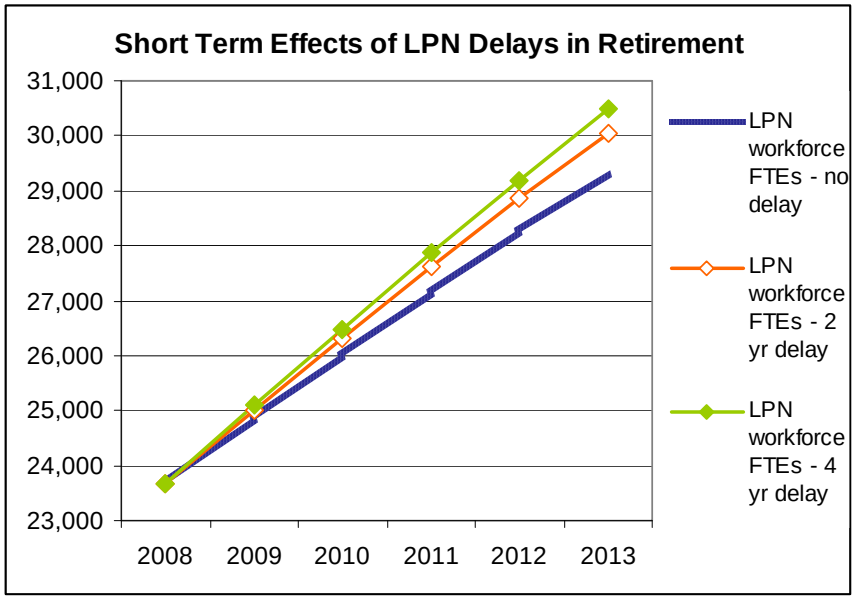
Year	Licensed LPNs w/10% adjustment	Active LPNs w/10% adjustment	LPN FTEs w/10% adjustment	Additional Licensed LPNs	Additional Active LPNs	Additional LPN FTEs
2008	30535	26,199	23,682	0	0	0
2009	32183	27,575	25,026	210	186	167
2010	33897	29,134	26,322	418	369	332
2011	35474	30,427	27,655	625	553	497
2012	37185	31,999	28,910	832	735	663
2013	38735	33,214	30,152	1038	917	828
2014	40410	34,772	31,408	1244	1100	993
2015	41898	35,933	32,615	1450	1282	1,157
2016	43508	37,412	33,810	1654	1463	1,321
2017	44888	38,402	34,882	1858	1641	1,482
2018	46434	39,890	36,069	2060	1820	1,645
2019	47774	40,786	37,028	2263	1996	1,805
2020	49256	42,241	38,214	2464	2172	1,965
2021	50510	43,070	39,104	2662	2344	2,121
2022	51900	44,458	40,244	2857	2512	2,274
2023	53092	45,225	41,072	3051	2680	2,426
2024	54430	46,560	42,163	3242	2843	2,574
2025	55588	47,348	42,990	3431	3006	2,722
2026	56875	48,601	44,013	3618	3165	2,867
2027	57966	49,323	44,757	3802	3321	3,008
2028	59202	50,540	45,775	3983	3474	3,147

Delaying LPN Retirement

A scenario in which LPNs delay their exit from the labor force was run to examine how such a change would influence the long range forecast of LPN supply in Virginia. The results, measured in terms of full-time equivalents (FTEs) in the workforce, are summarized in the charts here. The numbers can be found in Table 7 on the following page.



Because the LPN workforce in Virginia is slightly younger than the RN workforce in the state the impact of delaying retirement among LPNs is smaller than what we saw earlier for RNs. Yet there is still a sizeable impact on the size of the LPN FTE workforce over time.



The short-term impact of delays in retirement are illustrated in the chart to the left. Over a period of just five years, a two year delay in LPN retirements would add approximately 728 FTEs to the LPN workforce – about a 3% increase from the starting point in 2008.

Table 7. Effect of LPN Retirement Delays on Future Supply of Virginia LPN FTEs

Year	No Delay	2 Year Delay	4 Year Delay
2008	23,682.2	23,682.2	23,682.2
2009	24,858.4	25,023.0	25,113.8
2010	25,989.6	26,318.6	26,462.5
2011	27,157.8	27,630.9	27,871.3
2012	28,246.9	28,875.9	29,178.8
2013	29,324.6	30,052.9	30,477.2
2014	30,415.4	31,306.0	31,796.8
2015	31,458.2	32,446.7	33,072.1
2016	32,489.6	33,655.9	34,349.7
2017	33,399.6	34,674.9	35,516.8
2018	34,423.3	35,885.6	36,807.3
2019	35,223.0	36,754.1	37,841.8
2020	36,248.5	37,976.4	39,146.7
2021	36,983.4	38,785.0	40,117.7
2022	37,970.0	39,965.5	41,381.8
2023	38,646.5	40,722.4	42,296.7
2024	39,588.5	41,861.9	43,520.2
2025	40,268.3	42,610.2	44,430.1
2026	41,146.1	43,679.6	45,583.8
2027	41,748.5	44,364.6	46,427.2
2028	42,628.3	45,433.6	47,584.9

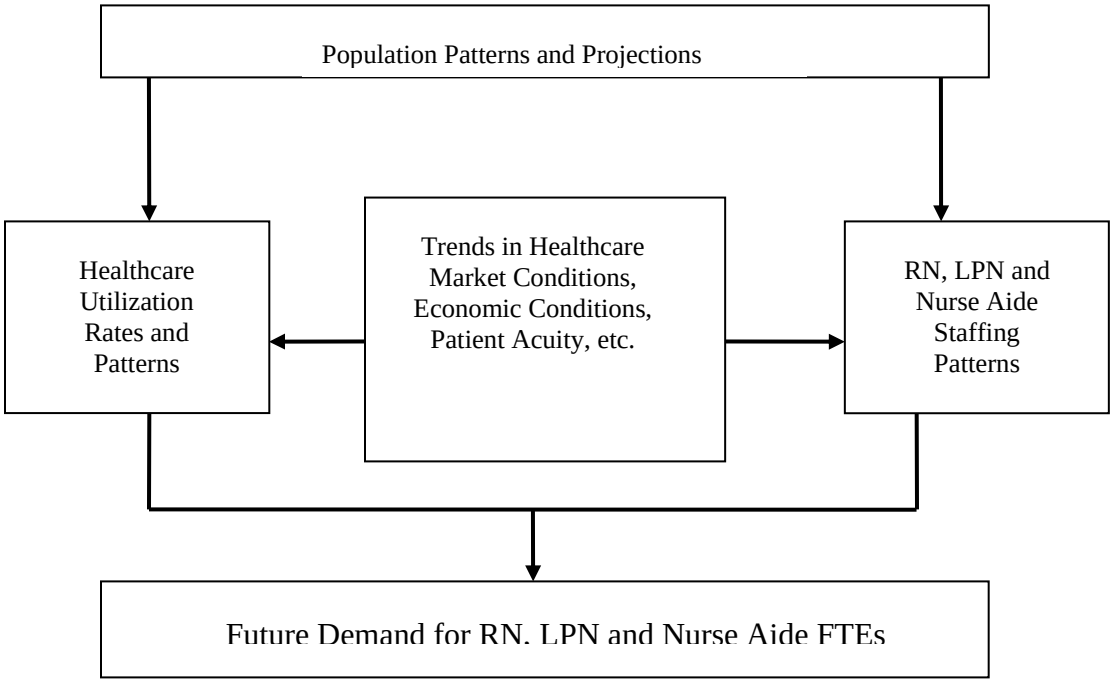
Forecasting the Demand for Nurses in Virginia

Nurse Demand Model Overview

Information about the future nursing workforce supply is most useful when it can be compared to an estimate of the demand for nurses. Only then can a determination be made as to whether or not an estimated future supply will be adequate. We used the HRSA Nurse Demand Model to forecast the demand for RNs and LPNs in Virginia over the period 2008 – 2028.

The Nurse Demand Model is an econometric forecasting model that combines historical trend analysis, population-to-provider ratio analysis and a service target approach to estimate the demand for nursing services in the future. Released by the Bureau of Health Professions at HRSA in 2004, this model produces annual estimates of demand at the state level over a twenty five year period. More information about the model can be found in Biviano, et.al.[6]

Figure 1. Simplified Description of the Nurse Demand Model



There are three principle components to the Nurse Demand Model: 1) per capita healthcare utilization rates that capture the level of demand for medical services at a personal level; 2) detailed characteristics of the population being served broken down by age, gender, and urban or rural location which interact with the utilization rates to determine the demand for services by

the entire population; and 3) staffing levels (measured in FTEs) for nursing personnel by setting type during the baseline year. The model relies on changes in population size and composition to drive future levels of demand for both healthcare services and nurses, modified by an extensive set of exogenous variables representing the state's healthcare operating environment, economic conditions, population characteristics and associated health status.[7]

All nursing workforce demand estimates are reported in terms of full-time equivalents (FTEs) for RNs, LPNs and nurse aides. RN estimates are broken down into twelve settings or practice areas: hospital in-patient, hospital out-patient, hospital emergency department, long-term care hospitals, nursing homes, ambulatory care facilities, home health agencies, occupational health, student health, public health departments and clinics, and all other settings. Demand for LPNs is estimated for hospital in-patient units, long-term care hospitals, nursing homes, home health, and all other settings. Aggregation over these setting-specific estimates produces the annual total demand estimates for RNs or LPNs. The Nurse Demand Model also estimates the demand for nurse aides in the same settings as LPNs. However, because we were not able to determine a reliable source of information regarding nurse aides in Virginia in the baseline year of 2008 we were not able to modify that aspect of the model. The result is that any demand estimates produced for nurse aides in this analysis are based on the default data and may not represent the current reality in Virginia.

Nurse Demand Model Input Data Replacement

For state-level workforce planners, the Nurse Demand Model provides all the data needed to produce state-specific forecast estimates. Most of the data that arrives with the model is based on national trends and healthcare utilization rates. The RN staffing levels are based on data from the National Sample Survey of Registered Nurses, and use multiple data sources for LPN and nurse aide staffing patterns. However, the model also allows for new data values to be imported into the model and for the baseline year to be adjusted. Tables 9 through 13 describe the data elements that can be changed within the model and indicates which ones were replaced with Virginia-specific information based on our baseline year of 2008. When a field is identified as "fixed" that means that a baseline year value is entered and that baseline value is the only value used by the model. When a field is identified as "variable" then the field requires input data for multiple years or an assumption about future trends for each year in the projection period. For fields requiring an assumption regarding change over time, the actual value entered for the baseline year is less important than the rate of change over time. It is the trend in the data values that produce change within the model estimates. For example, we chose to use the default values for nurse wages because the dollar values were not as important as the relative balance between the different types of nurses and how those values trended over time.

Nurse Staffing Levels at Baseline: The Nurse Demand Model uses the distribution of nurses over a variety of work settings at baseline to establish staffing levels within the model. A comparison was made of the default data provided by the NDM and comparable information generated from the 2007 and 2008 Virginia nursing workforce survey results on the distribution

of nurses across employment settings. The way in which RNs were distributed in the NDM default data was slightly different than the patterns seen in the Virginia survey data (see Table 8). However, the source data for the NDM default data is the 1996 National Sample Survey of RNs. That source used a more detailed description of hospital setting options (i.e., hospital in-patient, hospital out-patient, hospital emergency department, long term hospital) than was available in the Virginia replacement data. This difference in how the data was collected may account for some or all of the difference between the two data sources. Also, time is a factor in that the NDM baseline uses a measure from 1996 compared to our Virginia data which was collected in 2007 and 2008. The proportion of RNs in non-hospital settings were similar between the two data sources, with the exception of the 'other' category which might contain some of the discrepancies related to hospital employment patterns within the Virginia source data.

Table 8. RN FTE Counts and Proportions in the Nurse Demand Model

	NDM default data proportions	VA source proportions:	NDM Baseline RN FTE Counts - 1996	NDM Default Model Projected Counts for VA in 2008	Virginia Source Data RN FTE Counts – 2008
	%	%	#	#	#
All hospital settings:	0.623	0.538			
Hospital -outpatient	[0.033]	na	1,554	2,344	1,958
Hospital -inpatient	[0.441]	na	21,078	23,616	26,588
Hospital -emergency	[0.038]	na	1,829	1,937	2,308
Long term Hospitals	[0.111]	na	5,285	6,224	6,668
Long term care	0.054	0.064	2,601	3,923	4,604
Ambulatory care	0.131	0.131	4,106	4,842	8,868
Home health	0.059	0.055	2,816	3,201	3,794
Occupational health	0.014	0.010	649	734	665
School health	0.030	0.031	1,410	1,613	2,144
Public health	0.048	0.030	2,292	2,596	2,149
Nursing education	0.027	0.026	1,275	1,489	1,832
All other settings:	0.060	0.114	2,870	3,250	8,049
Totals:	100%	100%	47,765	55,769	69,627

We used the proportions from the NDM default data on how RNs were distributed across the four hospital-based settings and applied those detailed hospital-type proportions to the Virginia source data count of RN FTEs employed in hospitals. The remaining Virginia RN FTE distributions are based on the findings from the 2007 and 2008 Virginia Nursing Workforce Survey (see Table 8). Be advised that the larger proportion of RNs captured in the 'other settings' category in the Virginia source data means that there may be undercounts in some of the

Table 9. Nurse Demand Model Data Elements, Characteristics and Sources – Exogenous Table

Field Name in the NDM	Field Description	Value Across Time	NDM Data Source	Virginia Data Source
Exogenous Variables				
AGE_M	mean age of population forecast over time	variable	U.S. Census Bureau	U.S. Census Bureau updated tables
BASE_ED	total population age 5 – 17 in the baseline year	fixed	U.S. Census Bureau	U.S. Census Bureau updated tables
BASE_OC	total population age 18 – 64 in the baseline year	fixed	U.S. Census Bureau	U.S. Census Bureau updated tables
BASE_POP	total population in the baseline year	fixed	U.S. Census Bureau	U.S. Census Bureau updated tables
ED_POP	total population age 5 – 17 forecast over time	variable	U.S. Census Bureau	U.S. Census Bureau updated tables
HH_MCR	average Medicare payment per home health visit	variable	assumes a 1% annual increase	NDM default
HISPANIC	percent of population that is Hispanic forecast over time	variable	U.S. Census Bureau	U.S. Census Bureau updated tables
HMO	percent of population enrolled in HMOs	variable	assumes a ½% annual increase	2008 value for Virginia from statehealthfacts.org – no increase
MEDICAID	percent of population enrolled in Medicaid	variable	extrapolation based on population projections	NDM default
NF_MCD	average Medicaid payment per day for nursing facility care	variable	assumes a 1% annual increase	NDM default
NHADL	average number of activities of daily living (ADL) limitations per nursing home resident	variable	assumes a ½% annual increase	NDM default
NONWHITE	percent of population that is not white forecast over time	variable	U.S. Census Bureau	U.S. Census Bureau updated tables
OCC_POP	total population age 18 – 64 forecast over time	variable	U.S. Census Bureau	U.S. Census Bureau updated tables
PCPI	per capita personal income	variable	assumes a 1% annual increase	NDM default
POPULATION	total state population forecast over time	variable	U.S. Census Bureau	U.S. Census Bureau updated tables
SURGERY	percent of hospital surgeries performed on in out-patient setting	variable	assumes a 2% annual increase	NDM default

Field Name in the NDM	Field Description	Value Across Time	NDM Data Source	Virginia Data Source
Exogenous Variables continued -				
UNINSURED	percent of population with no health insurance	variable	extrapolated based on projected population changes	NDM default
URBAN	percent of population living in metropolitan areas	fixed	U.S. Census Bureau	NDM default
WAGE_HHA	average wage for home health aides	variable	assumes a fixed ratio against other nurse types	NDM default
WAGE_LPN	average wage for LPNs	variable	assumes a fixed ratio against other nurse types	NDM default
WAGE_NA	average wage for nurse aides	variable	assumes a fixed ratio against other nurse types	NDM default
WAGE_RN	average wage for RNs	variable	assumes a fixed ratio against other nurse types	NDM default

Table 10. NDM Data Elements, Characteristics and Sources – Utilization Rates Table

NDM Field Description	Value Across Time	NDM Data Source	Virginia Data Source
Healthcare Utilization Rates Table			
Utilization rates by setting, gender, age and rural or urban location	fixed	Health Cost Utilization Project, National Hospital Ambulatory Care Survey, National Nursing Home Survey, and other sources	NDM default values

Table 11. NDM Data Elements, Characteristics and Sources – Healthcare Utilization Tables

NDM Field Description	Value Across Time	NDM Data Source	Virginia Data Source
Healthcare Use in Base Year Table			
Short term hospital outpatient visits	fixed	2000 and 2001 Area Resource File	NDM default
Short term hospitals inpatient days	fixed		NDM default
Short term hospitals emergency visits	fixed		NDM default
Long term hospitals emergency visits	fixed		NDM default
Long term hospitals inpatient days	fixed		NDM default
# of nursing facility residents	fixed	American Health Care Association publications	NDM default
# of home health visits	fixed	Center for Medicare/Medicaid Services	NDM default

Table 12. NDM Data Elements, Characteristics and Sources – Population Table

Field Name in the NDM	Field Description	Value Across Time	NDM Data Source	Virginia Data Source
Population Table				
Males age 0 - 4 Males age 5 - 18 Males age 19 - 24 Males age 25 - 44 Males age 45 - 64 Males age 65 - 74 Males age 75 - 84 Males age 85 and over Females age 0 - 4 Females age 5 - 18 Females age 19 - 24 Females age 25 - 44 Females age 45 - 64 Females age 65 - 74 Females age 75 - 84 Females age 85 and over	State population in 8 age categories by gender and year from baseline over 20 years	variable	U.S. Census projections	U.S. Census Bureau updated projection tables for Virginia

Table 13. NDM Data Elements, Characteristics and Sources – Nurse Staffing Table

NDM Field Description	Value Across Time	NDM Data Source	Virginia Data Source
Nurse Population (RNs, LPNs and nurse aides) at Baseline			
Settings for RNs:			
Short-term hospital -outpatient	fixed	1996 National Sample Survey	2007 and 2008 Virginia Nursing Workforce Survey data; Virginia hospital RNs were divided into inter-hospital settings using the default data proportions
Short-term hospital -inpatient	fixed		
Short-term hospital -emergency	fixed		
Long term Hospitals	fixed		
Long term care	fixed		
Ambulatory care	fixed		
Home health	fixed		
Occupational health	fixed		
School health	fixed		
Public health	fixed		
Nursing education	fixed		
All other settings:	fixed		
Settings for LPNs:			
Short-term hospital -inpatient	fixed	Area Resource File, BLS Occupational Employment Statistics, American Health Care Association data	2007 and 2008 Virginia Nursing Workforce Survey data
Long term Hospitals	fixed		
Long term care	fixed		
Home health	fixed		
All other settings:	fixed		
Settings for nurse aides:			
Short-term hospital -inpatient	fixed	Area Resource File, BLS Occupational Employment Statistics, American Health Care Association data	NDM default
Long term Hospitals	fixed		NDM default
Long term care	fixed		NDM default
Home health	fixed		NDM default
All other settings:	fixed		NDM default

categories used within the model and, if true, over time the estimates of the demand for nurses in those settings generated by the model will be understated. This inability to measure the deployment of nurses across work settings in exactly the same way as that used by the NDM model can be expected to introduce measurement error into the final projections in another way since the projections are based on the intersection of service utilization rates and nurse staffing patterns within specific workforce settings. Starting with an undercount of the true staffing levels in a specific workforce setting will result in systematic undercounts throughout the model projection period.

Population Estimates: Specific population counts and trends are one of the most important elements in the Nurse Demand Model because these values establish the volume of healthcare services at baseline and in the projected future. The default data supplied with the NDM was drawn from the U.S. Census Bureau prior to the 2000 census but was then adjusted for early census results. However, more recent adjustments have been made that show more rapid growth in Virginia than the earlier figures.

We have replaced the default NDM population projections with figures released by the U.S. Census Bureau, Interstate Population Projections, 2005 for Virginia which are based on the 2000 census and all subsequent adjustments made through 2005. Population-based statistics located in the NDM Exogenous Table, such as the percentage of the population that is Hispanic, or non-white, or mean age were all calculated from the Virginia estimates in the State Interim Population Projections by Age and Sex: 2004-2030 published on-line by the U.S. Census Bureau.

Future Nurse Demand Estimates

The demand estimates generated by the model show a steady increase for all types of nursing personnel over the next 20 years. The demand for RNs is expected to increase from approximately 70,000 in 2008 to approximately 80,000 in 2017. By 2032 the demand for RN FTEs is forecast to be 109,000 – an increase of 55% over a 25 year period (see Table 14 for the annual demand estimates). Some of this growth in demand is driven by the growth expected to occur in the general population of Virginia. Beginning with a population of approximately 7,828,000 in 2008, Virginia is expected to add an additional two million people into the state by 2030 for a total population of approximately 9,825,000. That is a growth rate of 28% for the general population.

Note that in the early years of the demand forecast there is a slight decrease in demand for both RN FTEs and nurse aide FTEs predicted for 2010. This decrease in demand is also seen in the default model estimates and does not appear to be a result of Virginia population changes or other factors for which more recent Virginia data was entered into the model. It is more likely a result of the assumptions in the Nurse Demand Model about healthcare utilization rates, especially those affecting hospital care since it plays out in the estimates for RNs and nurse aides, but not LPNs. Only a very small percentage of LPNs are employed in hospitals.

Table 14. Estimated Demand for Nursing Personnel in Virginia: 2008 - 2030

Year	Demand for RN FTEs	Demand for LPN FTEs	Demand for nurse aide FTEs
2008	70,469	23,682	32,173
2009	71,550	24,122	33,016
2010	68,730	24,952	31,637
2011	70,365	25,498	32,707
2012	73,142	25,305	33,843
2013	73,538	26,287	34,497
2014	74,542	27,205	35,157
2015	76,517	27,453	36,600
2016	78,065	28,048	37,560
2017	79,686	28,676	38,579
2018	81,285	29,282	39,578
2019	82,959	29,908	40,634
2020	84,696	30,596	41,780
2021	86,400	31,258	42,908
2022	88,122	31,962	44,085
2023	90,043	32,694	45,356
2024	92,022	33,544	46,805
2025	94,205	34,413	48,349
2026	96,210	35,271	49,821
2027	98,435	36,211	51,449
2028	100,517	37,113	53,020
2029	102,808	38,102	54,776
2030	104,979	39,156	56,571
2031	107,256	40,201	58,371
2032	109,353	41,224	60,111

Why would the demand for nurses grow so much faster than the growth in the general population? The Nurse Demand Model includes changes in the age, race and gender composition of the population which are important predictors of the amount of healthcare utilization that can be expected in Virginia. One of the factors contributing to the rapid growth in demand for healthcare services and the nurses required to deliver those services is the aging of the population in Virginia. In 2008 the number of people age 65 and older in the state was approximately 940,000 and constituted 11.6% of the total population. By 2030 the number of people age 65 and older is expected to grow to approximately 1,844,000 and make up 18.8% of the population. That rapid growth is a 108% increase over 2008 levels. This aging of the population can be expected to greatly increase the demand for healthcare services and the associated nursing care.

Table 15 breaks down the demand estimates for Registered Nurses into the different practice settings used in the model. These setting-specific estimates are driven by the statistics in the model related to service utilization and how those utilization patterns differ by gender, race and

age. Not all settings will experience the same rapid growth in demand due to differences in the patient populations they serve. The demand for RNs is expected to grow most rapidly in skilled nursing facilities that primarily provide services to older people. Home health services and hospital out-patient care services are also expected to experience large growth in demand for RNs.

Table 15. RN FTE Demand Estimates by Setting and Year

Setting	2008	2012	2017	2022	2027	2032	Growth Rate 2008-2032
Short-term hospitals:							
outpatient	1,958	2,301	2,624	3,023	3,462	3,807	94.4%
inpatient	26,588	27,024	29,337	32,383	36,143	39,807	49.7%
emergency dept	2,308	2,395	2,531	2,670	2,829	3,000	30.0%
Long term hospitals	6,668	7,026	7,634	8,508	9,520	10,529	57.9%
Resident nursing facilities	4,604	5,415	6,502	7,817	9,704	12,209	165.2%
Ambulatory care	8,868	9,484	10,035	10,818	11,698	12,662	42.8%
Home health	3,794	3,160	3,724	4,573	5,689	6,854	80.7%
Occupational health	665	694	715	732	747	765	15.0%
School health	2,144	2,174	2,284	2,430	2,558	2,683	25.1%
Public health	2,149	2,252	2,380	2,507	2,632	2,762	28.5%
Nursing education	1,832	1,924	2,097	2,319	2,590	2,877	55.2%
All other settings	8,049	9,292	9,822	10,345	10,863	11,397	28.5%
Total RN FTE demand:	**70,469**	**73,141**	**79,685**	**88,125**	**98,435**	**109,352**	**55.2%**

Note: The Nurse Demand Model incorporates a small (7%) inflation factor into the estimate of demand for nurses in hospital in-patient settings at baseline under the assumption that there is already a nursing shortage at that point in time. This was true in 1996 when the original model was developed and remained true in 2004 when the current version was released. That is why the total nurse demand estimate at baseline is not the same figure as the actual nurse staffing levels at that point in time.

A similar analysis of the demand for LPNs by setting is summarized in Table 16. Note that the Nurse Demand Model uses a much smaller number of settings when forecasting for LPNs. Not surprisingly, it is skilled nursing facilities where the largest rate of growth in demand for LPN FTEs is expected to occur: a growth rate of 160% between 2008 and 2032. However, the home health industry is expected to experience a growth rate almost as large: 134% over the same period. The demand for LPNs in hospital in-patient settings is not expected to grow as fast as most other settings defined in the model, and not as rapidly as the expected growth for RNs. This may be due, in part, to the balance of RNs and LPNs in Virginia hospitals at baseline. Based on information reported in the 2007 and 2008 Nurse Workforce Surveys of licensed nurses in Virginia, only about 13% of the hospital-based nursing workforce is composed of LPNs.

Table 16. LPN FTE Demand Estimates for Virginia by Setting and Year

Setting	2008	2012	2017	2022	2027	2032	Growth Rate 2008-2032
Short-term hospitals - inpatient	6,555	6,983	8,038	8,749	9,589	10,459	59.6%
Long term hospitals	986	1,028	1,201	1,349	1,529	1,708	73.2%
Resident nursing facilities	4,970	5,787	6,994	8,356	10,334	12,945	160.5%
Home health	1,666	1,548	1,915	2,420	3,115	3,897	133.9%
All other settings	9,505	9,960	10,527	11,088	11,643	12,216	28.5%
Total LPN FTE demand:	**23,682**	**25,306**	**28,675**	**31,962**	**36,210**	**41,225**	**74.1%**

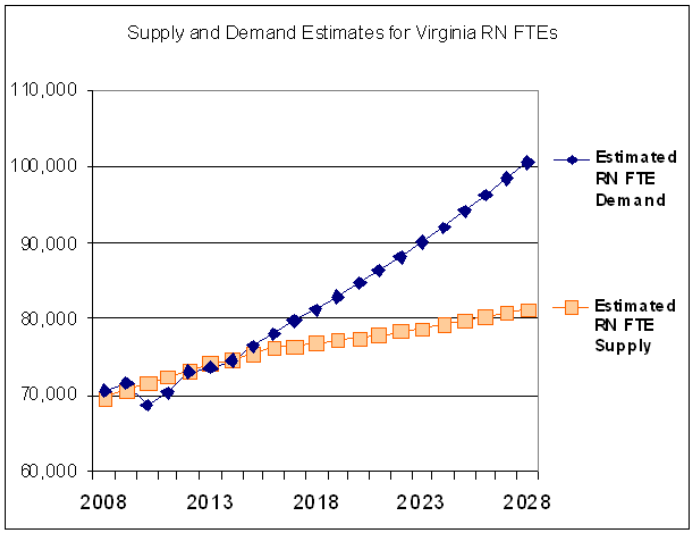
Note: When demand estimates by setting are summed for a specific year, the resulting sum may be slightly different that the number reported in earlier tables due to rounding within the model as the estimates are produced.

Combining Future Nurse Supply and Demand Estimates for Virginia

Knowing either the projected demand for nurses or the projected supply in isolation is not very informative. It is only by putting those projections together that we can address the question of whether the expected supply will be adequate to meet the expected demand for services. In this section of the report the long-range estimates of RN and LPN supply generated by the Nurse Supply Model are brought together with the long-range estimates of the demand for nursing services generated by the Nurse Demand Model. Both of these models have been modified to reflect current nurse labor market conditions in Virginia.

A word of caution is in order, though. In a free market economy labor market demand and supply work in tandem to create balance. They are responsive to each other through the mechanism of wages. As demand for a certain type of worker outgrows supply, wages increase – bringing more workers into that segment of the market place. As worker supply exceeds demand, wages stagnate or fall, encouraging workers to look in a different segment of the economy for a job and/or reducing the number of new entrants. For that reason, comparing the long-range estimates of nurse supply and demand generated by the HRSA models can be problematic. These models do not take the other's forecast into account. However, because the changes expected to take place in the demand for healthcare in the next 20 years are driven largely by an unusually large and aging cohort (i.e. the "baby boom" generation), and the decrease in supply is a result of those same "baby boomers" moving out of the workforce due to retirement, normal market forces may not be able to address the imbalance in a timely way.

RN Supply and Demand



Results show a relative balance of supply and demand for RNs in 2008 and 2009 – which indeed seems to be the case. The model projects a decline in demand for RNs in 2010 and then an immediate increase. The source of this brief decline in demand is not clear, but seems to be related to healthcare utilization assumptions within the model. All in all, the nursing workforce in Virginia is expected to be more or less in balance through 2015. At that point a shortage is projected to develop based on a sharp increase in demand for nursing services. That shortage is expected to increase in severity very rapidly, based on the assumptions of the Nurse Demand Model that healthcare utilization patterns related to age, race and gender seen in the

1990s and early 2000s will persist into the future. A cumulative shortage over the next ten years period (i.e., 2009 to 2019) is projected to be between 10,000 to 12,000.[1]

The current economic downturn, which began in 2007, has resulted in the retention of nurses in the workforce who otherwise might have left or cut back on their workforce participation. That set of circumstances is contributing to the current balance. If an economic recovery occurs suddenly the projected shortage could develop sooner. If the economy is slow to recover, it could result in more nurses delaying retirement and putting off the shortage for a few more years.

Table 17. Supply, Demand and Shortage/Surplus Estimates for RN FTEs: 2008 - 2028

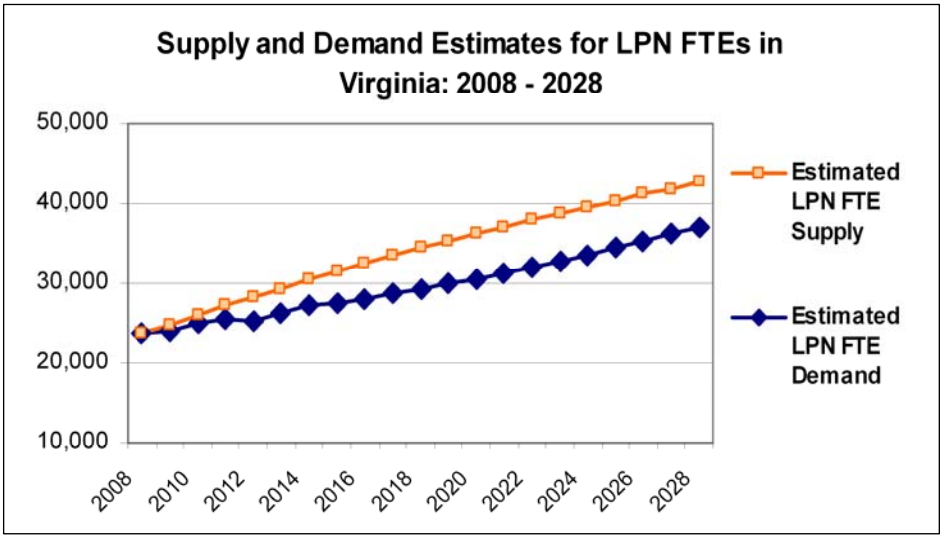
Year	Future Supply Estimates for RN FTEs in Virginia	Future Demand Estimates for RN FTEs in Virginia	Shortage Estimates for RN FTEs in Virginia
2008	69,627	70,469	-842
2009	70,754	71,550	-796
2010	71,626	68,730	2,896
2011	72,498	70,365	2,133
2012	73,304	73,142	162
2013	74,110	73,538	572
2014	74,875	74,542	333
2015	75,518	76,517	-999
2016	76,116	78,065	-1,949
2017	76,501	79,686	-3,185
2018	76,830	81,285	-4,455
2019	77,189	82,959	-5,770
2020	77,595	84,696	-7,101
2021	77,905	86,400	-8,495
2022	78,307	88,122	-9,815
2023	78,704	90,043	-11,339
2024	79,212	92,022	-12,810
2025	79,657	94,205	-14,548
2026	80,178	96,210	-16,032
2027	80,720	98,435	-17,715
2028	81,337	100,517	-19,180

Note: A negative number in the shortage estimate column indicates that demand is greater than supply. A positive number indicates that supply is greater than demand.

[1] This ten-year cumulative shortage is calculated by summing FTE shortage yearly estimates for 2009 through 2019, resulting in a total shortage for the decade of -11,058. Because no long-term projection is perfect and is as good as its most recent data, conservative range of 10,000 to 20,000 is offered here. Factor values will change over time and need to be incorporated into future projections. For example, population estimates will be updated with the 2010 census and will be used to refine the projections in future reports.

However, eventually nurses from the baby-boom cohort will leave the workforce. They will need to be replaced, in addition to the nurses that will be needed to fill new jobs being created by the increasing demand for nursing services. One unanticipated consequence of the current economic climate is that as older RNs increase their work hours and/or delay their retirements, fewer positions are available to new nurses just graduating from entry-level nursing education programs. This has created the perception that the nursing shortage, as we have known it over the past few years, has been solved. While that might be true in the short-term, there is little doubt that a shortage will develop as the largest generation in the history of the United States reaches their sixties and seventies. The increase in demand for health care services the baby boom generation will create will mirror the demand for educational capacity they ignited in the 1950s and 1960s when schools couldn't be built fast enough to house all of the in-coming students. We will need to be more proactive in planning for our healthcare system and keep the long-range forecast in mind.

LPN Supply and Demand



The supply and demand forecast for the LPN workforce in Virginia looks much different than that for RNs. The chart below shows that the supply of LPNs is expected to exceed demand for their services, resulting in a surplus. It is unlikely that a surplus as large as that depicted in the chart or Table 18 would actually develop. As noted earlier, market forces in an open economy work to balance worker supply and demand through adjustments in the wage level. Should the demand for LPNs drop below the available supply we could expect to see LPN wages drop or stagnate until enough of them have left the healthcare field to reach a balance.

However, if there is sufficient interest in the LPN role to generate the surplus seen in the chart and table, that presents an opportunity to address the RN shortage predicted earlier. Career ladders can be developed to help move experienced LPNs into RN education programs. This would free up positions for new entrants into the LPN workforce, and produce more RNs to address the shortages in that workforce. In addition, experienced LPNs can potentially complete the RN education curriculum faster than the traditional two years, improving the efficiency of the RN educational process for this group; and because LPNs are already familiar with the demands of the nursing profession they are more likely to complete their RN training and stay in the workforce once that

training is complete. One complicating issue, however, is whether most LPNs are educationally prepared for the rigors of the RN curriculum.

Table 18. Supply, Demand and Shortage/Surplus Estimates for LPN FTEs: 2008 - 2028

Year	Future Supply Estimates for LPN FTEs in Virginia	Future Demand Estimates for LPN FTEs in Virginia	Shortage Estimate for LPN FTEs in Virginia
2008	23,682.2	23,682	0
2009	24,858.4	24,122	736
2010	25,989.6	24,952	1,038
2011	27,157.8	25,498	1,660
2012	28,246.9	25,305	2,942
2013	29,324.6	26,287	3,038
2014	30,415.4	27,205	3,210
2015	31,458.2	27,453	4,005
2016	32,489.6	28,048	4,442
2017	33,399.6	28,676	4,724
2018	34,423.3	29,282	5,141
2019	35,223.0	29,908	5,315
2020	36,248.5	30,596	5,652
2021	36,983.4	31,258	5,725
2022	37,970.0	31,962	6,008
2023	38,646.5	32,694	5,952
2024	39,588.5	33,544	6,045
2025	40,268.3	34,413	5,855
2026	41,146.1	35,271	5,875
2027	41,748.5	36,211	5,537
2028	42,628.3	37,113	5,515

Note: A negative number in the shortage estimate column indicates that demand is greater than supply. A positive number indicates that supply is greater than demand.

Conclusions

Long-range forecasts of supply and demand for RNs in Virginia over the next 20 years show the likelihood of a shortage beginning to develop around 2015 and rapidly become severe. Conversely, forecasts for the LPN workforce estimate a potential surplus. Given the different scopes of practice in these two groups of nursing professionals, this is not surprising. Patient care needs are becoming more acute and more complex, creating a sustained and growing need for Registered Nurses.

The current economic downturn has caused many nurses to increase their work hours and work beyond traditional retirement points. These changes in work behavior contribute to the current balance between supply and demand for RNs, leading many to declare that the nursing shortage of the past few years has been solved. However, the long-range problems of an aging population

increasing the demand for nursing services, and the mass retirements expected within an aging nursing workforce still exist. Those concurrent demographic events are still on track to create a rapid and severe nursing shortage in Virginia. The fact that such a shortage has been temporarily postponed should not distract policy makers from planning for that future now.

End Notes

[1] Interim State Projections of Population for Five-Year Age Groups and Selected Age Groups by Sex: July, 1 2004 to 2030. U.S. Census Bureau, Population Division, Interim State Population Projections, 2005.

[2] These statistics are based on all NCLEX-RN test-takers sitting for the exam during 2008. Accessed May 29, 2009 at: https://www.ncsbn.org/Table_of_Pass_Rates_20082.pdf

[3] This was done by setting the allocation percentage for each state other than Virginia to zero, and 100% to the state of Virginia.

[4] Commonwealth of Virginia Board of Nursing, Nursing Education Programs and Nurse Aide Education Programs Report of Statistics: July 1, 2007 – June 30, 2008. Virginia Department of Health Professions. This report can be accessed at: http://www.dhp.virginia.gov/nursing/nursing_reports.htm

[5] Lacey Research Associates. The Nursing Workforce in Virginia. Deliverable under contract HWDC-2008 to the Virginia Department of Health Professions. 2009.

[6] Biviano, M., Fritz, M., Spencer, W., and Dall, T. (2004). What is Behind HRSA's Projected Supply, Demand, and Shortage of Registered Nurses? Retrieved June 12, 2009 from ftp://ftp.hrsa.gov/bhpr/workforce/behindshortage.pdf.

[7] Nooney, J.G. and Lacey, L.M. (2005). Validating HRSA's Nurse Supply and Demand Models: a State-Level Perspective. *Nursing Economic$,* Vol. 25, No. 5.