FCN Florida Center for Nursing

Technical Report: Use of HRSA's Nurse Supply and Demand Models in Florida

Project Staff:
Jennifer Nooney, Ph.D.
Lynn Unruh, Ph.D., RN, LHRM
Valerie Danesh, MS, RN
John Cantiello, Ph.D.

July 2008

Addressing Nurse Workforce Issues for the Health of Florida

www.FLCenterForNursing.org

Table of Contents

Technical Report: Use of HRSA's Nurse Supply and Demand Models in Florida

This technical report provides detailed information on the models and methods used to forecast the supply and demand of Registered Nurses (RNs) and Licensed Practical Nurses (LPNs) in Florida. The resulting projections, along with the results of simulations designed to increase the supply of nurses, can be found in "Forecasting Supply, Demand, and Shortage of RNs and LPNs in Florida, 2007-2020." We used forecasting models developed by the Health Resources and Services Administration (HRSA) in 2004 with Florida-specific data from recent Center research projects. In this report, the structure and operation of the models are described, including the assumptions made by the models about the primary forces driving nurse supply and demand. Next, we compare our results using Florida-specific replacement input data with projections that use the "default data" – the input data that come with the models. We then detail the data sources used to create Florida-specific input data for the models. Finally, we discuss limitations of these forecasting models and directions for future research to improve model input data and structure.

Model Development, Structure, and Operation

The HRSA Nurse Supply and Demand Models were developed between 2000 and 2004 as replacements for older versions of these models that ran on DOS operating systems using FORTRAN. These earlier models were quite difficult to use for the majority of policy analysts at the state level; locating and replacing state-level input data within the models was onerous, and users had few options for changing the structure of the models or assumptions they made about the forces impacting nurse supply and demand. The 2004 release of the HRSA forecasting models solved many of the problems with the earlier versions. They operate in a Windows environment and have a user-friendly interface with the typical menus, drop-down options, and buttons available in most Windows software. The models come with complete data for all 50 states and the District of Columbia, and state-level users with little research experience or little data on the state's nurse supply can generate projections of supply and demand with the click of a mouse. Since the models generate projections for the years 2000-2020, by the time the models were released in the summer of 2004 the input data for the beginning of the projection period in 2000 were already outdated. For states with little data, however, the models provided forecasts that would have been completely unavailable. For states with more data, the models proved flexible enough to generate revised forecasts incorporating new information about the state's nurse supply and demand.

The Nurse Supply Model (NSM) was designed to project the supply of licensed RNs, RNs working in nursing, and RN full-time equivalent (FTE) positions in the nursing workforce. It is a stock-and-flow model in which nurses enter and leave the supply of licensed RNs in a state to create the projected annual change in size of the nurse supply. In the course of a year, nurses enter the supply when they graduate from Florida nursing programs and become licensed, endorse into Florida from other states, or immigrate into Florida from foreign countries. Nurses leave the supply when they migrate out of Florida or drop their nursing licenses. The number of nurses at the end of the year, resulting from these in-flows and out-flows, becomes the starting number of nurses for the next year's projection.

The NSM works by projecting the number of licensed RNs each year and then applying factors that transform the number of licensed RNs into the number of RNs in the nursing workforce

(participation rate) and the number of RN FTEs (FTE participation rate). These participation rates are assumed to be stable over time unless the user specifies causal influences on the rates. In addition, the supply is measured by age and level of education. Age is measured in 44 categories ranging from "22 and under" to "65 and older." Education is measured as "Diploma and Associates," "Bachelor's Degree," and "Master's or Higher." In addition to in-flows and out-flows, the NSM tracks two changes in the nurse supply that occur during the course of one year: each nurse is aged by one year, and an estimate of "education upgrading" is applied to the supply. Nurses can upgrade their education from Diploma or Associates to the Bachelor's, or from the Bachelor's to Master's or Higher.

The NSM makes a number of assumptions, some of which can be changed by the user through data replacement or policy scenarios that can be implemented in the model. The baseline projections assume that 1) rates of licensed nurse participation in the workforce, by age and education, remain stable over time, 2) rates of state-to-state migration, by age and education, remain constant in each state over time, 3) the number of foreign immigrants moving to each state remains constant, as does their age distribution 4) rates of attrition by age remain constant, and 5) the number of new graduates each year changes based on the size of the potential applicant pool, defined as the population of women aged 20-44, but its age distribution remains constant.

The complexity of forecasting and lack of necessary data often make it difficult to construct plausible alternative assumptions. For example, the economy may experience a deep recession, which could change the retirement behavior of older nurses. But because we are unable to predict the economy's direction through 2020 in a meaningful way, it is wise to assume that attrition rates remain constant unless concerted efforts are made to retain nurses, which we can specify directly for the model as a simulated intervention. On the other hand, some model assumptions do not make sense given our current knowledge of the nursing workforce. For example, projections for Florida using the default input data show a declining number of new graduates in the state over time. This occurs because the population of women aged 20-44 – a proxy for the size of the nursing school applicant pool – was projected to decline in size over time. Yet between 2000 and 2007 (our baseline year), the number of new graduates increased considerably. Florida's nursing programs routinely turn away as many qualified applicants as they admit, showing that interest in the profession of nursing is much higher than the capacity of our nursing education system.[1] Changes in the number of new graduates is and will continue to be affected more by nursing program expansions and the attractiveness of the nursing profession when compared with changes in the number of working-aged women. Luckily, it is possible to specify increases in the number of new graduates directly as a simulated intervention.

HRSA developers used the National Sample Surveys of Registered Nurses (SSRN) to generate most of the supply model's default input data: the baseline year counts of nurses in each state, the rates of migration and attrition, and participation rates. Where possible, they used the most recent wave of the survey. Counts of nurses by age and education in each state were estimated using the 2000 SSRN for the baseline year of 2000. For more complex estimates, such as those for migration, developers used multiple waves of the survey. Conducted every four years, the National Sample Survey reaches a large, nationally representative sample of licensed RNs that typically contains 30,000 to 35,000 respondents. One goal of the SSRN is adequate representation at the state level, so a complex sampling strategy is used. Cleary the SSRN is the

best choice of data for a national model of nurse supply. Even with a complex sampling design, however, estimates of RN population size and composition based on sample survey results can be inaccurate at the state level. In 2004, only 1,368 SSRN respondents worked or lived in Florida. Much more detail about the NSM structure and sources of input data can be found in the NSM Technical Report and User Guide[2] as well as Biviano et al.[3]

The Nurse Demand Model (NDM) is a more complicated, multi-equation model in which demand for healthcare *services* is projected first and then is used to project the demand for nursing labor. It projects demand for RN, LPN, and nurse aid FTEs. For RNs, the NDM projects demand in nine different healthcare settings including short-term hospitals, long-term hospitals, nursing homes, home health agencies, occupational health, public health, ambulatory care, nursing education, and all other settings of nurse employment combined. In short-term hospitals, the model provides separate projections for inpatient units, outpatient units, and the emergency department. For LPNs and nurse aides, the NDM projects demand in short-term hospitals (inpatient units only), long-term hospitals, nursing homes, home health agencies, and all other settings of employment combined.

The demand for healthcare services is modeled as a function of changes in population size and composition, based on known variations in the healthcare use of individuals differing in age, sex, and rural or urban location. These initial projections of healthcare service demand are refined by taking into account projected changes in the overall health of the population, economic conditions, and the healthcare operating environment. Next, projections of *nurse staffing intensity* are performed by the model – the amount of nursing labor (in FTEs) needed to accomplish one unit of healthcare service (e.g., FTEs per inpatient day, per home health visit, etc.). Patient acuity, economic conditions, and other factors are assumed to change the staffing intensity needed to accomplish a unit of service. Finally, the projections of staffing intensity are combined with the projections of demand for healthcare services to generate an estimate of the number of FTEs needed each year. Presumably developed before the NSM, the demand model projects the demand for nurses for the years 1996-2020. However, since matching supply projections are only available from 2000-2020, and the models were not released until 2004, the addition of four earlier years is of little benefit to the average model user.

HRSA developers used multiple sources of information to derive the default input data for the NDM: Census Bureau population projections by age and sex, the Area Resource File, the 1996 SSRN, the 1996 Health Cost and Utilization Project database, and survey data from several organizations that study setting-specific issues (such as the 1997 National Nursing Home Survey and the 1995 National Home and Hospice Care Survey). Much more detail about the many sources of data used, as well as the equations estimated to project demand for healthcare services and nurse staffing intensity, can be found in HRSA's technical report for the Nurse Demand Model.[4]

Most of the assumptions made by the model are reflected in the input data elements of the NDM. For example, one component of the healthcare operating environment is the percentage of the population enrolled in a Health Maintenance Organization (HMO) – this structures the settings in which individuals receive care as well as the amount of care they receive. The baseline scenario of the NDM assumes that HMO enrollment increases by one-half percent each year, but users can modify the input data for each year to change this assumption. At the time this model was

developed in the late 1990s, HMO enrollment was climbing and there was little reason to suspect the trend would change. Since 1999, however, total HMO enrollment has declined considerably in Florida – although Medicaid and Medicare HMO enrollment has increased.[5] Our decision was to hold constant the proportion of people enrolled in an HMO over the projection period, as the data do not suggest that HMO enrollment is likely to skyrocket over the next 13 years. We will discuss further assumptions we made using the models in a later section of this report.

Comparison of Projections Using Default and Replacement Data

Data replacement substantially altered both the supply and demand projections generated by the models. In general, we found that both supply *and* demand are projected to be higher in each year than anticipated by the default projections. Figure 1 displays the projected RN FTE supply using the default input data for the Nurse Supply Model compared with the replacement data we assembled. The Center's estimate of RN FTEs in 2007 is nearly 28,000 larger than the default model's projection of RN FTEs in 2007. This occurs because the number of licensed RNs in 2007 was larger than the model's projection and also because licensed RNs in Florida report higher FTE participation rates than the default rates used by the model.

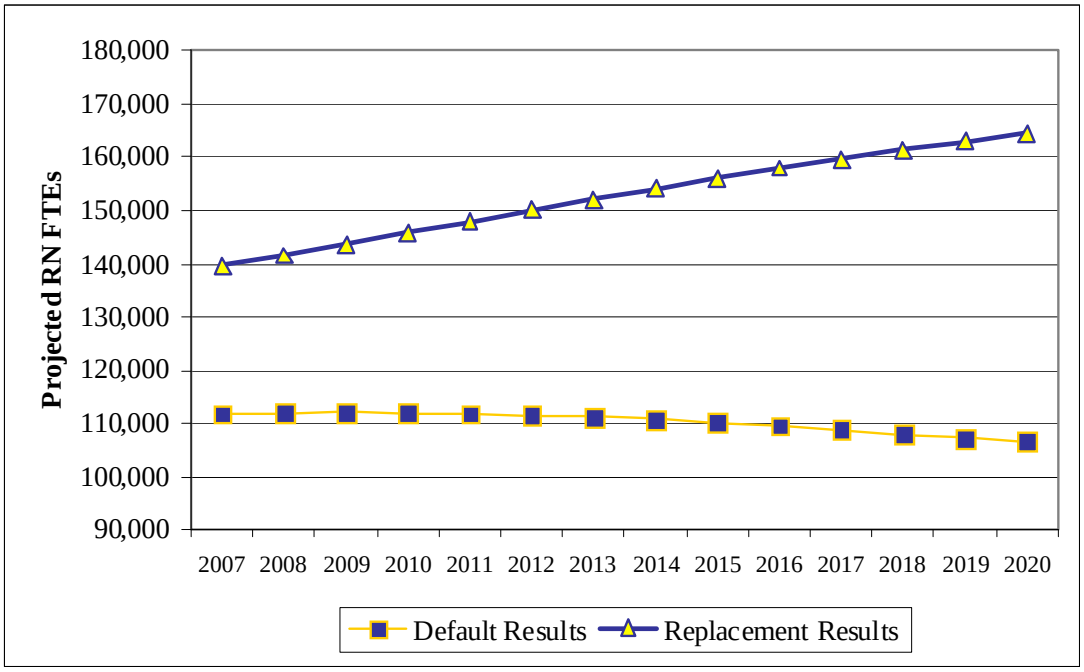

Figure 1. RN FTEs Projected by Default and Replacement Nurse Supply Models

Of greater interest than baseline comparisons, however, is the very different trend in RN supply projected by the models. Projections using the default input data show the nurse supply maintaining its current size until 2009, after which it is projected to *decline* in size through the year 2020. Our projections using replacement data, in sharp contrast, show the nurse supply *increasing* in size steadily and linearly from 2007 through 2020. An in-depth analysis of our results revealed that the most important difference between the two models is the increased number of new RN graduates we specified for the year 2007 based on NCLEX statistics for Florida. Our projections increase the number of graduates by about 1-2 percent each year, which

does not drastically increase the total number produced each year. However, the baseline year count of new graduates (5,907) is so much larger than the default model's projection for 2007 (3,633) that our forecasts show a larger number of in-flows due to new graduates than out-flows due to migration or attrition – increasing the nurse supply each year. The default model, in contrast, projects a shrinking number of new graduates each year. We regard this as unlikely given the large number of applicants turned away from Florida nursing programs each year and the efforts of many programs to increase enrollment in recent years.

Figure 2 compares the demand for RN FTEs predicted by the default and replacement models. Again, baseline demand for our model is larger than the 2007 projection of the default nurse demand model. We specified this level of demand based on estimated RN FTEs in 2007 and FTE vacancy rates from the Center's 2007 Nurse Employer Survey, which is discussed in more detail below. The two demand projections trend in the same direction, but our projections using replacement data increase somewhat more rapidly than those using the default input data for the Nurse Demand Model. The complexity of the NDM makes detailed diagnostics difficult, as several projection equations work together to produce these results. One very likely cause of the difference, however, is the higher rate of population growth projected by Florida's Office of Economic and Demographic Research (EDR), which we used in place of Census Bureau projections. In addition, EDR projected a substantially larger number of persons aged 74 or older. These older Floridians are assumed to use more healthcare services than younger age groups within the demand model.

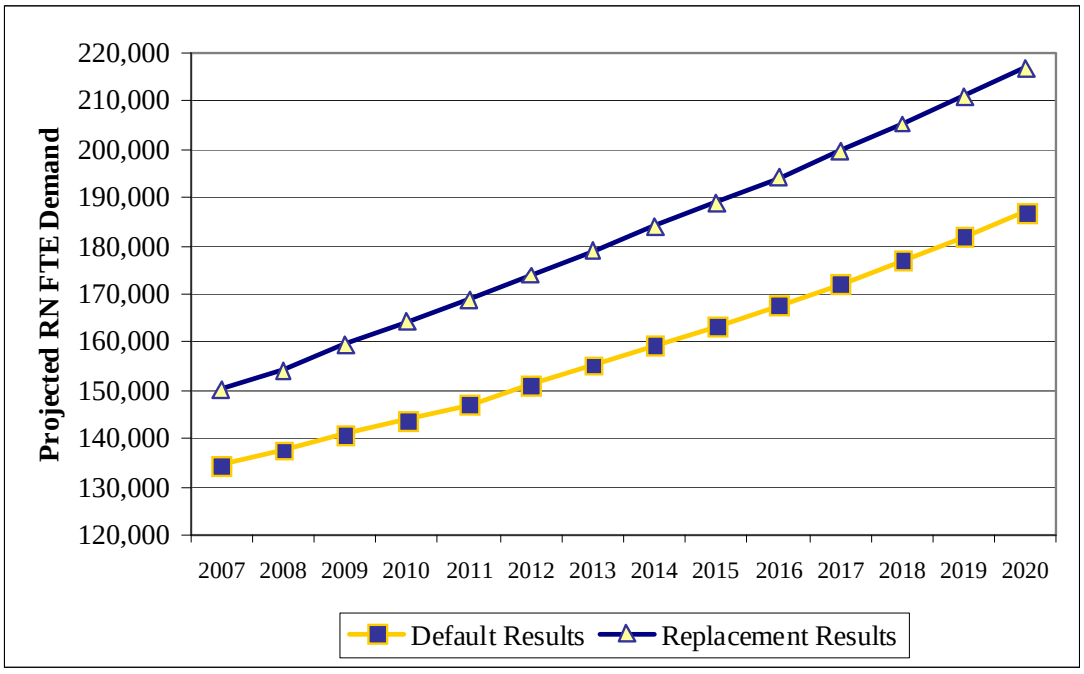

Figure 2. RN FTEs Projected by Default and Replacement Nurse Demand Models

Finally, Figure 3 illustrates the level of shortage projected by the default and replacement models when supply and demand projections are brought together. We begin the projection period in 2007 with a shortage of around 11,000 RN FTEs, while the default models projected a much more severe shortage of nearly 23,000 FTEs for 2007. Available evidence for Florida does not indicate that a shortage of this magnitude existed in 2007, so we are comfortable with our own

estimate of baseline year shortage when compared with the default projection of shortage for the year 2007.

In both the default and replacement models, the shortage is expected to grow steadily throughout the projection period. The default models project the shortage to grow more rapidly, however. By 2020, the models project a shortage of more than 80,000 RN FTEs. Our replacement models project the shortage to be about 52,000 RN FTEs – a difference of around 28,000 FTEs. The main cause of the growing shortage projected by the default models is a declining nurse supply combined with rising demand. In our models, demand rises even more rapidly but the nurse supply also grows more rapidly, which helps to mitigate the levels of shortage projected by HRSA for Florida.

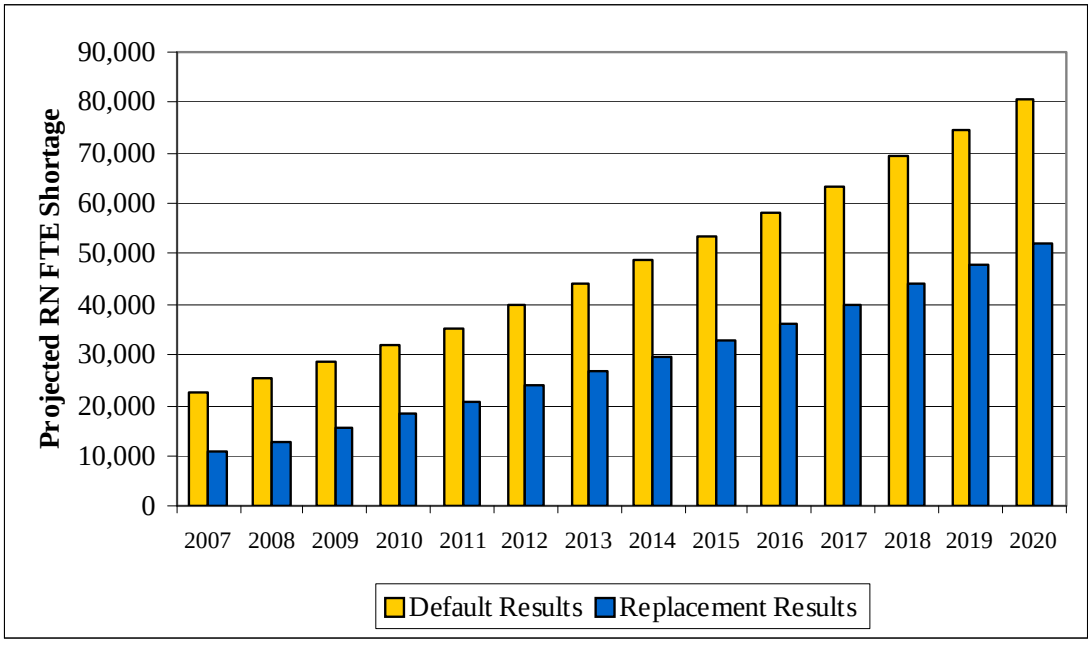

Figure 3. RN FTE Shortage Projected by the Default and Replacement Models

While the Center's shortage projections using replacement data are more optimistic than those originally published by HRSA, we regard a projected shortage of 52,000 RN FTEs as daunting. Such a shortage is capable of crippling Florida's healthcare delivery system. Thus, our results do not suggest that we can afford to make less effort to combat the nursing shortage than we previously assumed. If anything, the results give hope that concerted efforts to resolve the shortage might produce a less intense shortage that is less likely to compromise the quality of and access to patient care. As argued in the Main Report for this project, it is unlikely that we will avoid a worsening shortage over the next few years despite our best efforts. We do believe that resolution of the shortage by 2020 is more achievable under our projections than it would have been under those released by HRSA, but Florida is by no means out of the woods in its need to increase the supply of licensed nurses.

Nurse Supply Model Input Data Replacement

Nurse Supply Model for RNs

Table 1 lists each input data element for the NSM along with the default data source used by HRSA and the new data source we used for RN supply projections. We chose to replace National Sample Survey Data with Florida population-level nurse data whenever our available data sources were judged to be superior to the SSRN. Several considerations in this decision were the concern over representativeness of the Florida SSRN sub-sample, the use of nationwide SSRN data for many of the fields (which ignores state-to-state variation in the behavior of nurses), and the availability of more recently collected data specific to Florida. Two main sources of data we used in place of the SSRN data were Florida Board of Nursing (FBON) licensure data from January 2007 and RN survey data collected in January-April 2008.

Table 1. Input Data Element for the Nurse Supply Model – RN Model

Variable	Variable Description	HRSA Default Source (2000 as Baseline Year)	New Source (2007 as Baseline Year)
Nurse Population in the Base Year			
RN_AD	Nurse population in base year trained a diploma or associate level	SSRN	January 2007 FBON Licensure Data - RNs distributed into education categories using 2008 FCN Renewal Survey
RN_BA	Nurse population in base year trained at baccalaureate level	SSRN	January 2007 FBON Licensure Data - RNs distributed into education categories using 2008 FCN Renewal Survey
RN_MA	Nurse population in base year trained at masters or higher level	SSRN	January 2007 FBON Licensure Data - RNs distributed into education categories using 2008 FCN Renewal Survey
U.S. Graduates			
Grad_DIPAD	Base year number of new RN graduates at diploma or associate level	National Council of State Boards of Nursing - first-time NCLEX test takers in 2000	Persons passing NCLEX in Florida + 42% of the people who failed NCLEX under the assumption that these would eventually pass and join the nurse supply

(continued)

Table 1. (continued)

Variable	Variable Description	HRSA Default Source (2000 as Baseline Year)	New Source (2007 as Baseline Year)
Grad_BA	Base year number of new RN graduates at baccalaureate level	National Council of State Boards of Nursing - first-time NCLEX test takers in 2001	Persons passing NCLEX in Florida + 42% of the people who failed NCLEX under the assumption that these would eventually pass and join the nurse supply
%DIPAD	Age distributions of new RNs graduating with diploma or associates degree	SSRN – national rates	FBON Licensure Data - all RNs newly licensed by examination in 2007
%BA	Age distributions of new RNs graduating with baccalaureate degree	SSRN – national rates	FBON Licensure Data - all RNs newly licensed by examination in 2007
Foreign Nurse Graduates			
FNGRADS	Proportion of new foreign nurses migrating to individual states	SSRN	Florida set to 100%, all other states set to 0%
FOREIGN	Age Distribution of foreign trained RNs	SSRN – national rates	FBON Licensure Data - all RNs newly licensed by examination in 2007
FGRADS	Total foreign-trained RNs immigration to U.S. each year	assumed to be 3,500 nationally	National Council of State Boards of Nursing - foreign immigration counts (2006) for Florida only
General Population			
POPULATION	State-level population forecasts	Census Bureau	Florida Office of Economic and Demographic Research
WNPOP	State-level population forecasts of women ages 20-44	Census Bureau	Florida Office of Economic and Demographic Research

(continued)

Table 1. (continued)

Variable	Variable Description	HRSA Default Source (2000 as Baseline Year)	New Source (2007 as Baseline Year)
Attrition			
ATTRITION	Attrition rate from licensed RN population (by age)	Centers for Disease Control and Prevention, Current Population Survey – national rates	Default
Educational Upgrades			
POSTRN	Base year number of RNs upgrading from diploma or associate level to baccalaureate level	SSRN	Default
MSGADS	Base year number of RNs upgrading from baccalaureate to masters or higher level	SSRN	Default
%POSTRNBA	Age distribution of diploma and associate RNs upgrading to baccalaureate degree	SSRN – national rates	Default
%MA	Age distribution of baccalaureate degree RNs upgrading to master's or higher degree	SSRN – national rates	Default
Nurse Immigration and Emigration			
PEMIG_AD	Probability that RN prepared at diploma or associate level will emigrate this year	SSRN	Default
PEMIG_BA	Probability that RN prepared at baccalaureate level will emigrate this year	SSRN	Default
PEMIG_MA	Probability that RN prepared at masters or higher level will emigrate this year	SSRN	Default

(continued)

Table 1. (continued)

Variable	Variable Description	HRSA Default Source (2000 as Baseline Year)	New Source (2007 as Baseline Year)
Nurse Immigration and Emigration			
PIMMIG_AD	Probability that RN prepared at diplomat or associate level immigrated last year	SSRN	Default
PIMMIG_BA	Probability that RN prepared at baccalaureate level immigrated last year	SSRN	Default
PIMMIG_MA	Probability that RN prepared at masters or higher level immigrated last year	SSRN	Default
FTE Participation Rates			
FTE_AD	FTE workforce participation rates for RNs prepared at diploma and associate level	SSRN – national rates	2008 FCN Renewal Survey
FTE_BA	FTE workforce participation rates for RNs prepared at baccalaureate level	SSRN – national rates	2008 FCN Renewal Survey
FTE_MA	FTE workforce participation rates for RNs prepared at masters or higher level	SSRN – national rates	2008 FCN Renewal Survey
Participation Rates			
ACTIVITY_AD	Workforce participation rates for RNs prepared at diploma and associate level	SSRN – national rates	2008 FCN Renewal Survey
ACTIVITY_BA	Workforce participation rates for RNs prepared at baccalaureate level	SSRN – national rates	2008 FCN Renewal Survey
ACTIVITY_MA	Workforce participation rates for Runs prepared at masters or higher level	SSRN – national rates	2008 FCN Renewal Survey

Baseline Year Nurse Population: The licensure database contains a record for every RN, ARNP, and LPN license held in Florida and includes information on the age of the license holder, the year the license was issued, and whether the license was issued after successful passage of the NCLEX examination or through endorsement from another state. We used licensure data from January 2007 to produce a count of nurses with active licenses who work and/or live in Florida – the potential pool of nursing labor in the state. The NSM counts

advanced practice nurses with other RNs, so our counts included both RN and ARNP licensees. We were able to produce counts for each of the 44 age categories, but licensure data do not specify the level of education for each nurse. To distribute our counts into the three education levels, we used data from the first RN/ARNP cohort renewing their licenses in 2008. Approximately one-third of licensed RNs and ARNPs were scheduled to renew during the January-April 2008 cycle, and about 90% of those who did renew completed a renewal survey and provided information on their level of education and work behaviors.

Baseline Year U.S. Graduates: New graduate nurses are defined in the NSM as the number of first-time NCLEX test takers. Yet not all of those who take the NCLEX pass and become able to join the nurse supply. In 2007, 83.2 percent of first-time NCLEX test takers in Florida passed the examination.[6] To account for NCLEX failure when estimating additions to the nurse supply, we used the number of persons *passing* the NCLEX from Florida programs in 2007 plus 42 percent of persons *failing* NCLEX. The National Council of State Boards of Nursing reports that about 42 percent of those who fail NCLEX on the first attempt will pass the second time around,[7] so our counts assume that at least some of those who failed NCLEX will eventually join the supply of licensed nurses. We used quarterly NCLEX reports from the Florida Board of Nursing to assemble counts from Florida associate degree and baccalaureate programs separately. Although we could not determine the age distribution of new graduates separately for associate's and bachelor's graduates, we were able to use the licensure database to produce an age distribution for all new licensees by examination during 2007, which we used for both education categories in the model. Consistent with previous reports of increasing age among new graduates,[8] we found that our replacement distribution indicated an older new graduate population than was found in the 2000 SSRN.

Foreign Immigrants: The NSM distributes a national estimate of foreign-trained RNs to each state using percentages. Of the 3,500 foreign-trained RNs introduced annually by the model, 396 RNs (or 11.3%) were distributed to Florida. A review of reports from NCSBN shows that Florida routinely accepts more than double this number of foreign-trained RNs annually. We used the most recent estimate of foreign-trained immigrants to Florida from the NCSBN, which was 835 in 2006.[9] To ensure that all were distributed to Florida, we reset the state-level percentages to 100% for Florida and 0% for all other states. We could not compute an age distribution for foreign graduates, but because the NSM uses the SSRN age distribution for new graduates, we distributed foreign nurses according to our age distribution for newly licensed RNs by examination in Florida in 2007.

General Population Projections: HRSA used Census Bureau projections of each state's total population and projections of the population of women aged 20-44. We replaced these projections with those released by Florida's Office of Economic and Demographic Research (EDR) in August 2007.[10] The EDR projections are refined based on consensus among top demographers in Florida and may be more accurate than those provided by the national Census Bureau. The 2007 projections show Florida gaining population at more rapid rates than those provided with the model, and this extends to the population of women aged 20-44.

Attrition Rates: The HRSA model developers correctly recognized that very little research exists on attrition from the population of licensed RNs. The default NSM attrition rates are based on mortality data from the Centers for Disease Control and rates of disability and retirement for all

college-educated women from the Current Population Survey conducted by the Census Bureau. These rates are intended to capture permanent departure from the nursing workforce due to retirement, disability, death, and other factors. Temporary departures from the workforce – for example, those due to time off for raising children – are captured by the activity rates used by the NSM to model the number of active and FTE nurses in the workforce at each age. As the attrition rates are not specific to nurses, they cannot adequately capture the extent to which younger (or older) nurses change careers due to dissatisfaction with the profession of nursing.

The licensure database in Florida, when analyzed over time, affords an opportunity to examine the extent to which nurses fail to renew their nursing licenses for any reason, including out-migration, career change, retirement, disability, or death. Unfortunately, the Center has access to data covering only one year of license renewals. During this one-year period, only one-third of RNs and ARNPs were scheduled to renew their licenses.

State-to-state Migration: We lacked information necessary to modify rates of in and out-migration to Florida, so the default HRSA rates were used. The default rates show that Florida gains more nurses through immigration from other states than it loses to nurses moving out of the state. While this may be historically accurate, economic changes in Florida and elsewhere mean that the trend may not always prevail. As we amass more information through continued analysis of licensure data, it will be possible to measure attrition due to all causes (including out-migration) as well as to identify new licensees who endorsed into the state (in-migration).

Workforce Participation Rates: We were able to use survey data collected from 90 percent of the RNs who renewed their licenses from January-April of 2008 to construct Florida-specific workforce participation rates. We found that Florida RNs reported working in the field of nursing at higher rates than the default (national) rates provided with the models, especially at older ages. Forecasts conducted for the state of North Carolina in 2006 also found that workforce participation was higher at older ages.[11] It is unknown whether our Florida findings are related more to the uniqueness of the Florida workforce or a national trend toward greater participation in the nursing workforce. The result of our revised rates is a higher estimate of RN FTE supply at baseline and throughout the projection period than would be true if the default rates were used.

Nurse Supply Model for LPNs

The NSM was not designed for use with LPNs, but we found the model quite adaptable to the changes necessary for forecasting LPN supply. Since LPNs have one level of education (an LPN certificate), we counted all LPNs by age within the Diploma/Associate's fields and disabled the other education categories by placing zeros in each. The same licensure database used to count RNs by age was used for LPNs. We also disabled the field that counts new graduates at the Bachelor's level by placing a zero there and counted all newly licensed LPNs by examination – reported on FBON's NCLEX report for 2007 – within the Diploma/Associate's field for new graduates.

In addition to disabling fields for higher levels of education, we elected to disable a number of other fields because we had insufficient evidence to use them appropriately for LPNs. For example, although some LPNs are likely to migrate into Florida from other states or to leave Florida for other states, it is unlikely that LPNs migrate at the high rates observed for RNs in the

United States. In any case, it is unknown what rates of LPN migration would look like; there is no evidence suggesting whether this process leads to a net gain or a net loss of LPNs for Florida. We chose to assume a zero net gain by disabling the fields. To disable them, we simply specified 0 percent probabilities that nurses at each age would migrate into (or out of) Florida each year.

Similarly, it is likely that some foreign-trained LPNs will enter Florida each year, but it is very unlikely that their numbers will approach the volume of foreign-trained RNs that do so. NCSBN reports the number of foreign-trained LPNs immigrating to Florida in some years, but the numbers are generally very small (less than 100). We elected to disable the foreign immigration fields to provide consistency with our decision to disable other in and out-flowing fields. The only inputs to the LPN supply are new graduates, and the only out-flows are losses to attrition. As with the RN model, we used the NSM default attrition rates to remove LPNs from the projected supply each year. It is unknown whether LPNs leave the workforce at rates similar to those of RNs, but there is no source of information that could be used to construct rates specific to LPNs at the present time.

We elected to disable the two fields that generate education upgrades among RNs for our LPN supply forecasts. Although LPNs can certainly pursue additional education, most additional training in nursing would make them eligible to sit for licensure as an RN. This would technically cause attrition from the supply of LPNs and additions to the supply of RNs. The RN version of our model already accounts for the LPN-to-RN transition because all newly licensed RNs (regardless of previous licensure) are included in our baseline counts of new graduates. Until we are prepared to construct our own rates of LPN attrition, we are unable to build license upgrading into the model. Our initial evidence suggests that losses due to license upgrading are probably minimal. In a 2007 survey of nursing programs in Florida, a total of 583 new RN graduates were counted from “bridge” programs that typically accelerate the progress of paramedics, LPNs, and others with previous healthcare training.[1]

We did choose to construct Florida and LPN-specific participation rates, as we were not comfortable with the assumption that LPNs in Florida work in nursing at the same rates (and similar numbers of hours) as do RNs. We used data from a 2007 survey of LPNs renewing their licenses to construct the rates.[12] This survey achieved a very low 5 percent response rate, but the rates we constructed were quite reasonable, and the 2007 survey is the only source of information specific to LPNs that could be used for this purpose. In general, the participation rates strongly resembled those we constructed for RNs using survey data provided by 90 percent of RNs renewing in January-April of 2008. The FTE participation rates we created were slightly lower among LPNs, suggesting that LPNs are more likely than RNs to work fewer hours or part-time.

Some of the concerns about the Nurse Supply Model discussed previously also apply to our use of the model to forecast LPN supply. We remain concerned about the inability of the default attrition rates to capture career changes in addition to permanent withdrawal from the labor force, for example. We look forward to revising these forecasts when sufficient data are available to measure LPN attrition for any cause, such as out-migration, career change, retirement, disability, or death. Continued analysis of annual licensure data files will allow future forecasts to benefit from a more detailed understanding of inflows and outflows.

Nurse Demand Model Input Data Replacement

Table 2 lists each element within the NDM along with the source of data (or assumption) used by HRSA and the source of data (or assumption) used by the Center. Fields in the NDM are either fixed, meaning that a baseline year value is entered, or variable, meaning that the field requires input data or assumptions 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 unimportant – demand for the baseline year must be specified by the user. Rather, it is change over time in the variable that produces change in the level of demand projected by the model for future years. In Table 2, these fields are characterized by the assumption made rather than the source of data used to set a baseline year value.

Table 2. Nurse Demand Model Input Data Elements and Sources

Field	Field Description	Fixed or Variable	HRSA Default Source (Baseline Year=1996)	New Source (Baseline Year=2007)
Exogenous Variables				
AGE_M	Mean age of population	Variable	Census Bureau	Office of Economic and Demographic Research
BASE_ED	Total population age 5-17 by state in the base year	Fixed	Census Bureau	Office of Economic and Demographic Research
BASE_OC	Total population age 18-64 by state in the base year	Fixed	Census Bureau	Office of Economic and Demographic Research
BASE_POP	Total population by state in the base year	Fixed	Census Bureau	Office of Economic and Demographic Research
ED_POP	Total population age 5-17 by state over time period	Variable	Census Bureau	Office of Economic and Demographic Research
HH_MCR	Average Medicare payment per home health visit by state	Variable	Assumes 1 percent annual increase	Default
HISPANIC	Percent of population Hispanic by state	Variable	Census Bureau	Office of Economic and Demographic Research
HMO	HMO enrollment by state	Variable	Assumes ½ percent increase annually	Assumes no change in enrollment rates over time

(continued)

Table 2. (continued)

Field	Field Description	Fixed or Variable	HRSA Default Source (Baseline Year=1996)	New Source (Baseline Year=2007)
Exogenous Variables				
MEDICAID	Percent of population in Medicaid by state	Variable	Extrapolated based on projected population changes	Default
NF_MCD	Average Medicaid payment/day for nursing facility care	Variable	Assumes 1 percent annual increase	Default
NHADL	Average number of activities of daily living (ADL) limitations per nursing home resident	Variable	Assumes ½ percent annual increase	Default
NONWHITE	Percent of population non-white by state	Variable	Census Bureau	Office of Economic and Demographic Research
OCC_POP	Total population age 18-64 by state over time period	Variable	Census Bureau	Office of Economic and Demographic Research
PCPI	Per capita personal income by state	Variable	Assumes 1 percent annual increase	Default
POPULATION	Total population in state over time period	Variable	Census Bureau	Office of Economic and Demographic Research
SURGERY	Percent of hospital surgeries performed in outpatient setting by state	Variable	Assumes 2 percent increase annually	Default
UNINSURED	Percent population without medical insurance by state	Variable	Extrapolated based on projected population changes	Default
URBAN	Percent of population living in metropolitan area by state	Fixed	Census Bureau	Default
WAGE_HHA	Wage for home health aides by state	Variable	Assumes fixed ratio against other nurse types	Default

(continued)

Table 2. (continued)

Field	Field Description	Fixed or Variable	HRSA Default Source (Baseline Year=1996)	New Source (Baseline Year=2007)
Exogenous Variables				
WAGE_LPN	Wage for LPNs state average	Variable	Assumes fixed ratio against other nurse types	Default
WAGE_NA	Wage for Nurse Aides, state average	Variable	Assumes fixed ratio against other nurse types	Default
WAGE_RN	Wage for RNs state average	Variable	Assumes fixed ratio against other nurse types	Default
Population Table				
	State population in 8 age categories by gender and year	Variable	Census Bureau	Office of Economic and Demographic Research
Health Care Use in Base Year Table				
	ST Hospitals (outpatient)	Fixed	2000 and 2001 Area Resource File (ARF)	2003 ARF
	ST Hospitals (inpatient)	Fixed	2000 and 2001 ARF	2003 ARF
	ST Hospitals (emergency)	Fixed	2000 and 2001 ARF	2003 ARF
	LT Hospitals (emergency)	Fixed	2000 and 2001 ARF	2003 ARF
	LT Hospitals	Fixed	2000 and 2001 ARF	2003 ARF
	Nursing Facilities (Residents)	Fixed	American Health Care Association publications	Florida Agency for Healthcare Administration Report: OSCAR 2007 results

(continued)

Table 2. (continued)

Field	Field Description	Fixed or Variable	HRSA Default Source (Baseline Year=1996)	New Source (Baseline Year=2007)
Health Care Use in Base Year Table				
	Home Health Visits	Fixed	Center for Medicare/Medicaid Services	Default
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	Default
Nurse Population in the Base Year (RN, LPN, Nursing Assistant) Table				
	Nursing FTEs by nurse type and setting in the base year	Fixed	SSRN, Area Resource File, BLS Occupational Employment Statistics, American Health Care Association data	NSM FTEs in 2007 distributed by setting according to 2008 survey (RNs) and AWI (LPNs), inflated for shortage following the 2007 Nurse Employer Survey

Baseline Year Demand: The baseline year demand for nursing FTEs is among the most important components of the NDM, as it defines the level of shortage a state begins with in the baseline year. HRSA recognized that quantifying a shortage is difficult and that there is some debate regarding the use of vacancy rates for this purpose. They noted, however, that there was a general consensus regarding the existence of a national shortage in 1996. Their decision was to inflate the estimated number of RN FTEs within all hospital settings measured by the model by 7 percent to reflect the fact that demand exceeded supply in the baseline year. LPN and nurse aide FTEs were entered as baseline demand assuming no shortage for these types of nursing personnel.

We began the process of defining baseline year demand with the Nurse Supply Model estimates of RN and LPN FTEs in 2007 that were generated after data replacement. These FTEs were then distributed into the different settings. Survey data provided by 90 percent of the RNs renewing from January-April of 2008 were used to distribute the RN FTEs into settings. Although survey data were collected from a small portion of LPNs renewing in 2007, we suspect that responding

LPNs were more likely to work in a hospital than was true of all LPNs. Therefore, we distributed our estimate of LPN FTEs according to employment statistics published by Florida's Agency for Workforce Innovation.[13] Because we lack a supply forecast for nurse aides, we will omit discussion of the estimates for this type of nursing personnel throughout this report.

The Center's 2007 Nurse Employer Survey, fielded in June 2007, collected the data needed to calculate FTE vacancy rates for RNs and LPNs in a number of different settings.[14] Since our survey asked for "vacant positions being actively recruited," we judge our FTE vacancy rates to be the best quantification of the shortage possible for 2007 – they reflect unmet demand for nursing labor in Florida at that time. We used these rates to inflate our baseline year estimate of employed FTEs, matching vacancy rates to the settings included in the Nurse Demand Model.

Once RN and LPN FTEs were distributed into settings, the FTE vacancy rates for each nurse type and setting were applied to create the baseline estimate of demand. RN FTEs were inflated by 9.5 percent in hospitals, 12.8 percent in nursing homes, 14 percent in home health agencies, and 9.4 percent in public health. All other settings were assumed to have no shortage. LPN FTEs were inflated by 6.4 percent in hospitals, 9.8 percent in nursing homes, and 21.4 percent in home health agencies. The total shortage generated by this inflation process was 10,850 RN FTEs and 2,644 LPN FTEs. These figures are generally in line with an estimate of total RN and LPN vacancies reported by the Center in 2008 using a different methodology.[15]

Exogenous Variables: Exogenous variables are the "external" forces that influence nurse demand. Change in Florida's general population is one important driver of future demand for nurses. As the size and age of the population increase, the number of healthcare services they will demand also increases, which will increase the demand for nurses. Each of the exogenous variables – excepting those which define Florida in terms of its location in the country – is listed in Table 2. Most of the baseline year general population data, as well as population projections, were obtained from Florida's Office of Economic and Demographic Research.

The exogenous healthcare operating environment variables required assumptions to be made about the funding and location of healthcare services in the future. Where there was evidence to challenge an assumption made in the default projections by HRSA, those assumptions were changed. However, in most cases we chose to adopt the default assumptions of the model, recognizing that a number of experts reached consensus on the assumption during model development. For example, the model assumes a one percent annual increase in Medicare payments per home health visit, Medicaid payment per day for nursing facility care, and per capita personal income. The demand for care is increased marginally as a result of economic conditions following these assumptions. If income and third-party payments for healthcare services increase more rapidly than one percent per year, the demand for nurses would also increase more rapidly. In contrast, if a protracted recession causes reduced income and reduced Medicare/Medicaid payments, demand for nurses would be reduced. Since economic conditions in Florida cannot be predicted with any certainty for a period of 13 years, we opted to retain the default assumptions regarding economic drivers of demand for healthcare.

Another example involves the wages of RNs, LPNs, nurse aides, and home health aides. The NDM is capable of modeling *substitution effects*, a situation where employers select a personnel type with lower wages because the wages of the preferred type have become too high for

employers. The default model scenario is a fixed ratio between the wages of all nursing personnel types. If RN wages increased at a more rapid rate than did LPN wages, employers would have an incentive to replace RN labor with LPN labor. We elected to retain the default assumption of no substitution effects since it is difficult to predict how the wages of RNs and LPNs will vary over time. If the RN shortage becomes severe, it is possible that their wages will rise relative to those of LPNs. It is also possible that employers will choose to utilize LPNs if RNs are more difficult to find because of an RN shortage. Since these are possibilities (but unknowns), the default assumption was used for the baseline projections reported by the Center.

We did alter the default assumption made by the model regarding the percentage of Floridians enrolled in a Health Maintenance Organization (HMO). When the model was being developed, HMO enrollment was on the rise nationally. However, in recent years total HMO enrollment in Florida has declined considerably while Medicare and Medicaid HMO enrollment has increased. We replaced the baseline year estimate of HMO enrollment, but we elected to assume no change (rather than an increase) in enrollment during the projection period.

Utilization Rates and Baseline Year Healthcare Use: Healthcare utilization rates were computed by HRSA using multiple data sources and are national rates by setting, gender, age, and rural or urban location. There is no reason to suspect that Florida's rates (again, accounting for setting, gender, age, and rural or urban location) would differ from those constructed nationally. Moreover, the data requirements for Florida-specific rates by each of these variables make the task of constructing new rates impossible. We elected to use the default utilization rates since the rates will adjust for Florida's changing population over time.

Finally, we examined and adjusted many of the fields measuring the use of healthcare services in the base year. HRSA used data from the 2000 and 2001 Area Resource Files (ARF) to obtain state-level estimates for the base year. We updated these estimates for Florida using a slightly more recent 2003 release of ARF. The variables measuring inpatient days in hospitals, outpatient visits to hospitals, and many others were not available in the ARF for the years 2004 or 2005 (the most recent release of ARF available to us). In general, our estimates are slightly larger than the earlier estimates for Florida provided with the model. We were able to get a more recent estimate of nursing home residents (2007) from Florida's Agency for Healthcare Administration, but we found no source of data on the number of home health visits in Florida. We used the default estimate provided with the model for this field.

Conclusions: Evaluation of the Models and Directions for Future Research

We evaluate the HRSA Nurse Supply and Demand Models favorably for their flexibility in handling assumption modifications, data replacement, and model structure modifications necessary to forecast the supply of LPNs in Florida. The HRSA models are exceptional forecasting tools, as they integrate a large number of forces that will drive the supply of and demand for nursing personnel. Comparison of the default and replacement models demonstrates the need for state-level analysts to evaluate and, if necessary, replace input data elements. The developers of these models often used national data sources that provided state-level estimates. We found that estimates for Florida were often inaccurate when compared with data on the population of nurses in Florida and general population projections for Florida made by our state's own Office of Economic and Demographic Research. We recommend that state-level

model users consider all available sources of data to judge the accuracy of input data elements provided with the two models.

The most challenging elements of the Nurse Supply Model to evaluate were the fields governing exits from the workforce. The attrition rates assembled by model developers were not specific to nurses but instead characterized the retirement behavior of all college-educated women. As such, the rates do not capture attrition from the licensed nurse population that occurs as a result of dissatisfaction with the profession of nursing or a specific job. We suspect that the model's rates underestimate licensed nurse attrition at younger ages, but at present we lack the data needed to construct rates characterizing the attrition of Florida nurses. Continued collection and analysis of licensure data files should provide us with a better understanding of the attrition patterns within Florida. In turn, our forecasts will be more accurate.

The Nurse Supply and Demand Models are very different from one another in structure, and this prevents us from projecting the level of shortage that will be experienced in different settings. While the demand model projects demand for nurses in multiple settings, the supply model does not generate corresponding estimates by setting. Similarly, the supply model projects the supply of nurses at three levels of educational preparation, but the demand model does not incorporate differential demand for nurses at different levels of preparation. To simplify the complex nature of nursing supply and demand for these shortage forecasts, we have omitted discussion of supply forecasts by education and demand forecasts by setting.

One important facet of nurse supply and demand that is ignored in these models is their interconnectivity. The supply of nurses influences demand, and vice versa. The Nurse Supply and Demand Models used here produce independent forecasts, however, that ignore the interplay between supply and demand. The ideal forecasting model would be econometric, such that the projections for supply would incorporate the response of employers to the availability (or lack) of nursing labor. Similarly, our projections of LPN shortage could not incorporate responses to a shortage of RNs, which may exacerbate the LPN shortage if employers choose to replace RN with LPN labor. The problem of interconnectivity is serious and could change the supply and demand for nurses considerably from the projections we have reported here. Unfortunately, there exists no truly econometric forecasting model that is capable of simultaneously accounting for external influences on supply and demand as well as those generated by interplay of the two. This is clearly an important direction for future development of forecasting models.

References

1. Florida Center for Nursing. (2008). 2007 Nursing Education Program Annual Report and Workforce Survey. Retrieved June 15th from http://www.flcenterfornursing.org/files/06-07_Education_Survey_Report.pdf

2. National Center for Health Workforce Analysis. (2004). *Nursing Supply Model: Technical Report and User Guide*. Rockville, MD: Health Resources and Services Administration.

3. 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 15th, 2008 from http://bhpr.hrsa.gov/healthworkforce/reports/nursing/rnbehindprojections/index.htm

4. National Center for Health Workforce Analysis. (2004). *Nursing Supply Model: Technical Report and User Guide*. Rockville, MD: Health Resources and Services Administration.

5. Baumgarten, A. (2007.) *Florida Managed Care Review 2006*. Retrieved August 3, 2007 from http://www.allanbaumgarten.com/index.cfm?fuseaction=dsp_report&state=fl

6. NCLEX pass rates in Florida are compiled quarterly by the Florida Board of Nursing and are available on request.

7. National Council of State Boards of Nursing. (2007). *Quarterly Examination Statistics: Volume, Pass Rates & First-Time Internationally Educated Candidates' Countries*. Chicago, IL: author.

8. Auerbach, D., P. Buerhaus, and D. Staiger. (2007). "Better Late Than Never: Workforce Supply Implications of Later Entry Into Nursing" *Health Affairs* 26(1): 178-185.

9. National Council of State Boards of Nursing. (2008). *2006 Nurse Licensee Volume and NCLEX Examination Statistics*. Chicago, IL: author.

10. Population estimates and projections from the Office of Economic and Demographic Research can be found at http://edr.state.fl.us/population.htm

11. Nooney, J. and L. Lacey. (2007). "Validating HRSA's Nurse Supply and Demand Models: A State-Level Perspective" *Nursing Economics*, 25(5): 270-278.

12. Florida Center for Nursing. (2007). *Licensed Practical Nurses in Florida: Analysis of 2007 Workforce Survey Data*. Retrieved June 15th, 2008 from http://www.flcenterfornursing.org/files/LPN_Report_2007.pdf

13. Florida Center for Nursing. (2008). *2007 Nurse Employer Survey Methods and Statewide Results*. Retrieved June 15th, 2008 from http://www.flcenterfornursing.org/files/2007_Employer_Survey_Report.pdf

14. Florida Agency for Workforce Innovation employment statistics were produced by request for the Florida Center for Nursing in October 2007.

15. Florida Center for Nursing. (2008). *Statewide Vacancies and Job Growth Expectations in Nursing-Intensive Healthcare Settings*. Retrieved June 15th, 2008 from http://www.flcenterfornursing.org/files/Vacancies_Job_Growth.pdf