FCN Florida Center for Nursing

Technical Report: Forecasting Nurse Supply and Demand in Florida

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Addressing Nurse Workforce Issues for the Health of Florida

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Technical Report: Use of HRSA's RN Supply and Demand Forecasts 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 our companion report "*RN and LPN Supply and Demand Forecasts 2010-2025: Florida's Projected Nursing Shortage in View of the Recession and Health Care Reform*." We used forecasting models developed by the Health Resources and Services Administration (HRSA), with Florida-specific data from recent Florida Center for Nursing (Center) research projects and various national data sources, to create RN and LPN supply and demand projections from 2010-2025. 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. We discuss specific data elements for each of the models, including our assumptions for specific fields after the implementation of healthcare reform. Next, we compare our results from 2010 with our previous forecasts published in 2008 and discuss the differences between the two projections. Finally, we discuss limitations of these forecasting models, input data sources, and ideas for future research to improve model input data and structure.

Model Structure and Operation

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 RN supply when they migrate out of Florida, upgrade to an ARNP license, 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 national and state projections published by HRSA in 2004 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, and its age distribution remains constant.

HRSA developers used the National Sample Surveys of Registered Nurses (NSSRN) 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. Unfortunately, the typical Florida sample from this survey includes less than 1,500 nurses. In contrast, data on all of Florida's nurses is available from the Florida Board of Nursing's (FBON) Nurse Licensure Database, and data on more than 90 percent of Florida nurses was captured during the Center's 2008-2009 Workforce Survey.[1,2] We have used this much more complete data for the forecasts reported. Much more detail about the NSM structure and sources of its original state and national input data can be found in the NSM Technical Report and User Guide[3] as well as the article by Biviano et al.[4]

The Nurse Demand Model (NDM) is a more complicated, multi-equation model in which demand for healthcare *services* is projected first and is then 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.

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 NSSRN, 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). We have replaced most of the original model data sources with updated information from Florida-specific data sources when available. Much more detail about the original sources of data used, as well as the equations used to estimate projected demand for healthcare services and nurse staffing intensity, can be found in HRSA's technical report for the Nurse Demand Model.[5]

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.

Most of the assumptions made by the model are reflected in the input data elements of the NDM. The baseline national and state projections published by HRSA in 2004 assume that 1) the staffing requirements per unit of service remain constant over time, 2) economic factors such as personal income, the percent of the population on Medicaid, and the percent of the population without health insurance will impact demand for healthcare services, and 3) the economic trajectory of the nation is one of slow, consistent growth throughout the projection period. We discuss the assumptions made in our forecasts in the next section of this report.

Nurse Supply Model Input Data Replacement and Assumptions

Nurse Supply Model for RNs

Table 1 lists each input data element for the NSM along with the data source we used for RN supply projections. As discussed above, we used Florida-specific data whenever available. In particular, we replaced the model's original NSSRN data with our census-level data on the population of Florida nurses as of January 2010.

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

Variable	Variable Description	Data Source (2010 as Baseline Year)
Nurse Population in the Base Year		
RN_AD	Nurse population in base year trained at diploma or associate level	2010 FBON Licensure Data and Florida Center for Nursing 2008-2009 Workforce Survey
RN_BA	Nurse population in base year trained at baccalaureate level	2010 FBON Licensure Data and Florida Center for Nursing 2008-2009 Workforce Survey
RN_MA	Nurse population in base year trained at masters or higher level	2010 FBON Licensure Data and Florida Center for Nursing 2008-2009 Workforce 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 – Persons passing NCLEX in 2009 in Florida + 42% of the people who failed NCLEX under the assumption that these would eventually pass and join the nurse supply + an estimate of education expansion for 2010

Variable	Variable Description	Data Source (2010 as Baseline Year)
Grad_BA	Base year number of new RN graduates at baccalaureate level	National Council of State Boards of Nursing – Persons passing NCLEX in 2009 in Florida + 42% of the people who failed NCLEX under the assumption that these would eventually pass and join the nurse supply + an estimate of education expansion for 2010
%DIPAD	Age distributions of new RNs graduating with diploma or associates degree	2010 FBON Licensure Data - all RNs newly licensed by examination in 2009
%BA	Age distributions of new RNs graduating with baccalaureate degree	2010 FBON Licensure Data - all RNs newly licensed by examination in 2009
Foreign Nurse Graduates		
FNGRADS	Proportion of new foreign nurses migrating to individual states	Florida set to 100%, all other states set to 0%
FOREIGN	Age distribution of foreign trained RNs	FBON Licensure Data 2010 – as a proxy, all new RN licensees by examination in 2009
FGRADS	Total foreign-trained RNs immigration to U.S. each year	2010 FBON Licensure Data, 2009 NCLEX results. The number of new licensees by examination in 2009 minus the number of new grads passing NCLEX from Florida schools.
General Population		
POPULATION	State-level population forecasts	Florida Office of Economic and Demographic Research
WNPOP	State-level population forecasts of women ages 20-44	Florida Office of Economic and Demographic Research
Attrition		
ATTRITION	Attrition rate from licensed RN population (by age). Followed the cohort of licensed nurses from 2008 to 2010 to track those who left the workforce. Halved the biennial rate to derive an annual rate of attrition.	FBON Licensure Data from 2008 and 2010

Variable	Variable Description	Data Source (2010 as Baseline Year)
Educational Upgrades		
POSTRN	Base year number of RNs upgrading from diploma or associate level to baccalaureate level	2009 Florida Center for Nursing Annual Report and Workforce Survey for Nursing Programs
MSGRADS	Base year number of RNs upgrading from baccalaureate to masters or higher level	2009 Florida Center for Nursing Annual Report and Workforce Survey for Nursing Programs
%POSTRNBA	Age distribution of diploma and associate RNs upgrading to baccalaureate degree	2010 FBON Licensure Data and 2008-2009 Florida Center for Nursing Workforce Survey – as proxy, the age distribution of all nurses with this degree
%MA	Age distribution of baccalaureate degree RNs upgrading to master's or higher degree	2010 FBON Licensure Data and 2008-2009 Florida Center for Nursing Workforce Survey – as proxy, the age distribution of all nurses with this degree
Nurse Immigration and Emigration		
PEMIG_AD	Probability that RN prepared at diploma or associate level will emigrate this year	Due to our data sources, this information was captured in the attrition variable. Emigration was set to 0 to avoid double-counting.
PEMIG_BA	Probability that RN prepared at baccalaureate level will emigrate this year	Due to our data sources, this information was captured in the attrition variable. Emigration was set to 0 to avoid double-counting.
PEMIG_MA	Probability that RN prepared at masters or higher level will emigrate this year	Due to our data sources, this information was captured in the attrition variable. Emigration was set to 0 to avoid double-counting.
PIMMIG_AD	Probability that RN prepared at diploma or associate level immigrated last year	FBON Licensure Data from 2008 and 2010
PIMMIG_BA	Probability that RN prepared at baccalaureate level immigrated last year	FBON Licensure Data from 2008 and 2010
PIMMIG_MA	Probability that RN prepared at masters or higher level immigrated last year	FBON Licensure Data from 2008 and 2010
FTE Participation Rates		
FTE_AD	FTE workforce participation rates for RNs prepared at diploma and associate level	2008-2009 Florida Center for Nursing Workforce Survey

Variable	Variable Description	Data Source (2010 as Baseline Year)
FTE_BA	FTE workforce participation rates for RNs prepared at baccalaureate level	2008-2009 Florida Center for Nursing Workforce Survey
FTE_MA	FTE workforce participation rates for RNs prepared at masters or higher level	2008-2009 Florida Center for Nursing Workforce Survey
Participation Rates		
ACTIVITY_AD	Workforce participation rates for RNs prepared at diploma and associate level	2008-2009 Florida Center for Nursing Workforce Survey
ACTIVITY_BA	Workforce participation rates for RNs prepared at baccalaureate level	2008-2009 Florida Center for Nursing Workforce Survey
ACTIVITY_MA	Workforce participation rates for RNs prepared at masters or higher level	2008-2009 Florida Center for Nursing Workforce 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. Our RN projections exclude those licensed as Advanced Registered Nurse Practitioners (ARNP) and Clinical Nurse Specialists (CNS). Almost 93 percent of RNs renewing their licenses during 2008 and 2009 responded to the Center's Nurse Workforce Survey.[1] The Nurse Workforce Survey provides information on education, employment setting, and work status. We used licensure data from January 2010 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. We distributed that count into education categories using percentages from our workforce survey.

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 2009, 88.4 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 2009 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 2009 year-end NCLEX reports from the Florida Board of Nursing to assemble initial counts of new graduates from Florida LPN, ADN, and BSN programs separately.[8,9]

Over 30 new nursing programs were approved by the Board of Nursing during 2009-2010. Some of these programs will begin to graduate students in 2010, and others will begin to graduate students starting in 2011 through 2013. We estimated the number of graduates per year from these new programs, taking into account the average student retention rate for nursing programs, and added this to the baseline number of graduates per year. Based on feedback from the Center's Research Committee, we also assumed existing AD programs would expand a modest 4 percent in 2010. For example, to create the estimates of 2010 AD program graduates, we added the projected number of graduates from new nursing programs in 2010 to the baseline number of graduates from 2009, plus 4 percent of the AD graduates from 2009. We projected an increasing number of graduates during years 2010-2013 to account for growth from these new programs, and held the number of graduates steady after 2013 for RN programs and 2012 for LPN programs. Our baseline models assumed there will be no further program expansion after 2013 because of clinical capacity limitations.

Although the total number of graduates can be identified from the NCLEX data, unfortunately new graduates cannot be cleanly identified using the FBON licensure data. Within the licensure data, we identified all new licensees by examination as a proxy method of identifying new graduates. In this way, we were able to use the licensure database to produce an age distribution stratified by education level for all new licensees by examination during 2009.

Foreign Nurse Graduates: Unfortunately, there is no direct method of identifying nurses who are foreign immigrants. We estimated the number of foreign immigrant nurses to Florida as the difference between the number of new licensees by examination in 2009 and the number of new graduates passing the NCLEX from Florida schools in 2009. This results in 880 foreign immigrant nurses. We distributed foreign nurses according to our age distribution for newly licensed RNs by examination in Florida in 2009.

General Population: We used data from Florida's Office of Economic and Demographic Research (EDR) for projections of Florida's total population through 2025 and projections of the population of women aged 20-44.[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.

Attrition Rates: The Florida nurse licensure database, when analyzed over time, affords an opportunity to identify nurses who leave the nurse supply via address change, failure to renew their license, or other reasons for attrition. We were able to track a cohort of nurses from January 2008 through January 2010 to identify nurses who had been lost from the supply of potential nursing labor in the state. We produced rates of attrition by age for the two-year period and then halved these rates to estimate annual losses. The probability that a nurse will drop out of the nurse supply is assumed to remain constant over time.

Educational Upgrades: The number of RNs upgrading from a diploma or associate's level to the baccalaureate level, and the number of RNs upgrading from baccalaureate level to the master's level, was identified from the Center's 2009 Annual Report and Workforce Survey of Nursing Programs.[11] Since we could not identify within the licensure data those persons who had an education upgrade, we used as a proxy the age distribution of everyone with those specific degrees.

State-to-state Migration: Using the licensure database, we were able to track nurses from 2008 to 2010 who immigrated into Florida for various reasons. These nurses were identified by: a new Florida address, endorsement of license into Florida, or a license change to eligible or active status. Nurses who emigrated from Florida were previously identified in the attrition variable, and the emigration variables were set to zero to avoid duplicate counts.

Workforce Participation Rates: We calculated FTEs and workforce participation rates using responses to the Center's 2008-2009 Nurse Workforce Survey.[1] The average FTE and workforce participation rate was calculated for each age-education strata. We theorized that as the economy slowly improves, nurses who were working more hours for economic reasons will begin to scale back their work hours. Thus, we decreased rates of FTE participation within each age category by 0.5 percentage point each year from 2011-2016. The FTE participation rates were held constant after 2016.

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. The FBON licensure database and the Center's workforce survey from January 2010 also had LPN data.[2] 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. We also disabled the field that counts new graduates at the Bachelor's level and counted all newly licensed LPNs by examination, as discussed above, within the Diploma/Associate's field for new graduates. We followed the same procedures as with the RN supply model to calculate data for attrition, immigration, FTE and participation rates.

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. We elected to disable the foreign LPN graduate fields, as we had no information on the number of foreign LPNs migrating to Florida. We disabled 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. Our LPN model counts these nurses as attritors.

Nurse Demand Model Input Data Replacement and Assumptions

Table 2 lists each element within the NDM along with the source of data or assumption we used. Fields in the NDM are either fixed, meaning that a baseline year value is entered and retained over the projection period, 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. Rather, it is change over time in the variable that produces change in the level of demand projected by the model for future years. We hypothesized that some variables would have different values based on anticipated changes with Health Care Reform (HCR) implementation and without HCR. The table includes a brief description of the two forms of the variables when appropriate, and more detailed descriptions follow in the report.

Table 2. Nurse Demand Model Input Data Elements and Sources

Field	Field Description	Fixed or Variable	Data Source (Baseline Year=2010)
Exogenous Variables Table			
AGE_M	Mean age of population	Variable	Office of Economic and Demographic Research
BASE_ED	Total population age 5-17 in the base year	Fixed	Office of Economic and Demographic Research
BASE_OC	Total population age 18-64 in the base year	Fixed	Office of Economic and Demographic Research
BASE_POP	Total population in the base year	Fixed	Office of Economic and Demographic Research
ED_POP	Total population age 5-17 over time period	Variable	Office of Economic and Demographic Research
HH_MCR	Average Medicare payment per home health visit. Without HCR – 1% annual increase. With HCR– decrease for 2 years then remain stable.	Variable	Articles and Centers for Medicare and Medicaid Services (CMS) Reports
HISPANIC	Percent of Hispanic population over time period	Variable	Office of Economic and Demographic Research
HMO	HMO enrollment. Assumed no change in enrollment rates over time	Fixed	http://www.floridahealthfinder.gov

Field	Field Description	Fixed or Variable	Data Source (Baseline Year=2010)
MEDICAID	Percent of population in Medicaid. Without HCR – no change over time. With HCR – estimated based on percentage population covered by HCR.	Variable	Kaiser Commission on Medicaid and the Uninsured. *Medicaid Coverage and Spending in Health Reform: National and State-by-State Results for Adults at or Below 133% FPL.*
NF_MCD	Average Medicaid payment/day for nursing facility care. Without HCR – 1% annual increase. With HCR – estimated decrease in payments first 2 years of model.	Variable	Health US, 2009
NHADL	Average number of activities of daily living (ADL) limitations per nursing home resident. ½ percent increase per year.	Variable	2004 National Nursing Home Survey
NONWHITE	Percent of population non-white over time period	Variable	Office of Economic and Demographic Research
OCC_POP	Total population age 18-64 over time period	Variable	Office of Economic and Demographic Research
PCPI	Per capita personal income	Variable	Office of Economic and Demographic Research
POPULATION	Total population in state over time period	Variable	Office of Economic and Demographic Research
SURGERY	Percent of hospital surgeries performed in outpatient setting. Assume no change from baseline.	Fixed	Area Resource File (ARF) 2008
UNINSURED	Percent population without medical insurance. Without HCR – assume no change. With HCR – extrapolated yearly decrease in percentage uninsured.	Variable	The Kaiser Family Foundation, http://statehealthfacts.org.
URBAN	Percent of population living in metropolitan area	Fixed	Office of Economic and Demographic Research
WAGE_HHA	Wage for home health aides state average. 1% increase per year.	Variable	State of Florida Agency for Workforce Innovation

Field	Field Description	Fixed or Variable	Data Source (Baseline Year=2010)
WAGE_LPN	Wage for LPNs state average. 1% increase per year.	Variable	State of Florida Agency for Workforce Innovation
WAGE_NA	Wage for Nurse Aides, state average. 1% increase per year.	Variable	State of Florida Agency for Workforce Innovation
WAGE_RN	Wage for RNs state average. 1% increase per year.	Variable	State of Florida Agency for Workforce Innovation
Population Table			
	State population in 8 age categories by gender and year	Variable	Office of Economic and Demographic Research
Health Care Use in Base Year Table			
	ST Hospitals (outpatient)	Fixed	2008 ARF
	ST Hospitals (inpatient)	Fixed	2008 ARF
	ST Hospitals (emergency)	Fixed	2008 ARF
	LT Hospitals (emergency)	Fixed	2008 ARF
	LT Hospitals	Fixed	2008 ARF
	Nursing Facilities (Residents)	Fixed	The Kaiser Family Foundation, http://statehealthfacts.org.
	Home Health Visits	Fixed	CMS Statistical Supplement, 2007
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. Kept default data from original HRSA model.

Field	Field Description	Fixed or Variable	Data Source (Baseline Year=2010)
Nurse Population in the Base Year (RN, LPN, Nursing Assistant) Table			
	Nursing FTEs by nurse type and setting in the base year	Fixed	NSM FTEs in 2010 distributed by setting according to license renewal survey (RNs & LPNs), inflated for shortage following the Florida Center for Nursing's 2009 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. We began the process of defining baseline year demand with the Nurse Supply Model estimates of RN and LPN FTEs in 2010. The Center's workforce survey data provided by 90 percent of the RNs and LPNs renewing during 2008-2009 were used to distribute the RN and LPN FTEs into settings. 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 2009 Nurse Employer Survey, fielded in June 2009, collected the data needed to calculate FTE vacancy rates for RNs and LPNs in a number of different settings.[12] 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 2009 – 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 4.6 percent in hospitals, 6.8 percent in nursing homes, 8.6 percent in home health agencies, and 2.5 percent in public health. All other settings were assumed to have no shortage. LPN FTEs were inflated by 2.2 percent in hospitals, 3.7 percent in nursing homes, and 8.8 percent in home health agencies. The total shortage generated by this inflation process was 5,917 RN FTEs and 1,261 LPN FTEs. These figures are in line with estimates of total RN and LPN vacancies reported by the Center in 2010.[12]

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 use also increases, which will increase the demand for nurses. Each of the exogenous variables – except 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.[10]

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. Most of the default assumptions used by HRSA in the original model were changed to utilize Florida-specific data and to reflect new demographic and economic realities.

We updated the wages of RNs, LPNs, nurse aides, and home health aides, but kept the default variable change assumption. Updated wage data were found in Occupational Employment Statistics and Wages, prepared by the Florida Agency for Workforce Innovation.[13] 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.

We altered 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[14] and elected to assume no change (rather than an increase) in enrollment during the projection period.

We also altered the default assumption for the percent of hospital surgeries performed in an outpatient setting. This variable was originally designed to increase two percent annually. The percentage of outpatient surgeries was 54.3 percent in 2008.[15] Since this was already a large number and we theorize that a natural ceiling in the capacity to move surgery to the outpatient setting will be reached during the projection period, we assumed no change over time for this variable.

We kept the default assumption of ½ percent annual increase in the average number of activities of daily living limitations among nursing home residents. The baseline number of limitations was updated using data from the 2004 National Nursing Home Survey.[16]

The implementation of health care reform from the Patient Protection and Affordable Care Act (PPACA), passed by Congress in March 2010, is expected to have a large impact on future healthcare demand. In order to isolate the effects of health care reform on nurse demand, we have created two demand models – one which incorporates potential changes by the PPACA and one which continues the status quo. We anticipate that certain variables relating to Medicare, Medicaid, and the number of uninsured persons will be affected by health care reform.

> **HH_MCR -** This variable is the average Medicare payment per home health visit. Without healthcare reform, we used HRSA's original assumption of a 1% annual increase in payment. With healthcare reform, we reduced the payments for 2011 and 2012 by the proposed 3.79%. Although there may be potential rebasing of costs and payments in the future, we kept the payments equal from 2013 through 2025.[17-20]

> **NF_MCD -** This variable is the average Medicaid payment per day for nursing facility care. Without healthcare reform, we used HRSA's original assumption of a 1% annual

increase in payment. With healthcare reform, we reduced payments for 2011 and 2012 by 3% each year, and kept the payments the same from 2013 through 2025.[21]

Medicaid - This variable is the percentage of people covered by Medicaid. Without healthcare reform, we assumed this remained steady with 15% of the population covered by Medicaid. With healthcare reform, we assumed a total 34.7% increase in Medicaid enrollment over six years (enrolling about 950,000 Floridians), beginning in 2014.[22]

Uninsured - This variable is the percentage of the population without medical insurance. Without healthcare reform, we used the current statistic of 23.8% of Floridians uninsured and kept this percentage unchanged over time. With healthcare reform, we conservatively decreased the percentage of the uninsured population from 2014 until 2019. We used data from the reports *Medicaid Coverage and Spending in Health Reform*[22] and The Kaiser Family Foundation's website statehealthfacts.org[23] to find projections of the number of uninsured people in Florida given healthcare reform. We estimated that 683,477 uninsured adults (living in Florida with an income less than 133% of the federal poverty level) would be newly enrolled in Medicaid by 2019. We also assumed that 50% of uninsured adults living in Florida with an income greater than 133% of the federal poverty level would purchase insurance under the PPACA plan (n=985,450).

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. We used data from the 2008 Area Resource Files to obtain state-level estimates of hospital use for Florida.[15] We were able to get a more recent estimate of nursing home residents (2008) from The Kaiser Family Foundation statehealthfacts.org[24] and of the number of home health visits in Florida from the CMS 2007 Statistical Supplement.[20]

Comparison of Projections Using 2008 and 2010 Data

A brief comparison of our new 2010 forecasts with our 2008 forecasts shows a difference between the original and updated nursing shortage forecasts. Over the next 3 to 4 years, the nursing shortage in Florida is predicted to be small because supply and demand are almost in balance. However, beginning in 2014, the nursing shortage will worsen and continue to increase throughout the forecast period. Over this time, the combination of the implementation of health care reform, an aging population requiring more healthcare services, and older nurses retiring from the workforce will contribute to the growing nursing shortage.

Since our first forecasts were released in 2008, four major changes have taken place that impact our analysis: a national economic recession, implementation of healthcare reform, new and improved nurse workforce data for Florida, and Florida nursing education program expansion.

First, the recession has impacted nursing employment through providing incentives for nurses to return to work or to increase the number of hours they are already working, as families struggle with job loss and decreasing wealth and investments for retirement. The resulting increase in nurse employment has driven down the number of new job openings and made it difficult for new graduate nurses (and those who wish to re-enter the workforce) to find jobs. Second, the demand for nurses is expected to increase as healthcare reform is implemented. The consequential increased accessibility to medical care, including inpatient, outpatient, primary, school-based health centers, transitional and chronic care management, and long-term care, is expected to increase the demand for nurses.[25] Third, the Center now has detailed longitudinal data on Florida's nurse supply, with demographic information available on the entire nurse workforce and workforce characteristics available on over 90 percent of the workforce. We now know where nurses work, their employment status, how many hours a week they work, and their highest level of education – all of which improve the accuracy of our models. Finally, the number of nursing programs at all levels of nursing education has expanded and is projected to continue to expand over the next 3-4 years, thus increasing the number of new nurses in Florida.
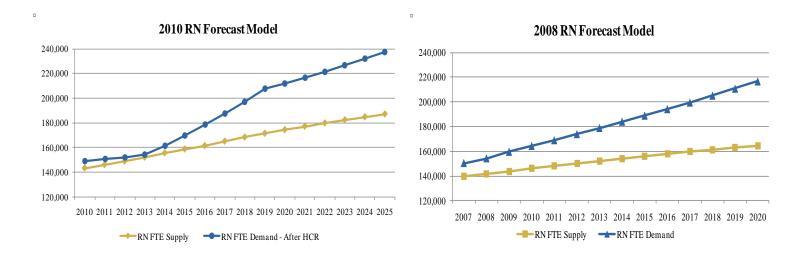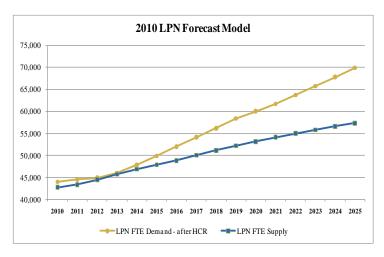

Figure 1. Comparison of RN Forecasts Developed in 2010 and 2008

A comparison of our 2008 and 2010 RN forecasts is shown in Figure 1. When compared with the 2008 model, our 2010 model projects a much more rapid increase in the supply of nurses. This occurs due to the recent and projected expansion of Florida nursing education programs as well as high participation rates owing to the slow economic recovery. Our 2010 demand projections show less growth than previously expected during the early years of the projection period but a rapid increase in demand beginning in 2014 with the implementation of healthcare reform. In 2008 we projected that the RN shortage would reach approximately 52,000 RN FTEs by 2020. Our 2010 models project that the RN shortage will exceed 50,000 RN FTEs by 2025. Though the models are quite different, their end results are similar.
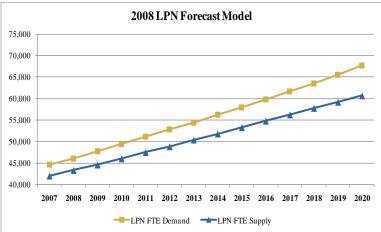
Figure 2. LPN Forecasts Developed in 2010 and 2008

Figure 2 displays our baseline LPN forecasts developed in 2010 and 2008. Similar to a comparison of RN projections, we now forecast a more rapid increase in both supply and demand than previously expected. The impact of healthcare reform is much less pronounced for LPNs, but population aging through our longer projection horizon yields increased demand in elder care settings where LPNs are most prominent. We previously projected a shortfall of about 7,000 LPN FTEs by 2020. Using our new data and assumptions, we now project a shortfall of about 13,250 LPN FTEs by 2025.

Conclusions

Our input data for the supply and demand models have greatly improved over the past two years. We have a full two-year license renewal cycle cohort of nurses, allowing in-depth examination of the education and workforce participation details of the population of licensed nurses in the state of Florida. We can also track these nurses over time to determine new entries into and departures from the workforce. The workforce participation data provides information on FTEs by various employment settings, which is used in the NDM to more accurately measure demand. Whenever possible, we updated the baseline HRSA data used in the demand model with Florida-specific data and recent estimates of variables. We are also able to project the impact of healthcare reform-related variables on the nursing profession and estimate the effect this reform would have on certain variables.

We find there are two major limitations with the structure of the HRSA forecasting models. First, 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 RNs 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. Expanding the supply model to incorporate the same employment settings as the demand model would allow us to project setting-specific nurse shortages.

The second limitation is that the interconnectivity of nurse supply and demand is ignored in these models. 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.

At present, these are the only nurse forecasting models that incorporate a multitude of factors influencing supply and demand. Furthermore, the models have the flexibility to incorporate new data and very different assumptions, thus providing timely estimates for use by workforce planners and educators. We were also able to create models comparing nurse demand with and without healthcare reform – an important tool for nurse executives to use in understanding their future nurse staffing needs. We look forward to replicating these forecasts in two years, at which time we can revisit the implementation of healthcare reform and the economic recovery.

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