Wisconsin Registered Nurse Supply and Demand Forecasting Model: Technical Report

"Health workforce data analysis (including collection) and forecasting is necessary to develop an effective response to the health workforce shortage threatening our most vulnerable communities. A healthy Wisconsin requires a sufficient, diverse, competent and sustainable health workforce."

Wisconsin Health Workforce Data Collaborative

OVERVIEW

This technical report provides a detailed explanation of the models used to forecast supply of and demand for registered nurses in the state of Wisconsin. Results and analysis of the forecasts can be viewed in the forthcoming report titled "Wisconsin RN Supply and Demand Forecasts: 2010-2035."

Wisconsin's labor force is facing a great change as the baby-boom population begins to retire. The changes are inevitable, and economists at the Office of Economic Advisors (OEA) within the Wisconsin Department of Workforce Development (DWD) have already examined their effects in a paper, "The Impact of Aging Population on Wisconsin's Labor Force" (Winters et al., 2009). As stated in the paper, the effects of the shifting demographics on Wisconsin's workforce cannot be overstated. However, health care faces a unique set of challenges due to the nature of this industry. Along with decreasing the labor supply, the aging population will increase the demand for health care. Swift steps need to be taken to ensure high quality health care in the future.

The Office of Economic Advisors is working, along with other Wisconsin Health Workforce Data Collaborative (Data Collaborative) members, to alleviate the expected health care workforce crisis. The Healthier Wisconsin Partnership Program (HWPP), a part of Medical College of Wisconsin (MCW) Advancing a Healthier Wisconsin (AHW) endowment, awarded a grant to the "Collaborative Response to the Growing Wisconsin Health Workforce Crisis" project. One of this project's goals calls for the expansion of the existing forecasting tool for registered nurses (RNs) in Wisconsin.

It is essential to stress why specific supply and demand models are needed for RNs when the Bureau of Labor Statics (BLS) already requires ten-year employment projections for all occupations. One reason is that BLS employment projections estimate the number of jobs rather than the number of workers since it does not make a distinction between part- and full-time jobs. Also, the BLS employment projections do not estimate the demand or supply in the strict economic sense of these words. For any given wage, it is not known how many jobs employers would really want to provide. Likewise, it is not known how many people would want to work for any given wage. The BLS projections only indicate the number of jobs that will actually be filled in the projected year. As a result, BLS projections estimate the number of job openings assuming the market is in equilibrium.

A 2004 Health Resources and Services Administration's (HRSA) study projected RN supply and demand for the nation and states. The HRSA projections gave a basic overview of the state's future nursing shortage. However, the state projections relied on a small sample size of nurses and national health care usage rates. Due to these local limitations, a Wisconsin specific long-term supply and demand forecasting model (the Wisconsin Model)

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The Office of Economic Advisors (OEA) is more than just data. OEA is a group of economists and analysts charged with identifying, analyzing, interpreting, and projecting workforce trends. As a part of the Department of Workforce Development, OEA assists public and private sector partners to better understand the effects of trends on the state's employment and economic growth.

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was designed to more precisely quantify the supply-demand balance of nurses in the state.

Using the HRSA forecasting model as a guide, the Wisconsin Model was originally developed by DWD's health care policy analyst and OEA economists in 2007. However, the robustness of the supply and demand forecasts were limited by inadequate data. Since then, thanks to the mandatory 2010 RN License Renewal Survey (the RN Survey) data, the Wisconsin Model was expanded and improved to allow for enhanced supply and demand projections of RNs in Wisconsin through 2035.

Despite the fact that the HRSA model was used as a guide for the design of the Wisconsin Model, our model deviates from the HRSA model in several major ways.

First, the HRSA supply model is a "stock and flow" model. This design requires estimates of inflows to and outflows from the labor market to project RN supply. Other states, including Texas, Nebraska, North Dakota, California, and Florida, use this methodology to project RN supply. Similar methodology is used for other models including HRSA's Physician Supply Model. The "stock and flow" methodology provides accurate and reliable projections if all of the data elements are present and measured correctly.

By comparison, the supply side of the Wisconsin Model requires fewer data elements because it uses changing demographics and overall population growth to implicitly capture all the factors influencing supply. Another advantage of our approach is it is easily adaptable to other occupations. To project supply, the only required data elements are an occupation's labor force and population projections by age. On the demand side, the Wisconsin Model deviates from the HRSA model by using Wisconsin specific data, when available, to project the demand for RNs.

Another unique feature of the Wisconsin Model is that it allows users to generate forecasts based on their own assumptions about the future of the nursing workforce, as well as to estimate impacts of various policy interventions. This feature is captured through the scenario models. The base models provide forecasts under the assumption that the current market conditions remain constant over time, while the scenario models allow for changes to the model's underlying assumptions. Policymakers will be able to use this model as a tool when considering which steps to take to minimize the anticipated shortage of RNs.

Additionally, the two models differ in their equilibrium assumptions. HRSA made the assumption that the labor market for RNs was in equilibrium in 1996. The Wisconsin Model has a greater flexibility. Its base case assuming market equilibrium in 2010, but users can challenge this assumption. Flexibility is important because there is currently no data to definitively determine the RN equilibrium conditions in the state. Employer-based surveys asking about current unmet RN demand are needed to estimate the current gap between supply and demand. Equilibrium is a difficult concept to quantify even with available data from employer-based surveys. For example, there are many differing opinions on the appropriate staffing intensity to provide quality care for patients. The year 2010 was chosen as the base equilibrium condition based on the subject's literature and qualitative opinions of expert partners from the Data Collaborative. The ability to change the equilibrium conditions makes forecasting results less dependent on this assumption.

Finally, the Wisconsin Model improved the method of projecting nurse educators. The HRSA model projects educators based on demand for all other RNs in the current period. The Wisconsin Model projects demand for educators based on demand for RNs in a future period since it takes time to educate, train, and license a nurse.

Overall, the Wisconsin Model is unique in its versatility and ease of use. Changes to the supply base case can be made by altering the factors that influence supply. These factors are the number of new graduates, labor force participation, retirement, and net migration. Changes to the demand base case can be made by altering the overall RN demanded-to-population ratio or the ratio for any of the employment settings. Changes to the demand ratio come from changes in health care usage or staffing intensity rates.

Our model allows users to generate their own forecasts by changing factors in any combination. This versatility is important, because a combination of policies will need to be considered to alleviate the anticipated health care workforce gap. The Wisconsin Model allows for quick and easy multivariate sensitivity analysis. For example, policymakers might consider taking steps to increase nursing educational capacity and invest in technology designed to improve the efficiency of nurses. The anticipated impact of such policies can easily be estimated through this tool.

The Wisconsin Model is a tool that allows policymakers and stakeholders to perform multiple cost-and-benefit scenarios to decide on the best course of action.

RN Forecasting Models: The Wisconsin Model

The Wisconsin supply and demand models rely on changing demographics and the overall population growth as the major driving forces. The supply and demand models both have base and scenario versions: Base Supply Model, Scenario Supply Model, Base Demand Model, and Scenario Demand Model. Additionally, each model has four sub-models:

- Broad Nursing Workforce, Head Count RNs
- Broad Nursing Workforce, FTE[1] RNs
- Direct Patient Care, Head Count RNs
- Direct Patient Care, FTE[1] RNs

[1] FTE = Full-Time Equivalent

The Base Supply Model uses a constant ratio of RNs to the total population in each age group to project the future supply of RNs. The Scenario Supply Model lets users change the ratios by changing the factors that influence supply. (See page 6.)

The Base Demand Model relies on constant nurse staffing intensity and health care usage by age and by employment setting to project the future demand for RNs. The Scenario Demand Model allows users to change either the overall base demand or the base demand in any of the employment settings. (See page 12.)

Both base models assume that the nursing labor market was in equilibrium in 2010. However, this assumption can be challenged in the scenario models.

I. SUPPLY MODEL

1. Supply Model: Base

The primary driving forces for the base supply projections are changing demographics and the overall population growth. These forces implicitly capture all current RN inflows and outflows. The base supply projections are prepared based on the assumption that the 2010 RN-to-population ratios will remain constant going forward. This assumption is made since the historic data on the RN workforce is currently limited.

The RN-to-population ratios are calculated by comparing the number of nurses (head count or FTE) in an age group to the general population for that age group. The following thirteen age groups are used in the Wisconsin Model:

(20-24) (25-29) (30-34) (35-39) (40-44) (45-49) (50-54) (55-59) (60-64) (65-69) (70-74) (75-79) (80 & Above)

Wisconsin population estimates for the year 2009 were provided by the Wisconsin Department of Health Services (DHS), population projections by age for every projected period (2015, 2020, 2025, 2030, and 2035) come from the Wisconsin Department of Administration (DOA), and number of nurses (head count and FTE) in 2009 was estimated from the RN Survey.

For the purposes of this and other forecasting reports, we use the year 2010 as the base year for all models. While conducted in early 2010, the RN Survey contains data pertaining to nurses' current situation as well as their situation during the calendar year 2009. Additionally, we use July 1, 2009 point-in-time population estimates for the state of Wisconsin.

The following are the detailed explanations of the four sub-models available for the analysis of future supply of RNs in the state.

i. Direct Patient Care Model (Head Count and FTE RNs)

This sub-model projects the supply of direct patient care (DPC) RNs working in Wisconsin. The 2009 estimate of RNs providing direct patient care in Wisconsin comes from the RN Survey based on the following criterion:

Direct Patient Care RNs working in Wisconsin are defined as the respondents who stated that they provided direct patient care at either their primary place of work [these RNs answered "Yes" to Question 86: "At your primary place of work, do you provide direct patient care?"] or their secondary place of work [there RNs answered "Yes" to Question 104: "At your secondary place of work, do you provide direct patient care?"]. (see Appendix 1 at the end of this report for a list of the relevant RN Survey questions). Please see the next section for the definition of "working in Wisconsin."

The definition for "Direct Patient Care" was available to all survey takers, and it explains this concept as "Care provided personally by you to a patient, and which may involve any aspects of the health care of that patient, including treatments, counseling, self-care, patient education, or administration of medication."

This model is broken down by age and gender

groups to provide the following projections:

- Head Count of DPC RNs
- FTE DPC RNs

ii. Broad Nursing Workforce Model (Head Count and FTE RNs)

This sub-model projects the supply of RNs who are part of the Wisconsin's broad nursing workforce (BNW). The 2009 estimate of the RNs in the Wisconsin's broad nursing workforce comes from the RN Survey based on the following criterion:

Broad Nursing Workforce RNs working in Wisconsin are defined as the respondents who either stated that they work as a registered nurse providing direct patient care [these RNs answered "Yes" to Question 59: "Are you currently working as a registered nurse providing direct patient care?"], or who stated that at least one of their jobs require licensure as a registered nurse [these RNs answered "Yes" to Question 60: "Do any of your jobs require licensure as a registered nurse?"], or who indicated that they were either "actively employed in health care, not nursing" or "unemployed, seeking work in nursing" [based on Question 61: "Please indicate your employment status:"]. (see Appendix 1 at the end of this report for a list of the relevant RN Survey questions). For definition of "working in Wisconsin" please see the next section.

At first glance, the above definition may seem inconsistent with the definition of direct patient care described earlier, but it was chosen because Question 60 was not available by primary and secondary place of work separately. As a result, the decision was made to use Question 59 for direct patient care part of this definition as opposed to a combination of Questions 86 and 104 as used before. Future RN surveys may need to be adapted to account for this discrepancy.

This model is broken down by age and gender groups to provide the following projections:

- Head Count of BNW RNs
- FTE BNW RNs

Calculating Total Hours of Work in Wisconsin

Self-reported data from the RN Survey was used to calculate total nursing hours of work in Wisconsin. In the survey, the respondents had access to the following definitions before answering the survey questions:

"Hours worked: In calculating hours worked, include any time off paid by your employer such as vacation, sick time or other leave time benefit. Also include any unpaid volunteer work, if applicable.

Weeks worked: The number of weeks during which you performed any amount of nursing work in one or more jobs and/or at the specified place of work. Round to the nearest whole number. Include any time off paid by your employer such as vacation, sick time or other leave time benefit. Also include any unpaid volunteer work, if applicable.

Primary place of work: The place of work where you currently spend the most hours during your regular work week. If you have two part-time positions with exactly the same hours per week, you may choose which one you consider "primary."

Secondary place of work. If applicable, this is the place of work where you currently spend the second most hours during the regular work week. If you have two part-time positions with exactly the same hours per week, you may choose which one you consider "secondary.""

The RN Survey allows for two possible methods of calculating each RN's total hours of work in the state of Wisconsin in the base year:

Method 1:

Total Hours of Work in Wisconsin = Total Weeks Worked in Wisconsin (RN Survey's Question 79) x Total Hours Worked per Week in Wisconsin (RN Survey's Question 80)

Method 2:

Total Hours of Work in Wisconsin = [Total Hours Worked at Primary Place of Work, if Primary Place of Work is in a Wisconsin County (RN Survey's Questions 89 (not equal to "Out of State," coded as 999) and 101) x Total Weeks Worked at Primary Place of Work if Primary Place of Work is in a Wisconsin County (RN Survey's Questions 89 (not equal to "Out of State," coded as 999) and 100)] + [Total Hours Worked at Secondary Place of Work, if Secondary Place of Work is in a Wisconsin County (RN Survey's Questions 107 (not equal to "Out of State," coded as 999) and 119) x Total Weeks Worked at Secondary Place of Work if Secondary Place of Work is in a Wisconsin County (RN Survey's Questions 107 (not equal to "Out of State," coded as 999) and 118)]

Method 2 was selected for the Wisconsin Model because respondents were allowed to enter "0" as a

valid answer for Question 79, which caused the total hours of work from the first method to be underestimated. Future RN surveys may need to be improved to account for this issue.

Defining Full-Time Equivalency

An acceptable definition for full-time equivalent (FTE) needed to be agreed upon before final FTE calculations could be made. The definition of FTE for the 2004 National RN Study by HRSA was based on self-reported information. As explained by one of the researchers, *"For that study, we looked at several operational definitions of FTE, with one of the definitions using actual hours worked (e.g., 35+ hours considered an FTE). However, the definition we ended up using was based on self-reported information on (1) whether the RN worked full time or part time, and (2) whether the RN worked for the full year or only part of the year. We defined 1 FTE if working in nursing full time for the full year, ½ FTE if working part time for the full year or full time for part of the year, and ¼ FTE if working part time for part of the year."* This HRSA definition is not applicable because similar self-reporting questions were not asked on the Wisconsin RN Survey.

Below are the two definitions of FTE that we considered:

"High" FTE Definition:

FTE = 32 hours/week x 45 weeks/year = 1,440 hours/ year

This definition is derived from the definition of terms for a HRSA Loan Repayment. Full-Time Service is defined as *"The provision of nursing services for a minimum of 32 hours per week. No more than 7 weeks per service year can be spent away from the CSF for vacation, holidays, continuing education, illness, maternity/paternity, or any other reason. (NELRP-approved absences totaling greater than 7 weeks in a 52-week service year require an extension of the contract end date)."* Using this definition results in the calculation of a higher number of FTE's compared to using the "low" FTE definition described below.

"Low" FTE Definition:

FTE = 40 hours/week x 52 weeks/year = 2,080 hours/ year

After consulting the members of the Data Collaborative, the "low" FTE definition was selected. To calculate the number of FTE RNs using this definition we use the following formula:

FTE RNs = Total Annual Hours of Work ÷ 2,080 hours/ year

Resolving the Hours of Work per Week Issue

The responses to the RN Survey questions pertaining to hours of work per week are essential for the FTE calculations. Unfortunately, the self-reported data from the RN Survey indicates that many respondents claimed to be working highly implausible numbers of hours per week. Overall, 139 respondents claim to be working over 80 hours per week at their primary place of work. The large number of implausible responses may either be due to misunderstanding of the question (e.g., recording work hours per pay period instead of work hours per week) or other idiosyncratic reasons.

To preserve the data quality, these responses were not dismissed entirely, but were treated in order to mitigate the effect of this overestimation on the number of FTE RN calculation.

Specifically, the treatment of these responses was based on the Winsorization strategy. This strategy replaces predetermined extreme values to a specified value. In the case of hours worked, as agreed by the members of the Data Collaborative, any response greater than 80 hours per week was assumed to equal exactly 80 hours per week. Estimates based on Winsorization are usually considered to be more robust to the presence of outliers in the data.

Projecting Future Supply

The primary driving forces for the base supply projections are changing demographics and the overall population growth. These forces implicitly capture all current inflows and outflows of RNs in the workforce. The base supply projections are prepared with the assumption that the 2010 RN-to-population ratios will remain constant going forward. This assumption is made since the historic data on the RN workforce is currently limited. Further analysis may uncover new trends and incorporate them into future projections.

The direct result of this methodology is that future changes in the supply of RNs are only caused by changing demographics (i.e., aging population) and the overall population growth.

The following hypothetical example illustrates the basic intuition behind the base supply projections: Assume that there are 200,000 females ages 40 to 44 in the state of Wisconsin in the base year 2010. Additionally, assume that from the RN Survey we know that there were 8,000 females ages 40 to 44 who worked as RNs in the base year 2010. Now it is easy to calculate the RN-to-population ratio in this gender/age group: 8,000 ÷ 200,000 = 4.0%. This tells us, that in this hypothetical case, 4.0% of female population who are between the ages of 40 and 44 work as RNs in the state of Wisconsin. Given our base model's methodology, we assume that this 4.0% ratio stays constant over time and apply this ratio to the projected population of females ages 40-44 in Wisconsin, which, in our example, is 250,000. Thus, 4.0% x 250,000 = 10,000, which is a projected supply of female RNs ages 40 to 44 in Wisconsin. The above procedure is repeated for both gender groups and thirteen age groups to project the total supply of RNs in the state. This hypothetical example is illustrated in Table 1 below.

Symbolically, the Wisconsin Model for the base supply projections can be summarized as follows:

$$RNs_{[proj.year,age=a]} = \left(\frac{RNs_{[base\ year,age=a]}}{Population_{[base\ year,age=a]}}\right) \times Population_{[proj.year,age=a]}$$

where *proj. year* is the relevant projection year, such as the year 2015, 2020, 2025, 2030, or 2035, *base year* is the year 2010 for the Wisconsin Model, and *age* represents one of the thirteen age groups. The total projected number of RNs for a given year is calculated by summing the projected RNs across gender and age groups.

Another direct consequence of this methodology is that the base supply model does not account for policies that have already been put in place but have not yet had an affect on the nursing supply. A prime example is increased educational capacity. Viterbo University and University of Wisconsin—Madison, among others, have implemented policies to increase the number of nursing graduates. These graduates will not enter the nursing workforce for another four to five years. These and similar policies will not be taken into consideration in the base model, but can be estimated through a separate model that allows for scenario policy analysis as described later in this report.

Table 1: Base Supply Model Illustrative Example

RN Supply	Population: Female, Age 40-44	RN-Population Ratio	RNs
Year 2010 (Base Year)	200,000	4.0%	8,000
Year 2015 (Projected Year)	250,000	4.0%	10,000

2. Supply Model: Scenario

As stated previously, the Base Supply Model uses a constant ratio of registered nurses to the total population for each age group and gender to project the future supply of RNs. The numbers of RNs are projected for every fifth year through 2035 by multiplying the ratio observed in 2010 by the projected population for a given year. The base model does not allow for policy scenario analyses since all factors that effect supply are implicitly captured but not isolated.

The Scenario Supply Model identifies and isolates four factors that influence supply. This allows model users to determine the effects of changes to specific factors on the overall RN supply.

The Scenario Supply Model does not allow users to change the overall RN-to-population ratio. This is because all changes to supply can be attributed to changes in the isolated factors that influence supply. The isolated factors that influence supply are:

- Change in new graduates
- Change in labor force participation
- Change in retirement pattern
- Change in net migration (in minus out)

The main goal of policymakers might be to increase the overall supply of RNs. Individual policies to increase supply can be simulated by changing one or more of the factors that influence supply.

Factors that Influence Supply

Change in New Graduates

The National Council Licensure Examination (NCLEX) was used as a proxy for new graduates. The Wisconsin Department of Regulation and Licensing provided the total number of RNs that received a Wisconsin license for the first time through examination in 2009. The RN Survey was then used to estimate age, gender, and participation in either the Broad Nursing Workforce or Direct Patient Care. Graduation patterns were estimated using the education section in the RN Survey. The number of nurses that received their first nursing degree between 2007 and 2009 were compiled and placed in age groups based on the nurse's age at time of graduation. Three

years of data were used to make the distribution more accurate by increasing the sample size. The maximum age group for graduates was set at 55-59 because more than 99.5% of graduate were between the ages of 20 and 59 during the three year period. Broad Nursing Workforce and Direct Patient Care new graduate counts were projected by multiplying the total count for the age group by the participation rate for the same age group.

Change in Labor Force Participation

For the purpose of the model, labor force participation rate is defined as the ratio of RNs working in the nursing field to all survey respondents. Total licensed RNs are first projected by calculating the total licensed RN-to-population ratio for each age group from the RN Survey and multiplying it by population projections. The projected total licensed RNs are then multiplied by the labor force participation ratio to calculate the labor market participants.

Change in Retirement Pattern

Retirement was measured using the RN Survey. The number of retired RNs is the number of nurses that selected "retired" on Question 61("Please indicate your employment status"). Since retirement is a subset of labor force participation, any changes to the labor force participation also changes retirement. However, the retirement variable allows users to isolate retirement to focus on scenarios regarding changing retirement patterns.

Change in Net Migration

Base year net migration was estimated using 2009 American Community Survey (ACS), U.S. Census Bureau data accessed via IPUMS U.S.A. Responses were selected using the occupational code for RNs, and net migration was calculated separately for female and male nurses. A nurse that lived anywhere besides Wisconsin in the previous year and lived in Wisconsin in 2009 was considered an "in-migrant," while a nurse that lived in Wisconsin in the previous year but lived elsewhere in 2009 was considered an "out-migrant."

Death and Disability

To allow for comparisons between the Wisconsin Model and stock-and-flow models available for the U.S. and other states, death and disability rates were estimated but kept constant at their base year rates throughout the projection period.

Mortality rates by age and gender in the state were calculated using the Wisconsin's Department of Health Services data. We define mortality rate as the number of deaths in the age group divided by the population in that age group. The mortality rates were multiplied by RN projections by age to estimate the future number of RN deaths.

The number of disabled nurses was measured using Question 62 from the RN Survey, which asked respondents to identify the reasons they were unemployed. Respondents that selected "disabled" were broken down by gender and age groups. Labor force participation rates were used to estimate the number of disabled nurses that would have been working in the Broad Nursing Workforce or in the Direct Patient Care if they did not have a disability.

Question 132, which identified nurses that needed accommodation under the Americans with Disabilities Act (ADA), was also considered in estimating RN disability, but was not used since it included nurses that were currently employed.

Scenario Supply Model Construct

Like the Base Supply Model, the Scenario Supply Model is driven by population demographics, and the RN-to-population ratio. Unlike the Base Supply Model, the Scenario Supply Model allows for changes in the base RN-to-population ratio through four isolated factors. The ratio is adjusted for a given year by changing one or more of the isolated factors that influence the RN-to-population ratio. The RN supply changes carry through the following years as the new RNs "filter" through the model. The supply level changes for a period if the factors that influence supply are changed during the period, or if the factors were changed in any of the previous periods. The new RN supply is essentially the base supply for the period plus the net change in supply from the isolated factors that influence supply in the period, plus the net effect that changes in previous periods had on the supply of this period.

Symbolically, the Scenario Supply Model can be represented by the following:

$$\Omega_{[base\ year\ ,age=a,gender=g]} = \frac{RNs_{[base\ year\ ,age=a,gender=g]}}{Population_{[base\ year\ ,age=a,gender=g]}}$$

where *base year* is the year 2010 the Wisconsin Model, *age* represents one of the thirteen age groups, and *gender* represents either of the two gender groups here and throughout the report.

Factors that influence Ω:

- New Graduates = G, where g = G/Population
- Retirement = R, where r = R/Population
- Net Migration = M, where m = M/Population
- Labor Force Participation = LFP:
    - Labor Force Participation Rate: lfpr = Participants ÷ Licensed RNs
    - $Licensed\ RNs_{[proj\ .year\ ,age=a,gender\ =g]} = \left(\frac{Licensed\ RNs_{[base\ year\ ,age=a,gender\ =g]}}{Population_{[base\ year\ ,age=a,gender\ =g]}}\right) \times Population_{[proj\ .year\ ,age=a,gender\ =g]}$

      where *proj. year* is the relevant projection year, such as the year 2015, 2020, 2025, 2030, or 2035 here and throughout the report.
- Death = D, where d = D/Population (ratio remains constant throughout the model)
- Disability = B, where b = B/Population (ratio remains constant throughout the model)

Model Process

Step 1: A percent change of one of the isolated factors that influence Ω (G, R, M, or LFP) is estimated.

Step 2: The above percent change is applied to each age and gender group for the adjusted period. The new ratio equals the base ratio times the quantity of one plus the change:

$g_{[scenario\ =s,age=a,gender\ =g]}, r_{[scenario\ =s,age=a,gender\ =g]},$

$m_{[scenario\ =s,age=a,gender\ =g]},\ or\ \ lfpr_{[scenario\ =s,age=a,gender\ =g]} =$

$g_{[base\ case\ ,age=a,gender\ =g]}, r_{[base\ case\ ,age=a,gender\ =g]},$

$m_{[base\ case\ ,age=a,gender\ =g]},\ or\ \ lfpr_{[base\ case\ ,age=a,gender\ =g]} \times$

$(1+\Delta g),\ \ (1+\Delta r),\ \ (1+\Delta m),\ \ or\ \ \ (1+\Delta lfpr)$

where *scenario* is the scenario being analyzed, *base case* represents base year estimates, *age* represents one of the thirteen age groups, and *gender* represents either of the two gender groups here and throughout the report.

Step 3: The scenario totals for the isolated factors in the adjusted period are calculated by taking the scenario ratios for the factors that influence Ω times the population for each age group:

$G_{[scenario\ =s,age=a,gender\ =g]}, R_{[scenario\ =s,age=a,gender\ =g]},$

$M_{[scenario\ =s,age=a,gender\ =g]}, LFP_{[scenario\ =s,age=a,gender\ =g]} =$

$\Sigma_{[scenario\ =s,age\ ,gender\ ]}(g,r,m,\ \ or\ \ lfpr) \times$

$Population_{[age=a,gender\ =g]}$

Step 4: $\Omega_{[scenario=s,age=a,gender=g]}$ for the adjusted period is calculated by adding the net change in the isolated factors for each age group to the base supply projections for each age group, then dividing by the population:

$$\Omega_{[scenario\ =s,age=a,gender\ =g]} = \frac{\Delta G + \Delta R + \Delta M + \Delta LFP + RNs_{[base\ case\ ,age=a,gender\ =g]}}{Population_{[age=a,gender\ =g]}}$$

Step 5: Population for each age group is multiplied by $\Omega_{[scenario=s,age=a,gender=g]}$ to calculate the scenario supply:

$RNs_{[scenario\ =s,age=a,gender\ =g]} = \Omega_{[scenario\ =s,age=a,gender\ =g]} \times$

$Population_{[age=a,gender\ =g]}$

Step 6: $\Omega_{[Scenario=s,Age=a,Gender=g]}$ for the future periods (the periods following the adjusted period) is calculated by adding the sum of all changes since the adjustment to the base supply in all of the periods since the adjustment then dividing by the sum of the population in all periods since the adjustment:

$$\Omega_{[proj\ .year\ ,age=a,gender\ =g]} = \frac{\Sigma_{[scenario\ =s,age\ ,gender\ ]}(\Delta G + \Delta R + \Delta M + \Delta LFP) + \Sigma_{[base\ case\ ,age\ ,gender\ ]}RNs}{\Sigma_{[age\ ,gender\ ]}Population}$$

Step 7: Scenario Supply for the future periods is calculated by multiplying $\Omega_{[scenario=s,age=a,gender=g]}$ by Population:

$RNs_{[proj\ .year\ ,scenario\ =s,age=a,gender\ =g]} = \Omega_{[proj\ .year\ ,scenario\ =s,age=a,gender\ =g]} \times$

$Population_{[proj\ .year\ ,age=a,gender\ =g]}$

II. DEMAND MODEL

1. Demand Model: Base

Like the supply model, there are separate models for Direct Patient Care and the Broad Nursing Workforce. Head count and FTE demand projections will be made for the two workforces. There is no distinction for the gender of nurses demanded. Definitions for direct patient care, broad nursing workforce, and FTE are the same as the definitions used for the Supply Model.

Measuring Base Demand

The Base Demand Model relies on two data elements: 1. nurse staffing intensity and 2. health care usage by employment setting and by age. Both elements are held constant, which means aging population and overall population growth are the only driving forces for the Base Demand Model. The seven HRSA employment settings were used to categorize health care usage. Some settings were broken into sub-settings. Demand projections were made using the best obtainable data.

Nurse staffing intensity is measured through Questions 87 and Question 105 on the RN Survey (see Appendix 1 at the end of this report for a list of the relevant RN Survey questions). Employment setting groups agreed upon by the Data Collaborative were used to separate the 31 place-of-work survey choices into the seven HRSA employment settings. Various methods were used to measure the number of nurses in sub-settings. Health care use was measured through a variety of sources (see Table 2).

The biggest challenge to the demand model is the quality of the health care usage data. Usage data comes from multiple sources that vary in quality. In some cases, regional usage rates, slightly out-dated data, and methods of extrapolation had to be used to

Table 2: Summary of Health Care Utilization Measures and Data Sources

Employment Setting	Health Care Utilization Measure	Data Source	Data Year	Expected Data Update	Notes
Nursing Home & Extended Care: • Nursing Home • Hospice • Assisted Living • Community based residential facilities	 Residents Patients None None	 DQA WI DHFS None None	 12/31/2008 2005 None None	 Annually Discontinued None None	Nursing home and hospice projections were extrapolated to account for all nursing home & extended care demand.
Home Health Care	Cases	DQA	2009	Annually	Cases in Title 18/19 approved homes were used to project total demand.
Inpatient	Inpatient days	WI DHS	2009	Annually	Includes all inpatient days.
Emergency	Visits	WI DHS	2009	Annually	Includes all emergency visits.
Ambulatory Surgeries in Hospitals	Cases	WHA	2009	Annually	Includes all surgeries.
Ambulatory Care: • Surgeries in FASCs • Ambulatory care (excluding surgeries)	 Cases Visits	 WHA NCHS (regional)	 2009 2008	 Annually Annually	Wisconsin data was used for surgeries. Regional data was used for all other ambulatory care.
Public Health	Total population	WI DHS	2009	Annually	Demand is projected by a constant ratio of RNs per population.
Other	Total population	WI DHS	2009	Annually	Demand is projected by a constant ratio of RNs per population.
Nurse Educators	RNs demanded	Demand Model	NA	NA	Demand based on RNs needed in future period.

Notes:
⇒ Wisconsin specific data used unless otherwise noted.
⇒ NA = Not Applicable

fill in gaps in settings that lacked recent, Wisconsin specific data.

Overall, quality projections were made based on the best available data. Future demand projections can be improved by creating and improving methods of data collection for health care usage by employment setting and by age.

Nursing Home and Extended Care

There are four types of nursing home and extended care agencies: nursing homes, hospices, assisted living facilities, and community based residential facilities. Health care usage data are available for nursing homes and hospices but not for the other two subcategories. As a result, total health care usage for this employment setting is calculated based on the data for these two subcategories. According to the RN Survey, approximately 90% of nursing home and extended care nurses work specifically in nursing homes or hospices. Total nursing home and extended care demand projections were extrapolated by dividing the sum of nursing home and hospice demand projections by 90%.

Nursing Home

A 2008 census of nursing home residents was provided by the Wisconsin Department of Health Services, Division of Quality Assurance. Health care usage is measured by the number of residents, and staffing intensity is measured as RNs per 1,000 residents. The number of nurses working in nursing homes was measured by survey respondents that selected "Nursing Home" as their place of work.

Hospice

2009 hospice usage was estimated by using 2005 hospice utilization rates by age from a Wisconsin Department of Health Services report. The 2005 utilization rates were multiplied by the 2009 population to estimate 2009 hospice usage. Usage rates from 2005 could potentially be outdated. However, the estimated patient total using the utilization rates is consistent with more recent Wisconsin data from the Hospice Association of America. Health care usage is measured by the number of patients. staffing intensity is measured as RNs per 100 patients. The number of nurses working in hospices was measured by survey respondents that selected "Hospice" as their place of work.

Home Health Care

A 2009 census of home health cases in agencies that receive Title 18/19 reimbursement broken down by age was provided by the Wisconsin Department of Health Services, Division of Quality Assurance. Health care usage is measured by the number of cases closed during the year. Staffing intensity is measured as RNs per 1,000 cases. About 90% of home health agencies that are located in Wisconsin receive Title 18/19 reimbursement. Therefore, the total number of nurses selecting home health care in the survey was multiplied by 90% to estimate the number of nurses working in home health agencies receiving Title 18/19 reimbursement. RN projections for agencies receiving Title 18/19 reimbursement were extrapolated by dividing by 90% to project RN demand for all home health agencies.

Hospitals

Hospital usage was broken down into three types of patient care: inpatient care, emergency care, and ambulatory surgeries that take place in a hospital. Nurses working in hospitals often move between departments, which makes it impossible to accurately categorize a nurse as an "inpatient", "emergency", or "ambulatory surgery" nurse through the RN Survey. The number of nurses in each sub-setting was estimated through the sub-settings share of total hospital usage. The share of total usage for each of the sub-settings was measured through total charges billed from the 2009 Wisconsin Hospital Association (WHA) Health Care Data Report.

Inpatient Care

An age break down of 2009 inpatients and inpatient days from the Wisconsin Hospital Inpatient Discharge Data System was provided by the Department of Health Services, Division of Public Health. Health care usage is measured by the number of inpatient days. Staffing intensity is measured as RNs per 1,000 inpatient days. The number of nurses working in inpatient care was estimated to be approximately seventy percent of all nurses working in hospitals based on total charges billed.

Emergency Care

An age break down of 2009 emergency visits from

the Wisconsin Hospital Emergency Visit Discharge Data System was provided by the Department of Health Services, Division of Public Health. Health care usage is measured by the number of emergency visits. Staffing intensity is measured as RNs per 1,000 visits. The number of nurses working in emergency care was estimated as nine percent of all nurses working in hospitals based on total charges billed.

Ambulatory Surgeries in Hospitals

The total number of ambulatory surgeries in hospitals for 2009 came from the Wisconsin Hospital Association report. The report also included an age distribution for the 20 most common ambulatory surgeries. The total surgeries were broken down by age based on the age distribution of the 20 most common surgeries. Health care usage is measured by the number of cases. Staffing intensity is measured as RNs per 1,000 cases. The number of nurses working in ambulatory surgery departments in hospitals was estimated as eighteen percent of all nurses working in hospitals based on total charges billed.

Ambulatory Care

Ambulatory care was split into two categories: ambulatory surgeries in freestanding ambulatory surgical centers (FASCs) and all other ambulatory care.

Ambulatory Surgeries in FASCs

The total number of ambulatory surgeries in FASCs for 2009 came from the Wisconsin Hospital Association report. The report also included an age distribution for the 20 most common ambulatory surgeries. The total surgeries were broken down by age based on the age distribution as the 20 most common surgeries. Health care usage is measured by the number of cases. Staffing intensity is measured as RNs per 1,000 cases. It was assumed that the staffing intensity for FASCs is the same as staffing intensity for ambulatory surgeries in hospitals. The number of nurses working in FASCs was estimated by multiplying the staffing intensity for ambulatory surgeries in hospitals times the number of cases.

Ambulatory Care (Excluding FASCs)

2008 Midwest regional usage rates from a Center for Disease Control survey were used since no recent, Wisconsin specific data was found for ambulatory care. The following settings were included in the data set: private solo or group practice; free standing clinic/ urgent center (not part of hospital emergency department or outpatient department); community health center; mental health center; non-federal government clinic; family planning clinic; health maintenance organization (HMO), or other prepaid practice; faculty practice plan; other. Health care usage is measured by the number of patients. Staffing intensity is measured as RNs per 100 visits. The number of RNs was measured by subtracting RNs working in FASCs from the ambulatory care total determined through Question 87 and Question 105 on the RN Survey.

Public Health

It is assumed that the entire population utilizes public health at the same rate. A public health RN-to-population ratio was used to project demand.

Other

It is assumed that the entire population utilizes health care in the "other" employment setting at the same rate. An "other" RN-to-population ratio was used to project demand.

Nurse Educators

The current demand for nurse educators is determined by the total demand for nurses in the following period.

Projecting Base Demand

Symbolically, the Wisconsin Model for the base demand projections can be summarized as follows:

$$RNs\ Demanded_{[proj\ .year\ ]} = \Sigma_{[age\ ,setting\ ]}\left(\frac{Usage_{[base\ \ year\ ,age=a,setting\ =se]}}{Population_{[base\ \ year\ ,age=a]}} \times Staffing\ Intensity_{[base\ \ year\ ,setting\ =se]} \times Population_{[proj\ .year\ ,age=a}\right)$$

where *proj. year* is the relevant projection year, such as the year 2015, 2020, 2025, 2030, or 2035, *base year* is the year 2010, which is the chosen base year for the Wisconsin Model, *age* represents one of the thirteen age groups, and *setting* represents a given employment setting.

Nursing Home and Extended Care, Home Health Care, Hospitals, and Ambulatory Care Settings

Future nursing demand is projected by estimating the current ratio of health care usage to population for each age group. The ratio is multiplied by the population projections for the age group to project total usage. Then, usage is multiplied by the staffing intensity for the setting to project RN demand. Total demand is the sum of demand by each of the age groups:

$$RNs\ Demanded_{[proj\ .year\ ]} = \Sigma_{[age\ ,setting\ ]}\left(\frac{Usage_{[base\ \ year\ ,age\ =a,setting\ =se]}}{Population_{[base\ \ year\ ,age\ =a]}} \times Staffing\ Intensity_{[base\ \ year\ ,setting\ =se]} \times Population_{[proj\ .year\ ,age\ =a}\right)$$

Public Health and Other Settings

RN demand is projected by multiplying the current ratio of RNs-to-population by population projections:

$$RNs\ Demanded_{[proj\ .year\ ]} = \left(\frac{RNs_{[base\ \ year\ ,setting\ =se]}}{Population_{[base\ \ year\ ]}}\right) \times Population_{[proj\ .year\ ]}$$

Nurse Educators

Nurse educators demand is based on total RN demand in the next period. The ratio of educators in 2010 to total demand (excluding educators) in 2015 is multiplied by total demand (excluding educators) in the next period to project educator demand:

$$RNs\ Demanded_{[proj\ .year\ ]} = \left(\frac{Educators_{[base\ \ year\ ]}}{Total\ Demand_{[base\ \ year\ +1}}\right) \times Total\ Demand_{[proj\ .year\ +1]}$$

Counting Nurses

The demand model requires nurses to be counted by setting. It is impossible to count the exact number of nurses in each setting because nurses can work in more than one setting or have multiple jobs in the same setting. A nurse that has jobs in different settings would be counted twice, while a nurse with two jobs in the same setting would be counted once. A job count was calculated for each setting. This means a nurse with two jobs in the same setting was counted twice. The job count for each setting was then converted into a head count estimate to be consistent with the supply projections. The head count was converted based on the ratio of total head count to total jobs.

2. Demand Model: Scenario

The Scenario Demand Model allows users to change overall base demand or base demand for any of the settings in any of the six periods between 2010 and 2035. Most supply and demand models need to make assumptions for equilibrium conditions. The Base Demand Model assumes the labor market for registered nurses was in equilibrium in 2010. However, this assumption can be challenged in the Scenario Demand Model. The Scenario Demand Model allows users to change the following settings: Nursing Homes and Extended Care, Home Health Care, Inpatient Care, Emergency Care, Ambulatory Surgeries in Hospitals, Ambulatory Care, Public Health Care, Other, and Nurse Educators.

Scenario Demand Model Construct

Base demand projections are used to calculate a RNs demanded-to-population ratio for each employment settings. Changes to base demand are made through percent changes to the RN demanded to population ratios. Changes can be made to any of the individual settings or to the overall demand. After a new demand total is calculated through a change in the overall demand, the model recalculates demand in each of the individual settings based on the proportion of total nurses demanded in the setting prior to the change to overall demand.

Model Process:

Step 1: A percent change of one of the employment settings is estimated.

Step 2: The above percent change is applied to the RN-to-population ratio for the setting in the selected period.

Step 3: The scenario demand for the setting is calculated by multiplying the new RN-to-population ratio by the projected population.

Step 4: If a change was made to the overall demand, the new scenario total RNs demanded is redistributed across the settings at the weighted proportion of the overall demand prior to the change.

Step 5: If the change was applied to any setting other than nurse educators, a new scenario demand for

nurse educators in the previous period is calculated by multiplying the base ratio of RNs demanded to RNs demand in the next period times the scenario RN demand (excluding nurse educators).

III. CONCLUSION

The future cannot be predicted with absolute accuracy. Even so, the forecasting model presented in this report sheds light on Wisconsin's RN supply and demand. The model estimates the magnitude of the supply-demand gap, and allows policymakers and stakeholders to develop policy intervention plans required to close the approaching gap.

However, it is important to emphasize that the quality of the forecasting results depends strongly on the quality of the input data used to prepare these forecasts. Lack of historic supply and demand data makes it virtually impossible to measure labor market trends. The forecasting model will allow us to incorporate observed trends over time as the RN License Renewal Survey continues to be administered every two years, thus challenging the assumption about constant RN to population ratios in the current version of the model.

As mentioned earlier, the supply side data comes from the 2010 RN License Renewal Survey. Wisconsin law requires every RN in the state to complete this workforce survey when renewing his or her license. Thus, in essence, this is a census of RNs in Wisconsin, yielding a high quality supply database.

The quality of data on the demand side, however, can, and should, be improved. The accuracy of the demand projections is determined by the quality of the health care usage data, which needs to be improved. Efforts should be made to collect robust, Wisconsin specific data elements that are required for the demand model. Many health care settings are already surveyed on the employer side, but the surveys do not ask the questions necessary to determine health care usage by age. Existing surveys could be enhanced to improve the data for demand projections.

Finally, there is currently no way of conclusively determining equilibriums, shortages, or surpluses. More robust staffing and vacancy surveys on the employer side would help to more accurately predict market imbalances. Also, employer surveys would act as a check on staffing intensities measured through the survey.

The list of limitations and suggestions for improvement are not meant to diminish the quality of the model results. The models provide accurate and reliable projections of nursing supply and demand. Sensitivity analysis and versatility are probably the most valuable components of the model. Sensitivity analysis will allow users to estimate the efficiency of policies, which will help to determine if the benefits of a policy outweigh the costs. The models have the versatility to run almost any type of scenario. Also, the option to change the equilibrium assumption is a unique feature. Overall, this model provides a new and unique tool that will help Wisconsin policy makers take proactive steps towards determining the gap between nursing supply and demand.

The following are possible next generation model enhancements:

- The current version of the forecasting model does not account for geographic distributional issues of RNs supply and demand in Wisconsin. Future work on the forecasting models could look at these distributional issues by producing gap forecasts for different regions in the state as well as the break down of rural versus urban areas.
- A possible way to determine better health care would be to prepare forecasts for different educational level and correlate them to health outcomes. Forecasts for separate employment settings may prove helpful for policy makers working on drafting public policies aimed at reducing nursing shortages in specific employment settings.
- The current version of the Wisconsin Model does not address the issue of patient care quality which is often at the center of any health care policy. Future versions of the forecasting model would need to incorporate health outcomes in order to improve policy results. One possible approach to achieve this merger between health outcomes and the number of nurses may be to link forecasting model's result with the county health status profiles.

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Welcome to the 2010 RN Renewal Survey!

The 2010 Nursing Workforce Survey is designed to produce detailed and accurate information about the current supply, demand, location, and skill level of Wisconsin's nursing workforce. Your candid responses will help support efforts to maintain the quality of the state's nursing profession and, in doing so, ensure a healthy Wisconsin.

Importantly, no personally identifiable information is attached to your survey responses. The data collected is kept **strictly confidential**. All data results will be presented in an aggregate format so that no one individual's responses can be distinguished.

The survey should take no more than 15 minutes. In order to speed your completion of the survey, please have the following information within easy reach before you begin:

- your estimated nursing-related 2009 wage and earnings information; and,
- your place(s) of work address(es) with county location(s) and zip codes.

Survey notes and conventions: there is a link for each page of the survey to the definitions of key terms used.

- questions are sequentially numbered throughout the survey. The information you provide will determine which questions you are asked and you will not be asked every question in the survey. You may also experience a delay between questions as your answers are processed.

- questions with an asterisk (*) are required, and the survey tool will not advance unless a response is entered.

- to go back to the previous screen use the Back button at the bottom of the screen, NOT the back button in your browsers. Excessive use of either back button may cause the survey to not operate properly.

- the survey will time out if there is no activity for 15 minutes. If this happens, the survey information previously entered will be deleted and you will need to restart the survey process from the Reg and Licensing website. Your renewal information will not be affected if the survey times out.

On behalf of the State of Wisconsin, thank you for your time and participation in the Nursing Workforce Survey.

DEMOGRAPHIC INFORMATION

1. What is your age?*

2. What is your gender?*

○ Female ○ Male

CURRENT PRACTICE INFORMATION

Please take into account all your nursing jobs as well as volunteer nursing work when answering the following questions.

59. Are you currently working as a registered nurse providing direct patient care? *

○ Yes ○ No

60. Do any of your jobs require licensure as a registered nurse? *

○ Yes ○ No

61. Please indicate your employment status:*
(Check all that apply)

☐ Actively employed in health care, not nursing

☐ Actively employed in another field

☐ Retired

☐ Unemployed, seeking work in another field

☐ Unemployed, seeking work in nursing

☐ Unemployed, not seeking work

62. Please indicate the reasons why you are unemployed and not seeking work:*
(Check all that apply)

☐ Difficulty in finding a nursing position

☐ Disabled

☐ Family/personal reasons

☐ In school

☐ Other

Primary Place of Work

Please list the following information for your primary place of work, even if this is voluntary work. Your primary place of work is where you spend the most time.

85. Check if this primary position is: *

- ○ Paid Work
- ○ Unpaid Work (Volunteer)

86. At your primary place of work, do you provide direct patient care?*

○ Yes ○ No

87. Which of the following best describes your primary place of work?*

-- Please Select --
Ambulatory Care Setting
Assisted Living Facility
College Health Services
Community-Based Residential Facility (CBRF)
Community Health Center (Federally Qualified Health Center, FQHC)
Correctional Facility
Education - Universities/Colleges
Education - Technical Colleges
Education - Elementary/Secondary School
Federal Public Health Agency (e.g. CDC, HRSA)
insurance, workforce)
Home Health Care
Hospice
Hospital - Acute Care
Hospital - AODA/Psychiatric
Hospital - General Medical/Surgical (GMS)
Hospital - Rehabilitation
Hospital - Veterans Affairs (VA)
Individual Consultant/Private Practice
Local Health Department
Non-Governmental Public Health Agency
Non-Health Care Business/Corporation
Nursing Home
Occupational Health
Policy/Planning/Regulatory/Licensing Agency
Retail Clinics
State Public Health Department
Tribal Health Center
Wisconsin State Laboratory of Hygiene
Other Government Agency (e.g. Dept. of Corrections, Dept. of Health Services)
Other

88. Please specify other primary place of work:*

89. Select which county (if in Wisconsin) or Out of State for your primary place of work?*

-- Please Select --

100. During the year 2009, how many weeks did you work at this primary place?*
The value must be between 1 and 52, inclusive.

101. During the weeks you worked in the year 2009, how many hours per week, on average, did you work at this primary place?*
The value must be greater than or equal to 1.

Secondary Place of Work

Please list the following information for your secondary place of work, even if this is voluntary work.

103. Check if this secondary position is: *

- Paid Work
- Unpaid Work (Volunteer)

104. At your secondary place of work, do you provide direct patient care?*

- Yes
- No

107. Select which county (if in Wisconsin) or Out of State for your secondary place of work?*

-- Please Select --

118. During the year 2009, how many weeks did you work at this secondary place?*
The value must be between 1 and 52, inclusive.

119. During the weeks you worked in the year 2009, how many hours per week, on average, did you work at this secondary place?*
The value must be greater than or equal to 1.

132. Do you have any disability that requires a reasonable accommodation provided by an employer under the Americans Disabilities Act (ADA)?

- Yes
- No