Tennessee Health Workforce Projections: 2021-2035

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Executive Summary

Hospitals in Tennessee report experiencing difficulty in hiring workers in some occupations, with shortages in these areas having increased sharply since the beginning of the COVID-19 pandemic. This analysis of select occupations within Tennessee's health workforce was commissioned by the Tennessee Center for Health Workforce Development (TCWD), a subsidiary of the Tennessee Hospital Association (THA), to reflect the current and future challenges of recruiting and retaining pivotal roles in healthcare delivery. The methodology for this analysis follows the approach used by the federal government and for similar analyses for other state hospital associations and governments—with the model adapted to Tennessee and using Tennessee-specific data where available.

Tennessee's healthcare workforce shares many similarities with the overall U.S. healthcare workforce but is also unique in numerous ways. Analysis of state licensure data, supplemented with analysis of national data sources and computer simulation, finds that Tennessee is facing substantial shortfalls of healthcare workers in some occupations while employing more healthcare workers in other occupations than would be expected based on national patterns of care delivery. Data limitations prevented supply modeling and comparison to national benchmarks for some occupations—particularly those that do not require licensure.

Key findings include the following:

- Changing demographics of Tennessee's population will contribute to growing demand for healthcare services while placing constraints on the ability to grow the supply of healthcare workers. Between 2021 and 2035, overall population growth of 9.7% is projected. This includes projected growth of 13.3% for the population aged 65-74 and 54.1% for the population aged 75 and older. Growth in demand for healthcare services and personnel will be particularly high for healthcare delivery settings and occupations that predominantly serve an older population. At the same time, the population aged 18-44 has projected growth of 5.5% and the population aged 45-64 has projected growth of 4.1%. Low growth among the population of working-age adults could present challenges to expanding health workforce supply to meet the future demand for services.

- In 2021, the state faced a shortfall of 15,700 registered nurses (RNs), with supply of 62,900 full-time equivalents (FTEs) versus an estimated 78,600 FTEs required to provide a national average level of services. If current supply numbers and patterns continue, by 2035 RN staffing patterns in Tennessee will look more like national patterns—though an RN shortfall of 8,500 is projected. RN supply adequacy relative to national norms will rise from 80% to 91% over this period.

- The shortfall of RNs may account for the much greater use of licensed practical nurses (LPNs) in some settings relative to national staffing patterns—particularly in offices of healthcare providers, home health, school health, and residential care facilities. The LPN supply of 22,500 FTEs exceeded by 7,500 the estimated 15,000 LPNs required to provide a national average level of services. The state's reliance on LPNs is considered to be temporary due to the current RN shortage, as supply and demand for both professions is predicted to change drastically in the coming years. LPN supply adequacy relative to national norms will fall from 150% to 105% over this period.

- The 2,170 FTE supply of respiratory therapists in 2021 fell short of the estimated 3,110 FTE demand, suggesting that supply was sufficient to meet 70% of expected demand. This shortfall is projected to continue, with a projected shortfall of 1,080 FTEs in 2035 and supply adequate to meet 72% of demand.

- Demand for 8,910 FTE medical laboratory technologists and technicians in 2021 compares to 9,010 filled positions (including full-time and part-time positions) in May 2021 as reported by the U.S. Bureau of Labor Statistics (BLS). This count far exceeds the 4,600 professionals listed in state licensure files. Hospital administrators indicated that much of the lab work is sent to out-of-state testing facilities, which could explain why licensed supply is substantially below estimated demand. Demand is projected to grow by 1,220 (14%) between 2021 and 2035 while supply is projected to decline by 60 FTEs (-1%). This portends a growing shortfall in this occupation.

- Hospitals report challenges hiring and retaining emergency medical technicians (EMTs) in their communities. An estimated 2,990 FTEs would be required to provide a national average level of services in 2021, compared to an estimate of 3,490 FTEs in state licensure files. However, the demand estimate is for employed FTEs and state licensure files do not indicate if the licensed EMT works as a paid EMT, works as an EMT in a voluntary role, or works in a non-EMT role. BLS reports 3,220 EMT positions filled in May 2021 (including full-time and part-time positions). The number of new EMTs entering the workforce each year should be sufficient to meet future demands for services, but national sources indicate a high annual attrition rate as EMTs seek employment with better pay and benefits.

- State licensure files indicate an estimated supply in 2021 of 5,120 FTE social workers. Data limitations prevent development of a national benchmark to estimate demand—as federal databases use a different definition to categorize social workers and do not collect data on licensure status. Based on the healthcare settings where social workers are employed, demand is projected to increase by 27% (equivalent to approximately 1,360 FTEs) between 2021 and 2035. Tennessee, like the nation, is training a sufficient number of social workers to meet future demand for services. However, low pay and lack of employment opportunities contribute to many trained professionals leaving this field.

- In 2021, Tennessee had 2.1% of the nation's total population and 2.1% of the nation's population age 65 or older. Tennessee also had 4.8% of the nation's nurse practitioners (NPs). Across almost all care delivery settings, Tennessee employed NPs at close to double the rate of the national average. Estimated supply of 13,260 FTEs in 2021 compared to estimated requirements of 5,960 FTEs required to provide a national average level of NP services. Although analysis of the physician workforce is outside the scope of this study, other studies indicate a shortfall of physicians in Tennessee. Hence, the abundance of NPs appears to be helping offset the shortfall of physicians. NP supply in Tennessee, and throughout the U.S., is projected to grow rapidly. Coupled with a growing national shortage of physicians[1], Tennessee might continue to have to rely more heavily on the NP workforce (relative to the national average) to meet future demand for healthcare services.

- The physician assistant (PA) supply of 2,730 FTEs in 2021 was about 620 FTEs (19%) below the 3,350 FTEs that would be expected based on national patterns of care use and delivery. Although PAs and NPs have different qualifications, educational backgrounds, and responsibilities, the reduced availability of PAs in the state appears to be offset by greater use of NPs.

- Hospital administrators report struggling to attract staff to healthcare positions because of the low pay for long hours during unpopular shifts in a high-stress environment. Personnel and other costs are rising faster than reimbursement rates.

- Deans of nursing and allied health/health sciences schools described a dwindling pipeline, driven by both the decreasing numbers of younger adults in the high school and college age cohorts, as well as less interest in both college in general and healthcare careers specifically. The dwindling pipeline is particularly noticeable for 2-year programs—despite 2-year public colleges generally being tuition-free in Tennessee—as it is increasingly common for some programs to struggle to fill their available student openings with qualified applicants.
- Many of the trends affecting the health workforce—such as high levels of burnout and challenges attracting and retaining personnel—existed before COVID-19, but have been exacerbated by the pandemic.

Interviews with stakeholders in the healthcare workforce suggest educators and employers are devising creative ways to make do with the current workforce shortages, and these efforts are helpful in bridging the gap in the short run. However, the overarching message is the current system is not sustainable in the long term and will continue to deteriorate without significant systemic changes.

These workforce shortages are created by a combination of increasing demand for providers (as the aging population requires more care), and a dwindling pipeline of healthcare workers. Interviewees suggest the shortages will be resolved only by expanding the worker pipeline, retaining the existing workforce, and maximizing technology to increase staff efficiency and decrease workload. These shortfalls cannot be resolved without beefing up the pipeline because the current and future levels of demand cannot be met without more personnel. Raising wages to retain current staff and remain competitive in the industry will not fully solve the problem and may exacerbate financial challenges hospitals are already facing.

Recruiting new employees into the pipeline is essential to fully address hospital and healthcare workforce shortages. However, interviewees noted that even significant boosting of the worker pipeline simply will not produce enough personnel without accompanying technology to make workers more efficient. Additionally, healthcare costs continue to rise with little or no increase in reimbursements and with reimbursement changes not linked to the factors that providers use in making their staffing and other managerial decisions. Thus, changes to healthcare finance are also required for a long-term solution.

We recommend the following:

Expanded workforce pipeline for nursing and select allied health occupations in short supply

- Action item 1: Create a statewide awareness campaign to highlight the variety of hospital careers available and resources to assist in training and education for those careers.
- Action item 2: Develop programs to educate middle and high school students about career opportunities in healthcare.
- Action item 3: Create or augment existing programs that provide stipends or financial incentives (e.g., tuition assistance, paid internships, loan forgiveness, and help with child care) to pursue careers in high demand healthcare fields.
- Action item 4: Increase availability of clinical sites for nurse training.
- Action item 5: Increase supply of qualified faculty and resources for nursing programs.
- Action item 6: Explore joining the licensure compact for social workers.
- Action item 7: Provide the Board of Nursing with resources needed to expedite screening of NCLEX applicants.

- Action item 8: Build career pathways to support education and training for existing staff to accelerate career advancement into high-demand positions.

Retention of Healthcare Workforce

- Action item 9: Address social and economic drivers that cause healthcare workers to leave the profession, including the cost and availability of child and elder care.
- Action item 10: Establish a statewide workplace violence prevention consortium to provide training and support and recommend policy changes.

New Models of Care

- Action item 11: Explore new models of care focused on relieving professional staff of tasks that can be delegated to other assistive personnel.
- Action item 12: Maximize technology to increase staff efficiency and decrease workload.

Geographic Distribution

- Action item 13: Focus on expansion of training programs into underserved communities.

Data Collection

- Action item 14: Implement a survey of healthcare workers at time of license renewal, as has been implemented in several other states, to collect data on labor force participation, intentions to remain in the workforce, and factors contributing to labor force participation decisions.

Introduction

Hospitals in Tennessee report experiencing difficulty in hiring workers in some occupations, with shortages in these areas having increased sharply since the beginning of the COVID-19 pandemic. This analysis of select occupations within Tennessee's health workforce was commissioned by the Tennessee Center for Health Workforce Development (TCWD), a subsidiary of the Tennessee Hospital Association (THA), to reflect the current and future challenges of recruiting and retaining pivotal roles in healthcare delivery. The methodology for this analysis follows the approach used by the federal government and for similar analyses for other state hospital associations and governments—with the model adapted to Tennessee and using Tennessee-specific data where available.

Demand and supply projections of select occupations for Tennessee and THA's 8 districts (where data permits) cover the period 2021-2035. The occupations of interest for which both supply and demand could be modeled are:

- Registered nurses (RNs)
- Licensed practical nurses (LPNs)
- Respiratory therapists
- Medical lab technicians and technologists
- Emergency medical technicians (EMTs)
- Social workers
- Nurse practitioners (NPs)
- Physician assistants (PAs)

Sufficient data exist only to model medical lab technicians with technologists together and to model EMTs at the state-level only (not at the district level). Given data availability, only demand could be modeled for the following occupations that hospitals report challenges in recruiting:

- Cardiac catheterization laboratory technicians
- Surgical technologists (operating room technicians)
- Phlebotomists

The impact of COVID-19 is considered where possible. For example, we adjusted Tennessee population projections for COVID-19-related impacts on mortality and natality through 2021. However, as the pandemic is ongoing, and because definitive data are available only with a lag, not all of its impact can be captured in these projections. To contextualize the projections and discuss some of the impacts of COVID-19 not captured by the workforce simulation model, we conducted interviews with representatives from healthcare worker education and training pipelines in Tennessee and with hospital administrators grappling with the worker shortages.

In the following sections, we first summarize the methodology and data used to produce the demand and supply projections. Then, we present and discuss study findings. We contextualize the projections with a summary of the findings from our stakeholder interviews. The final section summarizes key findings, recommendations to grow and strengthen the health workforce, and study strengths and limitations. An appendix contains additional tables.

Methodology

This section provides a brief overview of the modeling approach, and describes the methods, data and assumptions used for demand and supply modeling.

Modeling Overview

Projections of health workforce supply and demand, by occupation, were generated using GlobalData's workforce demand and supply modeling framework. It employs a microsimulation approach, meaning individuals (workers for supply modeling, and patients for demand modeling) are the unit of observation. These workforce models have been validated through modeling efforts for the federal government, state governments, professional associations, and hospitals and health systems. Modeling methods and findings have been published in academic journals and major reports.[1–8]

The latest year for which reliable data are available, 2021 for this analysis, is the "base year." The period from the base year through the last year for which projections are made, 2021-2035 for this analysis, is the "projection period."

Demand modeling starts with a representative sample of the population in each county in Tennessee projected through 2035. The model then simulates demand for healthcare services based on demographics, health risk factors, disease prevalence, and hospital usage patterns observed in Tennessee. Projected future demand for healthcare services are used to estimate demand for the healthcare workers that provide them.

Supply modeling starts with a representative sample of the number of Tennesseans working in a given occupation at baseline and an estimate of the number of new entrants entering the profession annually in Tennessee at baseline. The model then simulates additions to, and attrition from, the workforce each year, as well as changes in work hours and retirement as the workforce ages, to project supply through 2035. Current and projected future supply for workers in each occupation are then compared to projected demand to assess adequacy of supply.

All supply and demand projections are reported as full-time equivalents (FTEs) unless otherwise indicated, with an FTE defined as the national average hours worked per week among people in the given occupation working at least 8 hours per week. For occupations where workers in Tennessee work more hours per week than their national peers, the number of Tennessee workers by head count will be slightly more than one FTE. Working longer hours than national peers is one possible indication of a worker shortfall in the state.

The core demand and supply projections are for a *Status Quo* scenario. For demand, this means that healthcare use and delivery patterns remain constant over the projection period at national average pre-pandemic levels. Thus, changes in demand over time are driven by changing demographics and associated prevalence of disease and health risk factors. For supply modeling, the *Status Quo* scenario models the implications if the number of annual new entrants to the workforce for a given occupation stays constant at baseline levels, and if labor force participation, retirement, and cross-state migration patterns (based on workforce participants' demographics) all stay constant while being applied to the changing workforce demographics expected over the projection period. A comparison of *Status Quo* supply and demand indicates future supply adequacy absent any changes in healthcare delivery or efforts to increase workforce supply.

Undoubtedly, changes from the *Status Quo* will occur over the projection period, but when and how cannot be known during modeling. As such, alternative or "what-if" scenarios are also modeled to assess how projections would be affected by certain possible changes to the *Status Quo*. The alternate demand scenario models if all people were to access care at the rates of otherwise identical insured, non-Hispanic Whites in metropolitan areas. This *Reduced Barriers* scenario explores how the demand for health workforce would change with substantial progress toward national goals for equity in healthcare access.[9,10] It should be noted that this scenario is not meant to identify individual members of the population who face significant barriers to obtaining care and/or are underserved; nor is it meant to suggest that healthcare usage of insured, non-Hispanic Whites living in metropolitan areas is appropriate or adequate. Rather, this "what-if" scenario yields general insights regarding the relationship between expected workforce adequacy and reducing barriers to access to care.

Alternative supply scenarios include:

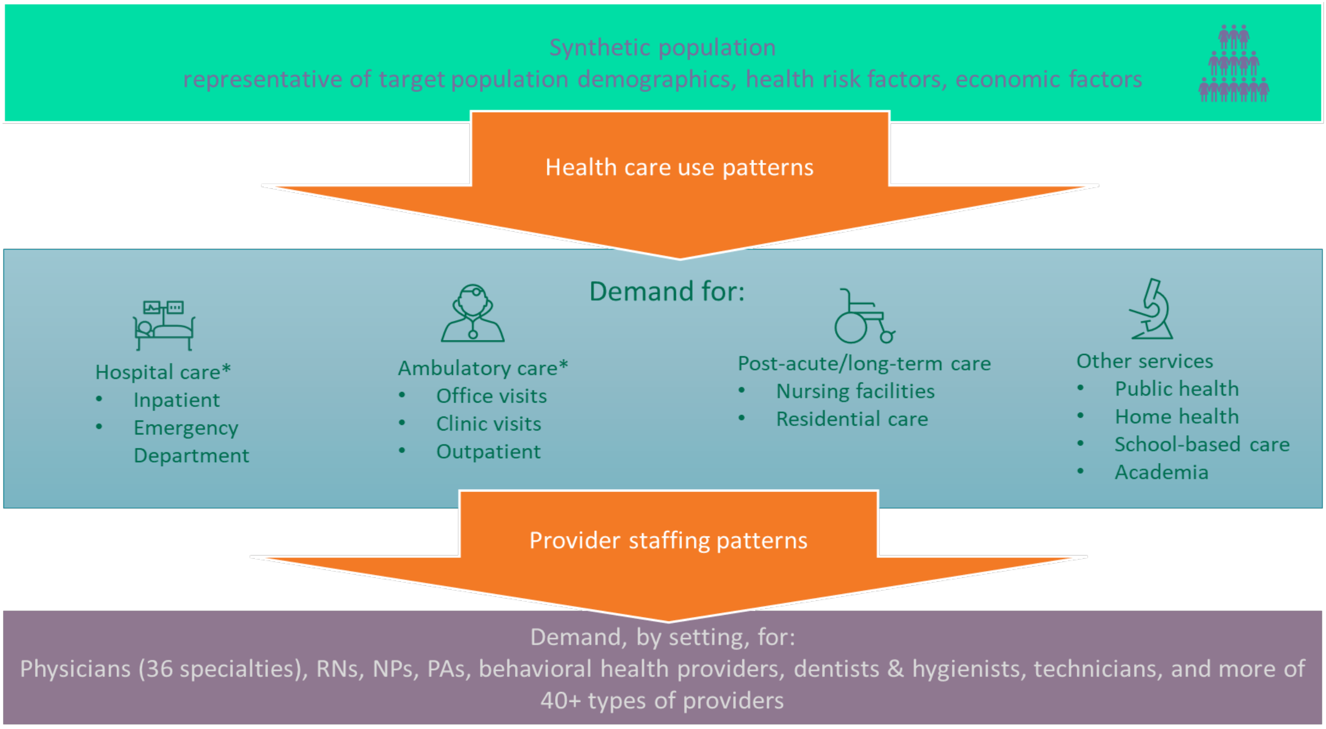
- *10% More Entrants*, which increases the annual supply of new entrants by 10%, thus exploring the potential impact of policies designed to enhance the worker pipeline;
- *10% Fewer Entrants*, which decreases the annual supply of new entrants by 10%, thus exploring the potential impact of a continued decline in interest in healthcare jobs;
- *Early Retirement*, which changes retirement patterns such that workers retire 2 years earlier than otherwise, thus exploring reported early retirements from burnout and other impacts of COVID-19; and
- *Delayed Retirement*, which changes retirement patterns such that workers retire 2 years later than otherwise, thus exploring the potential impact of policies designed to increase retention among senior staff.

Demand Modeling

Demand modeling entails analyzing relevant characteristics of the Tennessee population, predicting the amount of healthcare-related services they will consume based on these characteristics, and estimating the number of healthcare workers used to deliver these services (Exhibit 1). These analyses are performed by delivery setting, which include inpatient, emergency department, ambulatory settings, long-term care settings, schools, public health departments, and other patient care settings, as well as non-patient care settings such as within insurance companies and academia. Demand is estimated at baseline and projected forward through the projection period by accounting for the factors that drive employment growth in each setting over time.

Baseline demand within Tennessee is estimated by applying national patterns of healthcare use—based on demographics, socioeconomics, health characteristics and insurance status—to a population database representative of these characteristics for each county in Tennessee. Adjustments account for Tennessee-specific use of hospital-based services and that some hospital-based care in Tennessee is provided to non-Tennessee-residents, and some hospital-based care for Tennessee residents is provided in hospitals outside the state. Healthcare utilization projections into the future are based on forecasted changes to Tennessee's population size and demographics and projected growth in prevalence of chronic disease as the population ages. Demand for each type of healthcare worker is then derived from the expected demand for the services they provide based on national staffing patterns in healthcare delivery (e.g., observed worker-to-patient ratios). Caution, therefore, is required when comparing Tennessee supply numbers to demand as some states (like Tennessee) might use a different mix of providers relative to the national average. Furthermore, the national average is simply a benchmark for comparison.

Exhibit 1. Overview of the Demand Modeling Framework



Social work is one of the fields where hospitals note difficulties in recruiting. There are different types of social workers used in the healthcare system, and this presented challenges with developing demand estimates for comparison to supply. Licensed clinical social workers (LCSWs) participate in the assessment, diagnosis, treatment, and prevention of mental illness and behavioral disturbances. LCSWs have at least a master's degree. The Bureau of Labor Statistics (BLS) tracks employment numbers for three types of social workers: (1) healthcare social workers; (2) mental health and substance abuse social workers; and (3) child, family, and school social workers. The education and licensure requirements to work in these areas differ by state. Due to data limitations, estimates of the starting level of demand for social workers for comparison to Tennessee supply could not be derived from national data. However, knowing the healthcare settings where social workers are employed and how demand for care in those settings is projected to increase over time, we could estimate the rate of growth in demand for social workers. When modeling this rate of growth, we restrict our analysis to social workers employed in hospitals, nursing homes, residential care facilities, offices of physicians and other healthcare providers, and outpatient clinics. This definition excludes demand for social workers in schools, academia, and government-sponsored programs outside of traditional healthcare settings.

Demand for healthcare workers, for purposes of this study, is calculated as the number of providers required to provide a national average level of care controlling for demographics, socioeconomic factors, and prevalence of disease and health risk factors in Tennessee. Another approach to estimate starting year demand is simply to add Tennessee's current employment numbers plus estimates of unfilled positions (or vacancies). To assess this definition of demand, we reviewed data submitted by hospitals for the Joint Annual Reports (JAR). While the JAR data provided some insights, the modeling team only had access to hospital data (not for other healthcare settings) and in discussions with hospital administrators, there were concerns about the quality and interpretation of the data.

This study estimates and projects *demand* for healthcare services and health professions, defined, respectively, as the amount and types of healthcare services patients are willing and able to purchase at prevailing prices and the number of personnel that employers are willing and able to hire at prevailing salary levels. The concept of *demand* for services differs from *need* for services, which represents the services that patients would use based on clinical or epidemiological considerations combined with an assessment of the level of care that would be considered appropriate.

Modeling Methods and Data Sources

Expanding on this overview, the basic elements of the demand modeling are:

Population Database. The population database contains information about the characteristics of each member of a synthetic population that is representative of the resident population of each Tennessee county with regards to demographics (age, sex, race/ethnicity), health conditions and risk factors (arthritis, asthma, cardiovascular disease, diabetes, hypertension, history of heart attack, history of cancer, history of stroke, body weight status, and smoking status), household income, and health insurance status (whether insured, on public insurance, and in a managed care plan). Projections of demand for healthcare services and healthcare providers made at the county-level are aggregated to the district and state level. Key data sources used to construct this file are Tennessee residents' responses to the 2020 American Community Survey, Tennessee-county-specific data from 2021 CDC Places (based on 2018-2019 Behavioral Risk Factor Surveillance System data), and 2019 files from the Centers for Medicare & Medicaid Services (CMS) on the characteristics and prevalence of health risk factors of residents of nursing homes and residential care facilities in Tennessee.

The population database at baseline was created starting with county-level population estimates for 2020 published by the U.S. Census Bureau. Since the Census was taken during 2020, it is assumed to capture some, but not all, of that year's impact of COVID-19. So, the population baseline was adjusted to reflect the estimated impacts of COVID-19 on mortality and natality. Because of limitations in the Center for Disease Control's data used to adjust for COVID-related excess deaths—namely that the exact values of small numbers of deaths within specific county-by-age-by-sex-by-race/ethnicity categories had to be suppressed—the correction period was expanded to include 2020 and 2021 to capture an adequate amount of unsuppressed data. Thus, the baseline that fully reflects these corrections is 2021.

Healthcare use prediction equations. These equations are estimated from national data sources and used to predict healthcare demand (e.g., the number of office visits, number of expected hospitalizations and inpatient bed days) for each individual in the population database based on their individual characteristics included in the population database. Key data sources are the combined 2015-2019 files of the Medical Expenditure Panel Survey, and the 2019 National Inpatient Sample. To aid in calibrating the model to Tennessee, national utilization patterns were applied to Tennessee's resident population in 2020 and resulting predicted demand for hospital-based services was compared to actual usage reported in the 2019 and 2020 American Hospital Association Annual Survey.[11] The demand for inpatient services were underpredicted by 11%. The difference between underserved and predicted usage may reflect residents in other neighboring states seeking care in Tennessee. Demand was adjusted to set estimated and observed use of inpatient-based care equal at baseline, with the correction carrying forward through the projection period.

Care delivery patterns. National average levels of staffing were applied to projections of healthcare use by Tennessee residents, with staffing quantified in terms of the number of workers in a given occupation required to provide the projected number of services in the given care delivery setting. For example, demand for RNs in the emergency department is calculated as the number of emergency visits estimated in Tennessee divided by the base year national ratio of emergency visits per RN. Staffing ratios are calculated for RNs and are applied analogously to estimate demand in the inpatient, outpatient, office, and home health settings. For residential care and nursing home settings, the factors expected to drive demand for nurses are the size of the population living in residential care facilities and nursing homes, respectively, while the age 6-17 population is assumed to drive demand for nurses in schools, and the total Tennessee population is assumed to drive demand for nurses in the public health and all other settings. The number of new nurses being trained is the main driver of demand for nurses in teaching/academia. The staffing ratios for these settings are calculated by dividing national estimates of the demand driver by national estimates of FTE nurses working in the setting. Staffing ratios are modeled as remaining constant throughout the modeling period. We used analogous staffing ratios for the other health occupations modeled.

Projections of population growth, aging, and demographic shifts. Population projections accounting for future changes to population size by age, sex, race/ethnicity, and Tennessee county come from the Tennessee State Data Center.[12] As discussed above, we adjusted these population projections to correct for the impact of COVID-19 on mortality and natality.

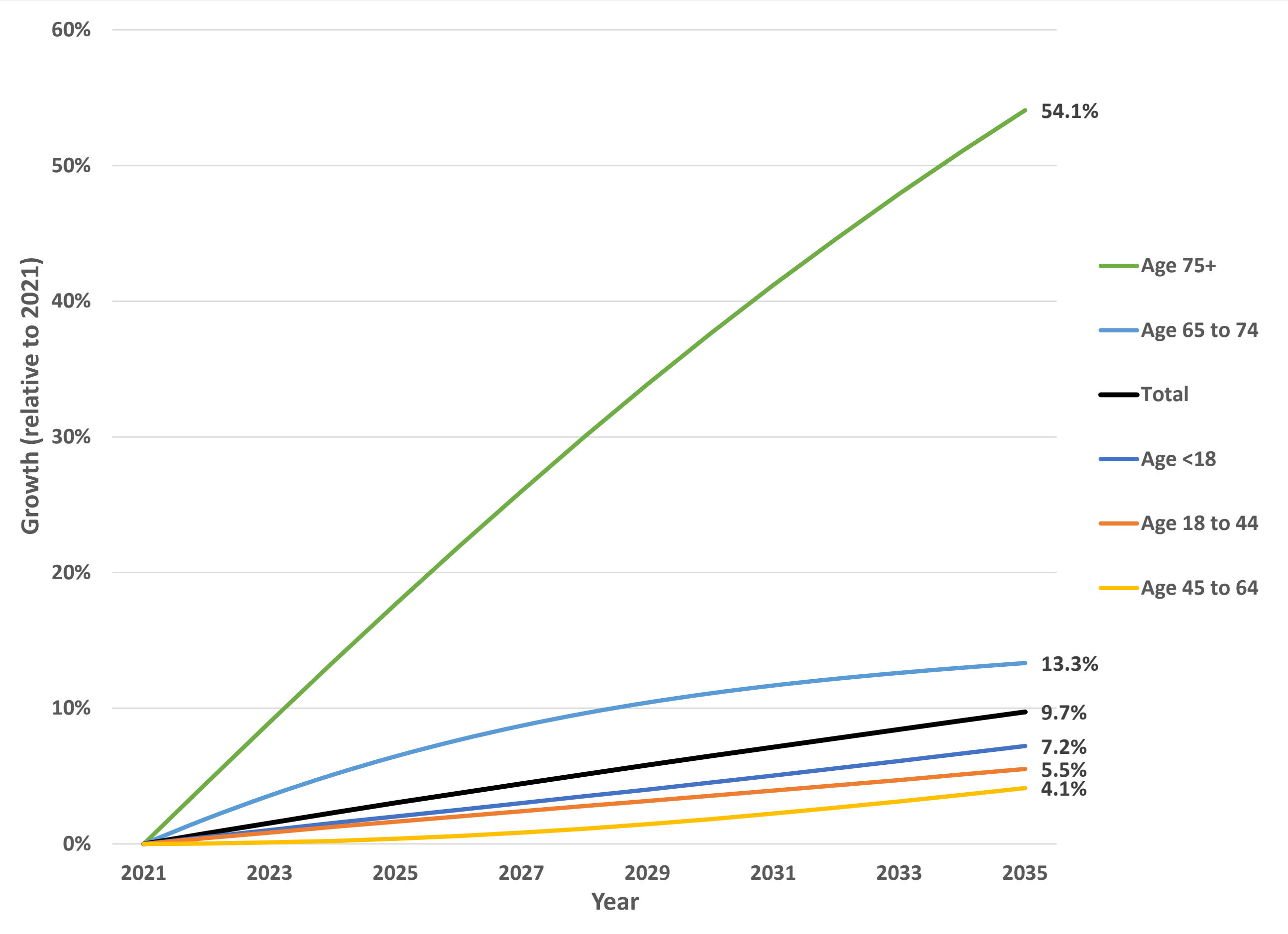
Additional information about modeling methods is detailed in the model's technical documentation, which is available elsewhere.[13]

Population Growth and Aging and Projected Demand for Healthcare Services

Population growth and changing demographics are the key drivers of changes in expected demand for healthcare services (and therefore the healthcare workers) over the projection period. The aging effect in particular will have an outsized impact on future demand for services, as the oldest population cohorts generally use services at a higher rate than those in younger age groups. Both the *Status Quo* and *Reduced Barriers* scenarios employ the same projected population changes over time.

Overall, the population of Tennessee is expected to grow 9.7%, or about 672,000 residents, from 2021 through 2035. There is considerable variation in population growth rates by age group (Exhibit 2). The number of Tennessee residents aging into the 45–64-year-old range (4.1% or 72,000 growth) is expected to grow the slowest over the period. Residents aged 18-44 years (5.5% or 137,000 growth) and younger than 18 years (7.2% or 107,000 growth) are expected to grow slightly faster but still less than the state average growth rate. The population aged 65-74 years is projected to increase 13.3% (95,000 people) and the population age 75 years and older is expected to increase a hefty 54.1% (261,000 people) over the projection period. As such, while demand for most healthcare services is likely to grow due to the increasing size of the overall population, growth in care settings that disproportionately serve older patients (e.g., hospital-based care, home healthcare, and care in nursing homes and residential care facilities) will be at a higher rate than other settings.

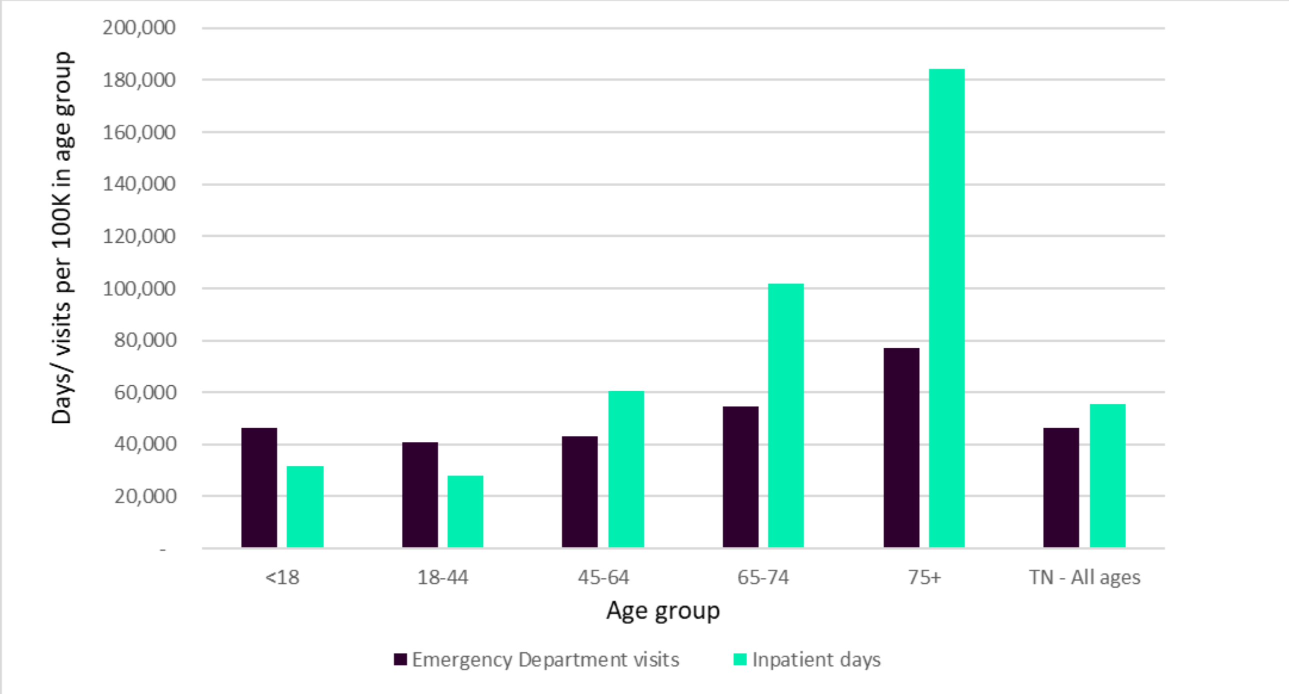
Exhibit 2. Expected Population Growth in Tennessee by Age Group, 2021-2035



Source: Analysis of Tennessee State Data Center population projections, adjusted for COVID-19 impacts on mortality and natality.

Exhibit 3 illustrates the relationship between population age and demand for hospital-based services. Individuals aged 75 and older use both emergency department and inpatient services at rates higher than other age groups. Compared with the Tennessee annual average utilization per 100,000 population of approximately 46,424 emergency visits and 55,634 bed days, utilization within the age 65-74 cohort is 17% and 83% higher than the Tennessee average emergency department and inpatient utilization, respectively. Utilization within the 75-years-and-older cohort is 66% and 232% higher for the respective settings. Thus, as the Tennessee population ages over the projection period, expected demand for healthcare services used disproportionately by older age cohorts (and consequently for healthcare workers in those settings) will increase faster than overall population growth.

Exhibit 3. Rate of Annual Use of Hospital-based Care by Age Group, 2021

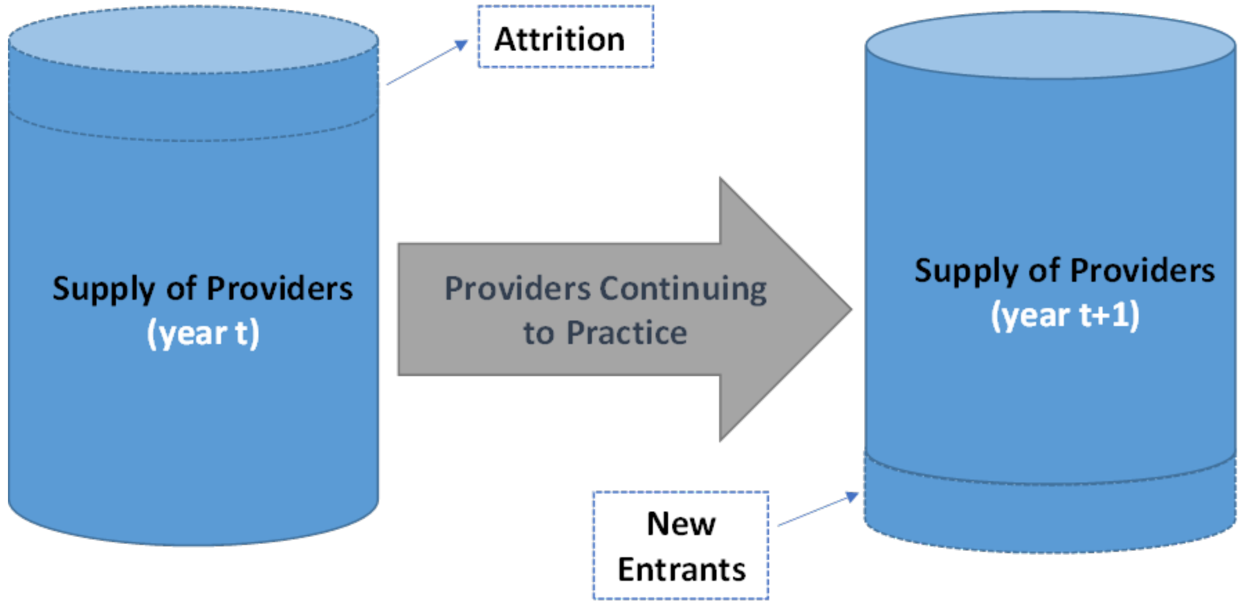


Supply Modeling

The major components to supply modeling are: (1) estimating the size and characteristics of the starting year supply; (2) modeling the number and characteristics of new entrants to the workforce; (3) modeling the labor force participation rate and weekly hours worked for those in the workforce; and (4) modeling attrition from the workforce—including people who retire, as well as those who move out of state (Exhibit 4). Using simulation during each subsequent year of modeling, workers' ages increase by one-year, weekly hours worked, and retirement probabilities are calculated for these new ages, new entrants are added to the workforce, and attrition is subtracted from the workforce.

Supply is modeled using a microsimulation approach, starting with building a representative population of health workers licensed and/or eligible to work in Tennessee. The model simulates each person's labor force decisions, including probability of being active in the workforce, weekly hours worked, probability of leaving the workforce, and other career activities, such as furthering one's education to change careers.

Exhibit 4. Overview of the Supply Modeling Framework



Licensure data maintained by the Tennessee Department of Health (TDH) is the basis for both the starting supply and estimates of new entrants to the health workforce for occupations that require licensure. National sources—such as the National Sample Survey of Registered Nurses (NSSRN), American Community Survey (ACS), and BLS Occupational Employment and Wage Statistics (OEWS)—are used to fill in information regarding education and workforce participation because Tennessee-specific data are unavailable from the TDH.

The licensure data contains nearly complete or fully complete information for age, sex, race, license status, and original license date. Demographic information (especially age) is important for supply modeling as labor force participation, hours worked, and retirement probabilities are correlated with demographics. The licensure data includes geographic location (practice county and practice state); however, information on practice county is incomplete and the degree of incompleteness varies by occupation. Tennessee, like many states, does not collect information on labor force participation or retirement intentions as part of the licensure renewal process. Pertinent to modeling RN supply, the licensure data does not contain information on the highest educational degree. Some people might have duplicate licenses.

To prepare the licensure data for modeling, we first removed individuals without an active license to practice in Tennessee, individuals with an active license but indication that they practiced outside the state, and duplicate licenses. For individuals with missing demographic information, we assigned age, sex, and/or race/ethnicity through sampling the TDH licensure data by occupation. Solutions for incomplete or missing data vary by occupation and are discussed in more detail later. The number of people with deduplicated licenses and still missing information is summarized in Exhibit 5.

Exhibit 5. Number of Licensure Files with Duplicate Records or Missing Data

Specialty	Deduplicated Licenses with practice location in Tennessee	Missing County	Missing Age	Missing Sex	Missing Race/ Ethnicity	Missing License Status	Missing Original License Date
RNs	91,777	66,046	81	32	17	0	3
LPNs	27,516	17,849	19	12	14	0	0
Respiratory Therapists	2,546	1,439	3	5	0	0	1
Clinical Laboratory Technologists and Technicians	5,547	2,286	5	28	7	0	2
EMTs	4,733	4,733	0	45	45	0	0
Social Workers	5,699	2,166	3	12	6	0	0
NPs	13,938	3,474	24	8	0	0	0
PAs	3,032	909	4	2	0	0	0

Source: Analysis of Tennessee Department of Health 2021 licensure data

We used survey responses from the 2018 NSSRN, 2015-2019 ACS and 2020 American Academy of Physician Assistants (AAPA) Masterfile to predict weekly hours worked. Prediction equations for each occupation (and for NPs and PAs for each specialty) are estimated using Ordinary Least Squares regression with weekly hours worked as the dependent variable and explanatory variables consisting of age, sex, race/ethnicity, and education level (associate degree or baccalaureate degree for RNs). Data were used on the national sample of health workers, rather than Tennessee respondents to these surveys, to increase sample size. We estimated separate regressions by occupation, using only data on individuals working at least 8 hours per week.

As noted previously, all supply and demand projections are reported as FTEs with an FTE defined as the national average hours worked per week among individuals working at least 8 hours per week. Exhibit 6 summarizes estimated average hours worked per week and provides the source for estimations. For example, 1 FTE RN is defined as working 37.8 hours per week. As the demographics of the workforce change over time, average hours worked might change for an occupation, but the definition of an FTE remains unchanged at the levels in Exhibit 6.

Exhibit 6. Estimated Average Hours per Week, Constituting an FTE, by Occupation

Specialty	Source[a]	Hours per Week
RNs	2018 NSSRN	37.80
LPNs	2015-2019 ACS	37.92
Respiratory Therapists	2015-2019 ACS	37.70
Clinical Laboratory Technologists and Technicians	2015-2019 ACS	39.04
EMTs	2015-2019 ACS	46.62
Social Workers	2015-2019 ACS	39.37
NPs	2015-2019 ACS	40.25
PAs	2020 AAPA Masterfile	42.41

Note: [a] National responses used instead of Tennessee-specific responses due to sample size.

As licensure data can be unreliable with removing individuals after they retire, individuals over the age of 70 are removed for analysis. Our analysis of ACS data and other surveys indicates few healthcare workers above age 70 in the workforce, and those that are still in the workforce typically work part-time. Likewise, licensure files indicate if the person is eligible to work in Tennessee but do not indicate whether the person is active in the workforce. Our analysis of Tennessee-specific survey responses from the 2015-2019 ACS for workforce participation are used to scale the starting supply estimates (Exhibit 7).

Exhibit 7. Labor Force Participation Rate, by Occupation

Specialty	Active in Workforce (%)
RNs	88%
LPNs	87%
Respiratory Therapists	90%
Clinical Laboratory Technologists and Technicians	88%
EMTs	91%
Social Workers	94%
NPs	97%
PAs	92%

Source: Analysis of Tennessee specific survey responses from the 2015-2019 American Community Survey.

Using the year a license is issued in the TDH licensure data, the number of annual new entrants to the Tennessee workforce is estimated as the average annual number of new licenses issued from January 2019 through January 2022. Exhibit 8 indicates the number of new individuals added annually to the workforce, with this number assumed to remain constant throughout the period under the *Status Quo* scenario. The number of new entrants to the RN workforce each year accounts for LPNs who become RNs; NP numbers account for RNs who become NPs. The demographic distributions of new entrants from analysis of the TDH licensure data remain constant when projecting into the future.

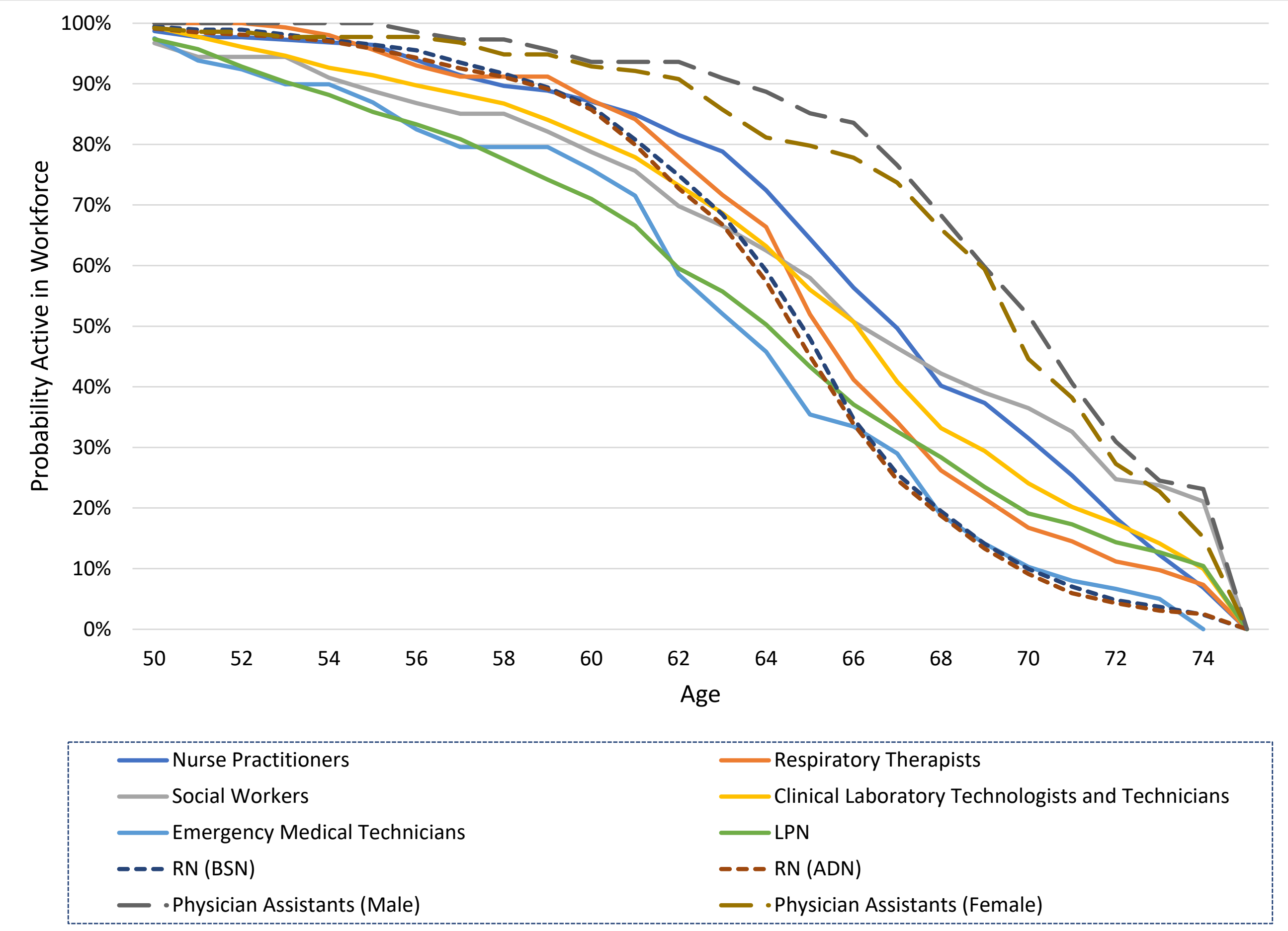
Exhibit 8. Annual New Entrants, by Occupation

Specialty	Annual New Entrants
RNs	4,947
LPNs	1,272
Respiratory Therapists	192
Clinical Laboratory Technologists and Technicians	204
EMTs	544
Social Workers	593
NPs	1,184
PAs	265

Source: Analysis of Tennessee Department of Health licensure data for people whose initial license in Tennessee was granted between January 2020 and January 2022.

Retirement patterns are derived from national survey responses in the 2018 NSSRN, 2015-2019 ACS, and 2020 AAPA Masterfile, and probability of retiring is based on age and occupation. (Probability of retirement for PAs also is separated by sex). As the modeling process progresses from year to year, an individuals' probability of retiring will change based on their new age, and this probability generally increases with age. Exhibit 9 depicts the probability that an individual aged 50 in the model will be active in the workforce over time. Included in this attrition process is the possibility that an LPN becomes an RN or an RN becomes an advanced practice registered nurse (APRN).

Exhibit 9. Probability of Workforce Participation, by Occupation & Age



Migration probabilities are calculated from prediction equations based on age, race/ethnicity, and sex (and by education level for RNs) estimated using 2015-2019 ACS data for all occupations, and specifically account for the number of individuals leaving Tennessee each year. In-migration is also accounted for in the model, but in-migration is tracked as new entrants to the Tennessee health workforce.

The supply modeling described above reflects the modeling assumptions for the *Status Quo* scenario. Several alternative scenarios are modeled to account for uncertainties in future health workforce patterns. Two scenarios reflecting changing retirement patterns were modeled—the *Early Retirement* scenario, reflecting individuals retiring two years earlier than they do currently, and the *Delayed Retirement* scenario, reflecting individuals retiring two years later than they do currently. The former scenario could reflect the impact of worsening provider burnout during COVID-19, and the latter could reflect the results of efforts by employers to retain senior staff. Similarly, two scenarios are modeled that assume alternately a 10% increase and a 10% decrease in annual new entrants to the workforce projected into the future (named the *10% More Entrants* and *10% Fewer Entrants* scenarios, respectively). The former scenario could reflect, for example, the impact of increased efforts within the state to attract and recruit new health workers to the profession, while the latter could reflect the challenges of growing the health workforce pipeline. (Supply projections for these alternative scenarios are summarized in the Appendix.)

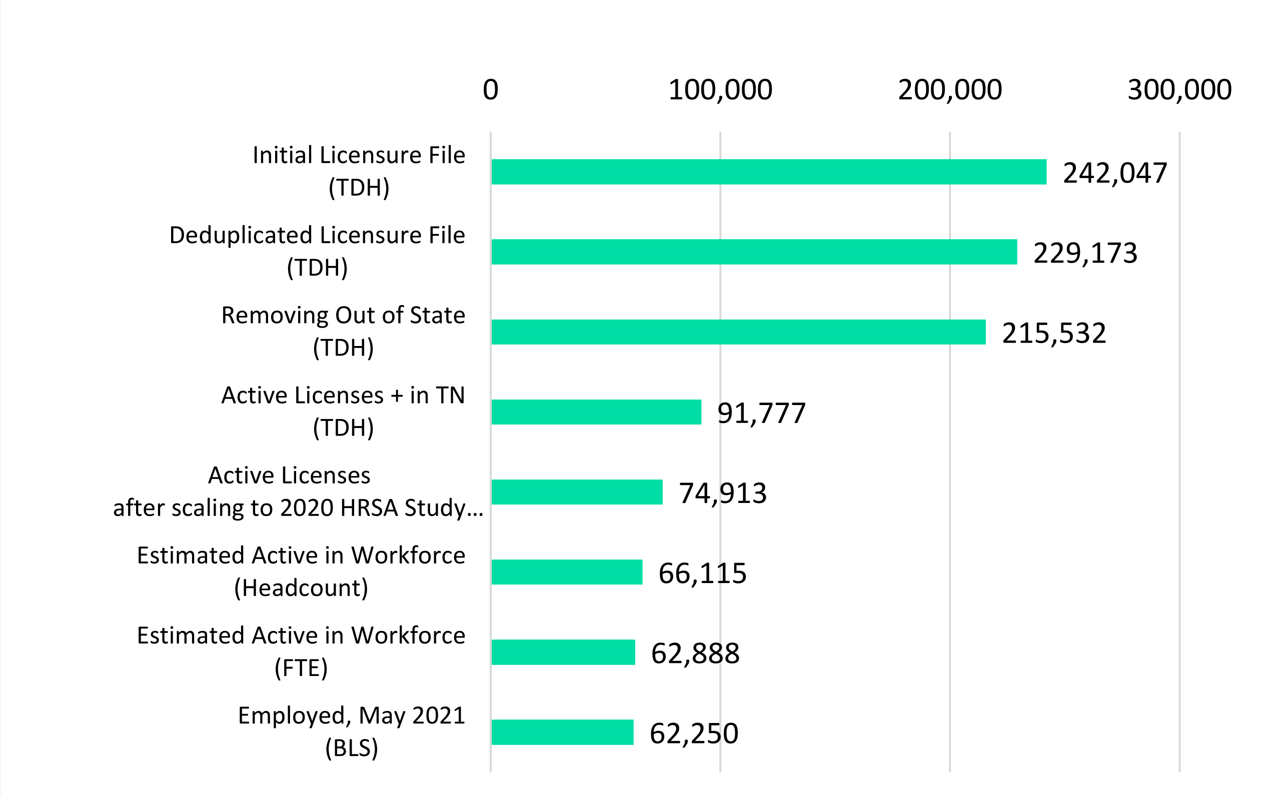
A key challenge with modeling supply for allied health occupations is that many occupations have multiple channels for entry to the occupation (including on-the-job-training) so there is a lack of data on the number of new entrants. For some occupations, pay is relatively low so there is high attrition from the occupation, which complicates supply modeling. Further, Tennessee does not require phlebotomists, operating room technicians, and catheterization lab techs to be licensed, which serves as the preliminary source for supply modeling. As such, only demand projections are available for these occupations. Below, we summarize analyses to estimate starting supply for each occupation.

- **Registered Nurses**: Exhibit 10 depicts the process to create the starting supply of RNs. The initial TDH licensure file contained 242,047 RNs. Removing duplicate entries, out-of-state RNs, and inactive licenses reduced the number to 91,777 RNs. However, the licensure data lacks information on whether the RN is in active practice in Tennessee, and if so, whether the RN is full-time or part-time.

  The Health Resources and Services Administration (HRSA), working with the U.S. Census Bureau, conducted a National Sample Survey of RN (NSSRN) in 2018. As part of that study, great effort was taken to adjust supply counts when an RN had active licenses in multiple states. The survey asked RNs whether they were currently working in a nursing role. Incorporating the HRSA survey findings, we estimate a starting RN supply of 74,913 in Tennessee. Sampling from the available 2021 practice county distribution of RNs on the TDH data dashboard completed cases where information on practice county was not available in the licensure data.[a] Tennessee responses to the 2015-2019 ACS were then used to estimate the head count of active RNs in the workforce to 66,115. Accounting for hours worked patterns, these steps yielded a baseline supply of 62,888 FTE RNs. For comparison, BLS reports 62,250 RN positions filled in May 2021 (to include both full-time and part-time positions).

[a] TDH Board of Nursing data dashboard can be accessed at: https://tnmap.tn.gov/health/nursing/

Exhibit 10. Registered Nurse 2021 Starting Supply Estimates



- **Licensed practical nurses**: The initial TDH licensure file contained 85,603 LPNs. Removing duplicate entries, out-of-state LPNs, and inactive licenses reduced the starting supply to 27,516. Sampling from the available 2021 practice county distribution of LPNs on the TDH data dashboard was used to complete cases where information on practice county was not available in the licensure data. 2015-2019 ACS Tennessee responses on labor force participation were used to estimate the head count of active LPNs in the workforce to 23,407. These steps yielded a baseline supply of 22,480 FTE LPNs.

- **Respiratory therapists**: The initial TDH licensure file contained 18,255 respiratory therapists. Removing duplicate entries, out-of-state respiratory therapists, and inactive licenses reduced the starting supply to 2,520. Sampling from the available practice county distribution of respiratory therapists in the TDH licensure data was used to complete cases where information on practice county was not available. 2015-2019 ACS Tennessee responses were then used to reduce the headcount of active respiratory therapists in the workforce to 2,277. These steps yielded a baseline supply of 2,171 FTE respiratory therapists. Due to respiratory therapists having a high turnover rate, an annual attrition rate of 4.19% was applied for respiratory therapists under the age of 50.

- **Social workers**: The initial TDH licensure file contained 36,648 social workers. Removing duplicate entries, out-of-state social workers, and inactive licenses reduced the starting supply to 5,497. Sampling from the available practice county distribution of social workers in the TDH licensure data was used to complete cases where information on practice county was not available. 2015-2019 ACS Tennessee responses were then used to estimate the headcount of active social workers in the workforce to 5,160. These steps yielded a baseline supply of 5,122

FTE social workers. Due to social workers having a high turnover rate, an annual attrition rate of 4.96% was applied for social workers under the age of 50.

- **Medical lab technicians and technologists**: The initial TDH licensure file contained 26,297 medical lab technicians and technologists. Removing duplicate entries, out-of-state medical lab technicians and technologists, and inactive licenses reduced starting supply to 5,298. Sampling from the available practice county distribution of medical lab technicians and technologists in the TDH licensure data was used to complete cases where information on practice county was not available. 2015-2019 ACS Tennessee responses were then used to reduce the head count of active medical lab technicians and technologists in the workforce to 4,677. These steps yielded a baseline supply of 4,600 FTE medical lab technicians and technologists.

- **Emergency medical technicians**: The initial TDH licensure file contained 49,753 emergency medical personnel. Selecting for EMTs, removing duplicate entries, and removing inactive licenses reduced starting supply to 4,679 EMTs. Analysis of 2015-2019 ACS data from Tennessee responses were then used to estimate the head count of active EMTs in the workforce to 4,254. These steps yielded a baseline supply of 3,491 FTE EMTs.

- **Nurse practitioners**: The initial TDH licensure file contained 66,830 APRNs. Selecting for nurse practitioners and removing duplicate entries, out-of-state NPs, and inactive licenses reduced the starting supply to 13,702. Sampling from the available 2021 practice county distribution of APRNs on the TDH data dashboard was used to complete cases where information on practice county was not available in the licensure data. 2015-2019 ACS Tennessee responses were then used to estimate the headcount of active NPs in the workforce to 13,276. These steps yielded a baseline supply of 13,257 FTE NPs.

- **Physician assistants**: The initial TDH licensure file contained 8,862 PAs. Removing duplicate entries, out-of-state PAs, and inactive licenses reduced the starting supply to 2,987. Sampling from the available practice county distribution of PAs in the TDH licensure data was used to complete cases where information on practice county was not available. 2015-2019 ACS Tennessee responses were then used to estimate the head count of active PAs in the workforce to 2,738. These steps yielded a baseline supply of 2,726 FTE PAs.

  Analysis of national data from the Current Population Survey, which asks people about their current occupation and their occupation one year ago, suggests EMTs have relatively high rates of career change. We conservatively estimate annual attrition of 7.88%, but the actual rate could be higher. High turnover in this occupation is due, in large part, to EMTs leaving the profession to pursue jobs with better pay or benefits. Another study noted an annual attrition rate of 4% nationally among all certified emergency medical services (EMS) personnel—though the study authors noted that the majority (72%) of surveyed EMS personnel who left reported that they are likely to return to EMS.[14] To account for this relatively high rate of career change, an annual attrition rate of 7.88% was applied for EMTs under the age of 50, in addition to modeling retirement patterns for those over 50.

  No information was provided on practice county for EMTs in the TDH licensure data. There was also no secondary source available at the time of this study to complete this missing information. Therefore, supply projections for EMTs are only presented at the state level.

Findings

Study findings are presented for the nursing workforce, select allied health occupations, and advanced practice providers. Additional tables with supply and demand projections are in the appendix.

Registered Nurses and Licensed Practical Nurses

As the largest healthcare provider occupation, nurses are the backbone of the hospital workforce, acting as the primary interface with patients, heavily impacting patients' experience and outcomes, and playing a critical role in quality assurance and helping achieve health equity.[9,15] Nurses work in nearly all healthcare settings—hospitals, provider offices and other ambulatory settings, nursing homes, residential care facilities, school health clinics, public health departments, and other settings.

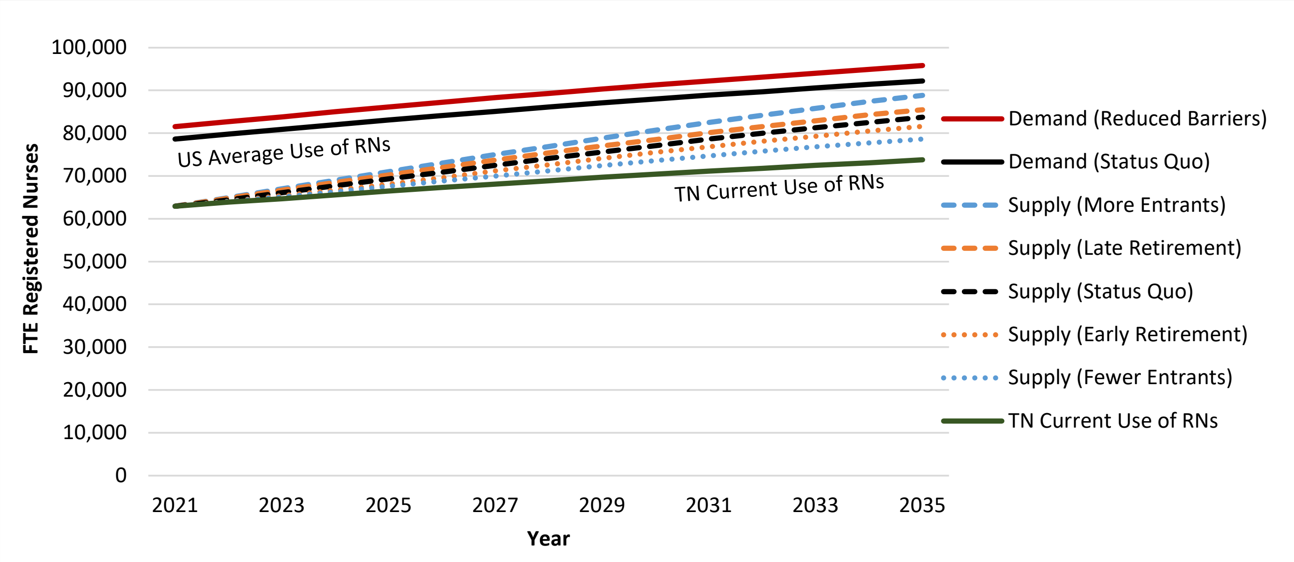
Exhibit 11, Exhibit 37, and Exhibit 45 summarize supply and demand projections for RNs under the modeled scenarios. FTE supply in 2021 was approximately 62,900 FTEs versus demand of 78,600. (Demand is defined as the number of FTEs required to provide the 2021 average national level of care). Study results show that in 2021, Tennessee needed about 15,700 more RNs to provide a national average level of care accounting for demographics, prevalence of disease and health risk factors, and socioeconomic factors within the state's population. That is, Tennessee's supply of RNs was sufficient to meet about 80% of demand.

Under the *Status Quo* supply scenario, RN supply will grow 33% between 2021 and 2035 (Exhibit 45). Under the range of assumptions modeled, projected supply growth is lowest under the *10% Fewer Entrants* scenario (25% growth, or 15,700 FTEs) and highest under the *10% More Entrants* scenario (41% growth, or 25,900 FTEs).

To provide a 2021 national average level of care, demand for RNs in Tennessee will rise from 78,600 FTEs to 92,200 FTEs by 2035. This represents a projected growth of 17% over the projection period or a little less than double the rate of population growth. The increasing demand for RNs is primarily driven by the projected increase in Tennessee's population, particularly the outsized growth of the eldest population age groups, which use a disproportionate amount of healthcare services. Under the *Reduced Barriers* scenario, demand for RNs would be approximately 81,500 FTEs (or almost 4% higher than under the *Status Quo* scenario) at baseline and 95,800 FTEs (also almost 4% higher than under the *Status Quo* scenario) in 2035.

Because RN supply is rising faster than demand under the *Status Quo* scenarios, Tennessee is on a path to move closer to the national average in RN staffing. Still, by 2035, there will be a projected 8,500 FTE shortfall—meaning that Tennessee supply should be sufficient to meet approximately 91% of demand. As discussed later, this shortfall of RNs is projected to be accompanied by a higher use of LPNs in Tennessee versus the national average.

Exhibit 11. RN Supply and Demand Projections, 2021 - 2035



Demand under the *Status Quo* scenario for RNs by employment setting is summarized in Exhibit 12. The factor driving demand in the office setting is office visits, in the inpatient setting it is inpatient days, and in nursing home and residential care settings the demand driving factor is the projected size of the population living in those settings. Demand for nurses in academia is projected to remain constant over time, which is consistent with the supply modeling assumption under the *Status Quo* scenario that the number of new nurse entrants will remain constant when projected into the future. If the size of the nurse training pipeline grows, then demand for nurses in academia will grow at the same rate. The 2021-2035 projected nurse FTE growth rates range from 9% in "Other Settings" (which includes schools, academia, public health, insurance companies, and the like) to 45% and 56% in the nursing home and residential care settings, respectively, reflecting the high projected population growth in the eldest age groups who use these services at above average rates. Over half of the projected growth in demand for RNs is expected to come from the hospital inpatient setting, for which demand is projected to increase by approximately 7,230 FTEs.

Exhibit 12. Demand for RNs by Setting (*Status Quo* Scenario)

Setting	2021	2035	FTE	%
Hospital	44,540	52,290	7,750	17%
Inpatient	40,070	47,300	7,230	18%
Emergency	4,470	4,990	520	12%
Ambulatory	14,180	15,850	1,670	12%
Outpatient	10,220	11,360	1,140	11%
Office	3,960	4,490	530	13%
Long Term Care	8,520	11,700	3,180	37%
Nursing Home	1,330	1,930	600	45%
Residential Care	1,950	3,050	1,100	56%
Home Health	5,150	6,610	1,460	28%
Adult Day Service	90	110	20	22%
Other Settings *	11,380	12,350	970	9%
Total	78,620	92,190	13,570	17%

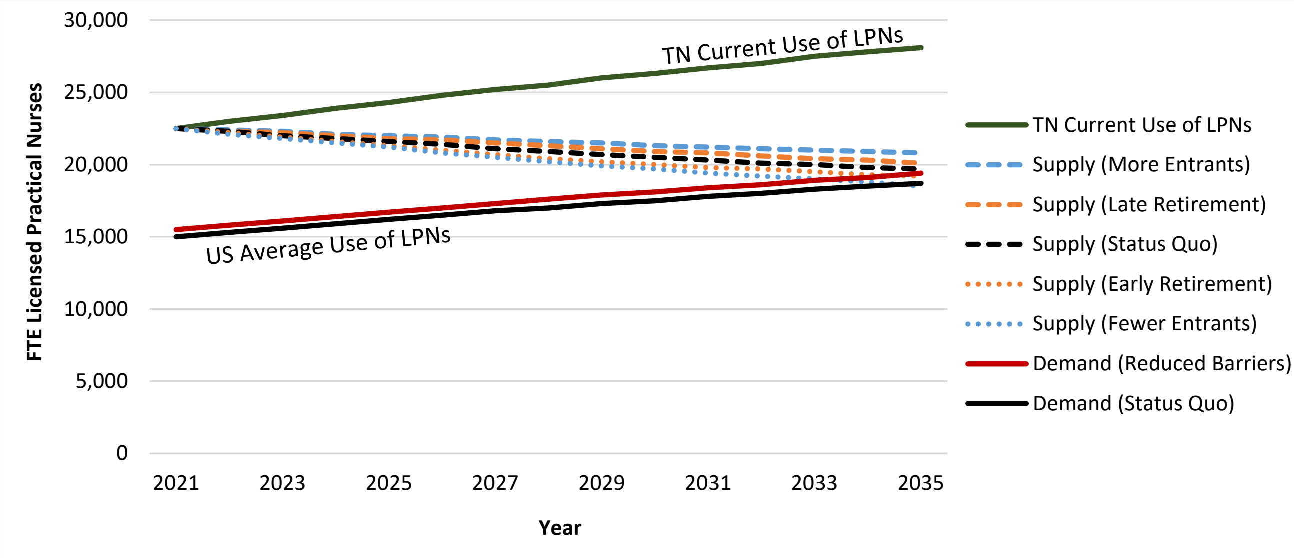
Notes: All values were estimated to whole numbers, then reported to the nearest 10 to avoid implying more precision than can be claimed. Due to rounding, totals might not exactly equal the sum of the components, and growth rates calculated from the rounded numbers may not exactly match those calculated reported in the table (calculated from unrounded numbers). * Other Settings: schools, academia, public health, insurance companies, etc.

Exhibit 13, Exhibit 38, and Exhibit 46 summarize supply and demand projections for LPNs under the modeled scenarios. The estimated 22,500 FTE supply in 2021 exceeds the approximately 15,000 FTEs required to provide a national average level of care to the population in Tennessee. The extra 7,500 LPNs that Tennessee currently uses only partially offsets the 15,700 shortfall of RNs.

Projected supply of LPNs decreases over the projection period for all scenarios, with a 12% (2,800 FTE) decline projected under the *Status Quo* scenario. The generally steady decrease in supply over the projection period reflects that the LPN workforce is disproportionately older (thus, containing many nurses reaching retirement age over the period) and fewer young replacements as new nurses are encouraged to pursue a nursing degree or other higher certifications. Under alternative scenarios (Exhibit 46), LPN supply is expected to decline between 1,700 FTEs (or 8% under the *10% More Entrants* scenario) and 4,000 FTEs (or 18% under the *10% Fewer Entrants* scenario). Increasing the number of new LPNs trained might prove challenging as the candidate pool (adults aged 18-44) is projected to increase by only 5.5% over the projection horizon. Thus, nursing will be under continued competition for recruits as the proportion of adults typically in the workforce (i.e., age 18-64) declines over time. Declines in the supply of LPNs could put further strains on the RN workforce.

The 15,000 FTEs required to provide a national average level of care is projected to increase to over 18,700 FTEs by 2035. This 25% increase is two and a half times the rate of overall population growth. Projected LPN demand growth is higher than projected RN demand growth because LPNs tend to work in care settings disproportionally used by older adult patients. This population is projected to grow faster than the overall Tennessee population. The *Reduced Barriers* scenario projects demand for 15,500 LPNs at baseline and 19,400 FTEs in 2035 (almost 4% higher than under the *Status Quo* scenario).

Exhibit 13. LPN Supply and Demand Projections, 2021-2035



Demand for LPNs by employment setting under the *Status Quo* scenario is summarized in Exhibit 14. As with RNs, the 2021-2035 projected nurse FTE growth rates range from 9% in "Other Settings" (which includes schools, academia, public health, insurance companies, and the like) to 45% and 56% in the nursing home and residential care settings. However, a larger percentage of LPNs work in the long-term care setting, which accounts for a larger overall projected increase in demand for LPNs (25% versus 17%) over the projection period.

Exhibit 14. Demand for LPNs by Setting (*Status Quo* Scenario)

Setting	2021	2035	FTE	%
Hospital	4,350	5,140	790	18%
Inpatient	4,350	5,140	790	18%
Emergency	-	-	-	NA
Ambulatory	2,620	2,940	320	12%
Outpatient	1,290	1,430	140	11%
Office	1,330	1,510	180	14%
Long Term Care	5,830	8,220	2,390	41%
Nursing Home	3,420	4,950	1,530	45%
Residential Care	660	1,030	370	56%
Home Health	1,700	2,180	480	28%
Adult Day Service	50	60	10	20%
Other Settings *	2,220	2,430	210	9%
Total	15,020	18,730	3,710	25%

Notes: All values were estimated to whole numbers, then reported to the nearest 10 to avoid implying more precision than can be claimed. Due to rounding, totals might not exactly equal the sum of the components, and growth rates calculated from the rounded numbers may not exactly match those calculated reported in the table (calculated from unrounded numbers). * Other Settings: schools, academia, public health, insurance companies, etc.

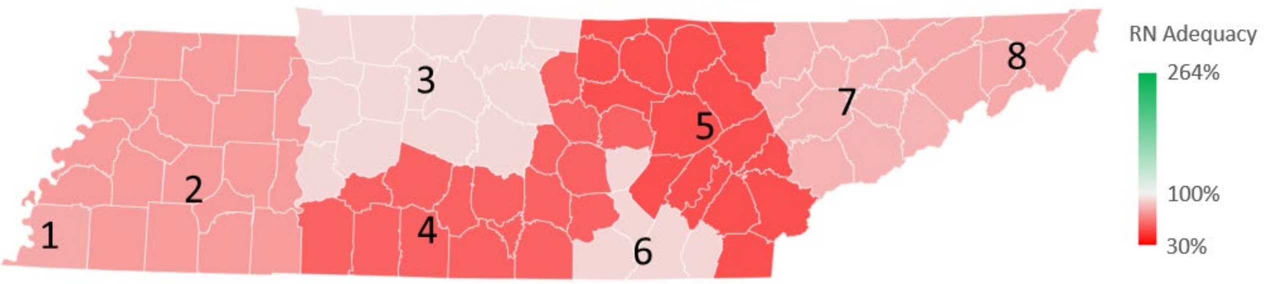
Supply and demand of healthcare workers are projected to grow differently across THA districts as population growth and other factors differ across the state. Exhibit 53 in the Appendix lists the counties in each of the 8 districts. Geographic variation in supply and demand at the district level can reflect a variety of factors, including: (1) differences in population demographics and characteristics; (2)

differences in projected population growth; (3) differences in opportunities for education and training; and (4) geographic variation in where hospitals and other employers of nurses are located.

Comparing supply and demand for nurses produces a measure of supply adequacy—defined as the degree to which FTE supply is available to provide a national average level of care (demand) to the population that resides in the district. Estimated supply adequacy for RNs (Exhibit 15) and for LPNs (Exhibit 16) reflect several patterns. Across the entire state, there is much less use of RNs and much greater use of LPNs relative to the national average. With the exception of Memphis (District 1), where there is a shortage of both RNs and LPNs relative to the national average, there is a strong inverse correlation across districts between supply adequacy of RNs and supply adequacy of LPNs. Districts where there is a greater shortage of RNs make greater use of LPNs.

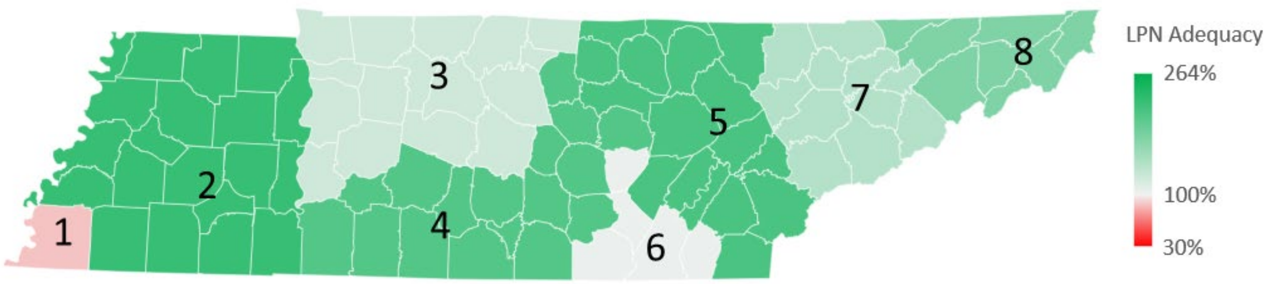
One caveat to consider when assessing local area estimates of supply adequacy is demand is modeled based on the resident population in the counties that comprise each district. The analysis does not account for some residents crossing district lines to receive care. Because major hospitals that provide specialized care to high acuity patients tend to be in metropolitan areas, local assessments might understate nurse supply adequacy in metropolitan areas and overstate supply adequacy in nonmetropolitan areas.

Exhibit 15. RN Supply Adequacy by District, 2021



Note: Supply is relative to the number of providers required to provide a 2021 national average level of services. Districts: 1 = Memphis; 2 = West; 3 = Middle; 4 = South Middle; 5 = Mid-East; 6 = Chattanooga; 7 = Knoxville; 8 = Northeast

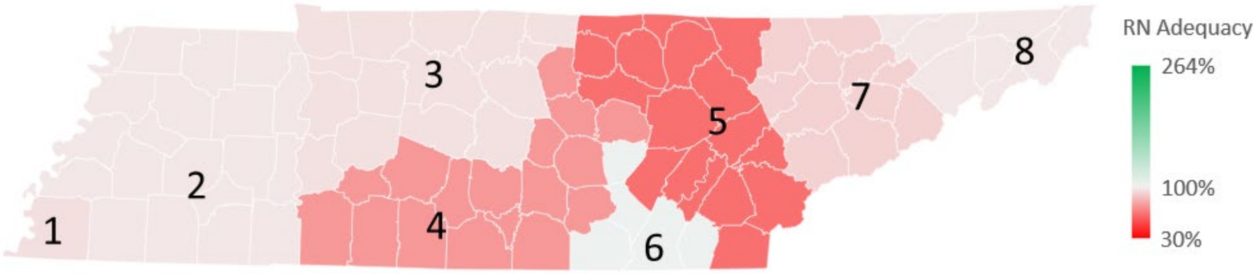
Exhibit 16. LPN Supply Adequacy by District, 2021



Note: Supply is relative to the number of providers required to provide a 2021 national average level of services. Districts: 1 = Memphis; 2 = West; 3 = Middle; 4 = South Middle; 5 = Mid-East; 6 = Chattanooga; 7 = Knoxville; 8 = Northeast

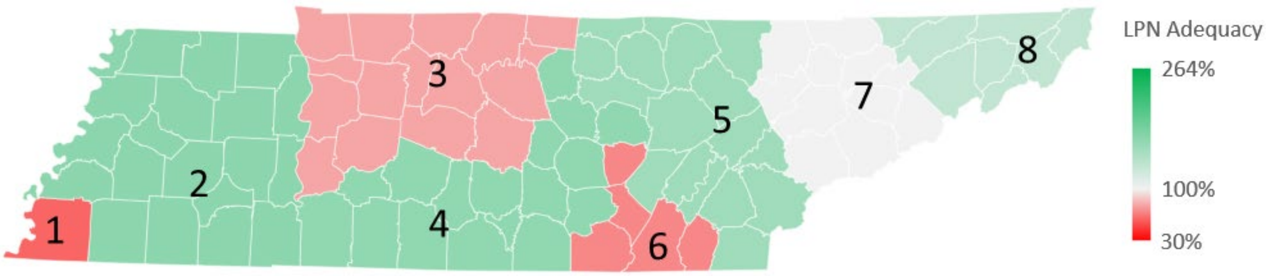
By 2035, as discussed previously, projections suggest that RN supply adequacy will improve at the state level while LPN supply adequacy will revert towards the national average. Based on the geographic distribution of where new entrants to the nursing workforce are practicing, much of the state will be able to employ nurses at patterns that are closer to the current national average level (Exhibit 17). Some districts will continue to have sufficient LPN supply to exceed national employment patterns, while other districts will have insufficient LPN supply to reach national employment patterns (Exhibit 18).

Exhibit 17. RN Supply Adequacy by District, 2035



Note: Supply is relative to the number of providers required to provide a 2021 national average level of services. Districts: 1 = Memphis; 2 = West; 3 = Middle; 4 = South Middle; 5 = Mid-East; 6 = Chattanooga; 7 = Knoxville; 8 = Northeast

Exhibit 18. LPN Supply Adequacy by District, 2035



Note: Supply is relative to the number of providers required to provide a 2021 national average level of services. Districts: 1 = Memphis; 2 = West; 3 = Middle; 4 = South Middle; 5 = Mid-East; 6 = Chattanooga; 7 = Knoxville; 8 = Northeast

BLS collects information from employers in May each year on the number of employed positions by occupation group. This data collection effort, the Occupational Employment and Wage Statistics, provides useful insights when comparing how Tennessee employs nurses relative to the national patterns. Approximately 2.1% of the US population resided in Tennessee in 2021, including 2.1% of the U.S. population age 65 or older. As illustrated in Exhibit 19, Tennessee accounted for about 2.0% of filled RN positions and 3.5% of filled LPN positions. Interestingly, Tennessee accounted for approximately 5.3% of the nation's filled LPN positions in offices of physicians and other healthcare providers, 4.2% of the nation's filled LPN positions in home health, and 4.1% of the nation's filled LPN positions in school health.

Looking at the distribution of RNs across employment settings, patterns were similar for Tennessee and the nation with the exception that 66% of Tennessee's filled RN positions were in hospitals while across the U.S., 61% of filled RN positions were in hospitals. The distribution of LPNs across employment settings indicates 20% of Tennessee's filled LPN positions were in provider offices, compared to 13% of the nation's filled LPN positions. Approximately 20% of filled LPN positions in Tennessee are in nursing homes, while at the national level, this is 28%. The RN-to-LPN ratio was 2.8:1 in Tennessee in May

2021, while the ratio was 4.8:1 for the nation. Within hospitals, which are more RN intensive than other settings, the ratio was 11.8:1 for Tennessee and 19.9:1 for the nation.

Interviews with hospital administrators indicated the much higher use of LPNs (relative to RNs) in Tennessee was more by necessity than by choice. With the large shortfall of RNs in Tennessee, hospitals (and other employers of nurses) recruit LPNs at higher rates than the national average. Still, many hospitals trying to use LPNs to support RN care face recruiting challenges because many employers are following a similar path to support nursing care in their institution.

Exhibit 19. Tennessee versus National Patterns of Employing Nurses, 2021

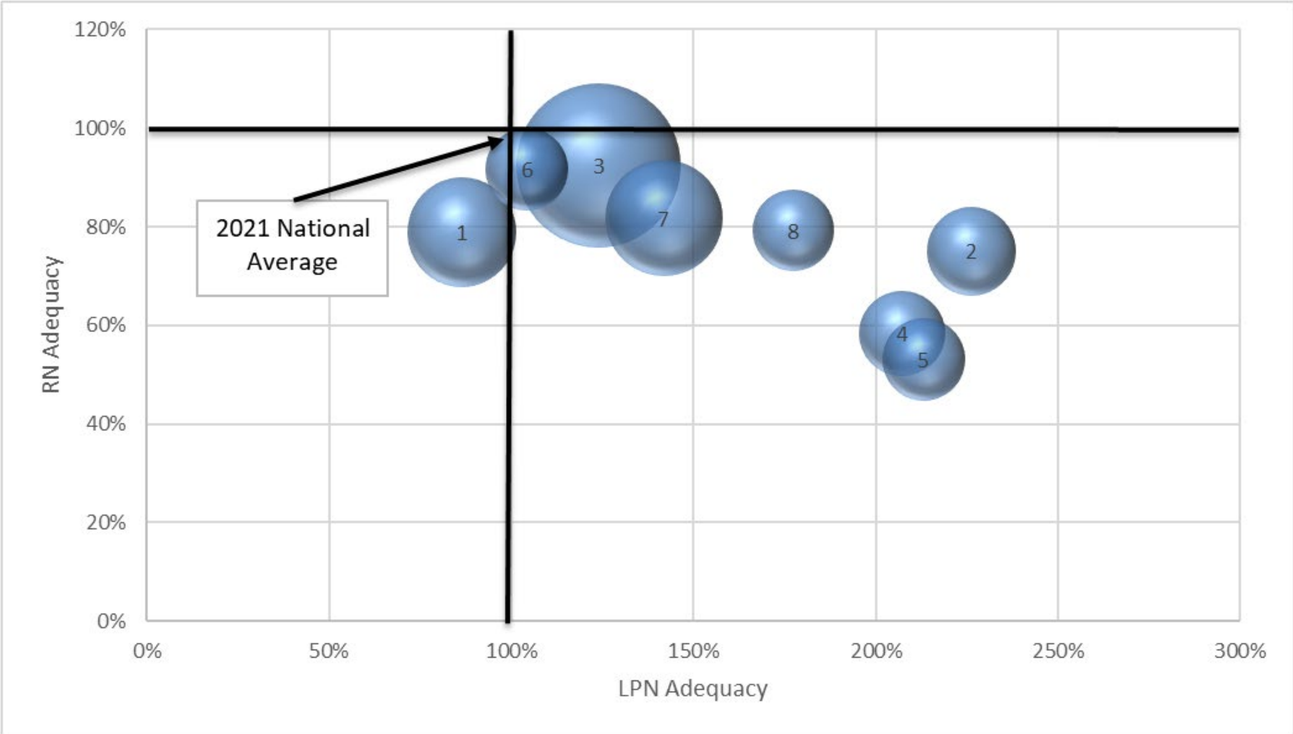
	Setting Distribution of Nurses									
	Office	Outpatient	Hospital	Home Health	Nursing Home	Residential Care	School Health	Academia	Other	Total
TN % of Total US Nurses										
RNs	1.8%	1.6%	2.2%	2.3%	1.6%	1.5%	1.9%	0.4%	1.9%	2.0%
LPNs	5.3%	1.8%	3.7%	4.2%	2.6%	3.9%	4.1%	1.8%	3.2%	3.5%
RN Distribution										
Tennessee	6%	4%	66%	6%	3%	1%	2%	0%	11%	100%
National	7%	5%	61%	6%	4%	2%	2%	1%	12%	100%
LPN Distribution										
Tennessee	20%	3%	15%	17%	20%	10%	2%	0%	12%	100%
National	13%	6%	15%	14%	28%	9%	2%	1%	13%	100%
RN/LPN Ratio										
Tennessee	0.8	3.8	11.8	1.1	0.5	0.4	2.4	1.6	2.5	2.8
National	2.5	4.4	19.9	1.9	0.7	0.9	5.2	6.7	4.3	4.8

Source: Bureau of Labor Statistics, May 2021 Occupational Employment and Wage Statistics.

Exhibit 20 contains a scatterplot of estimated 2021 LPN supply adequacy (on the x-axis) and 2021 RN supply adequacy (on the y-axis). Districts are plotted as bubbles on the chart, with each bubble sized according to 2021 district population. The national average adequacy of nurse supply is represented by the intersection of the dark vertical line marking national adequacy of LPNs (or 100% of supply required to meet demand for LPNs at baseline national levels of care) and the dark horizonal line marking national adequacy of RNs (or 100% of supply required to meet demand for RNs at baseline national levels of care). All districts are centered below the 100% RN adequacy line, meaning these districts have RN shortages at baseline. However, all districts except for District 1 are estimated to have exceeded 100% adequacy for LPNs.

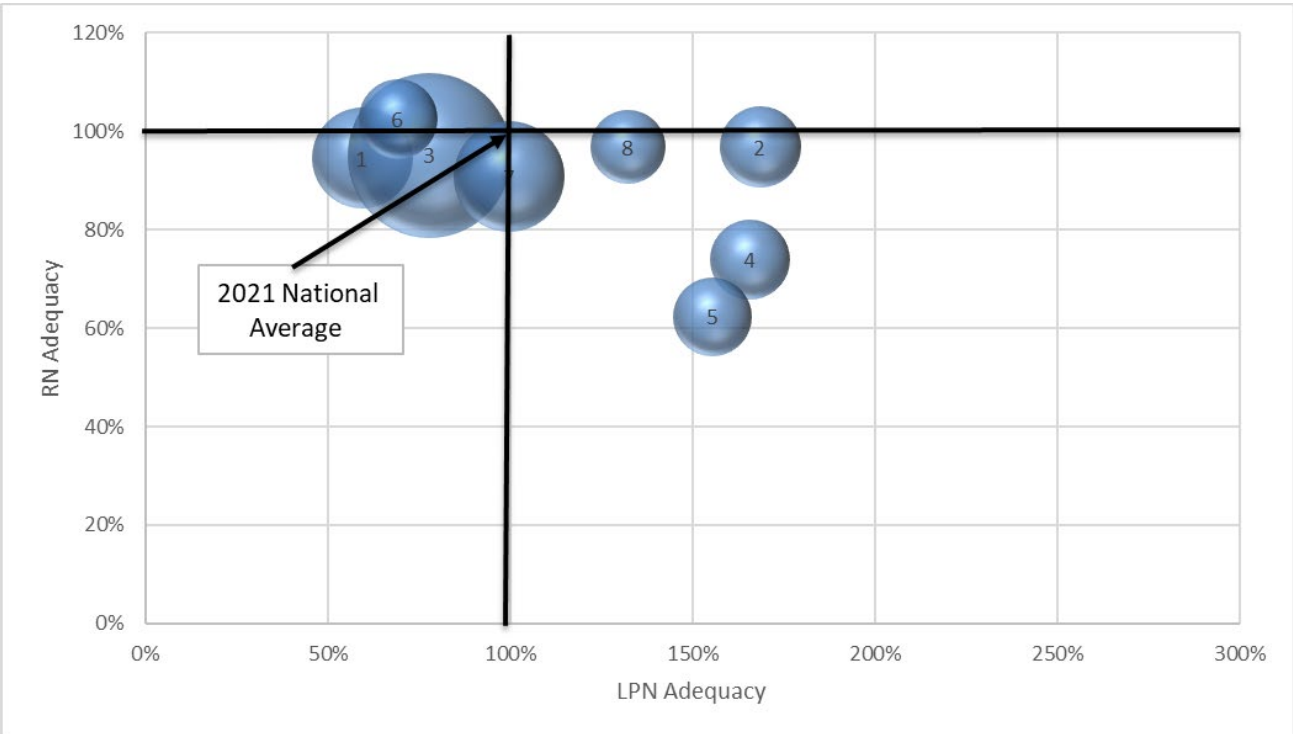
Exhibit 21 contains an analogous graph for 2035. In 2035, the bubbles generally have shifted up slightly and to the left considerably relative to the graph for 2021, meaning RN adequacy generally is somewhat more, while LPN adequacy is substantially less.

Exhibit 20. % LPN Adequacy versus % RN Adequacy, 2021, by District Population Size



Note: Adequacy is defined as supply relative to the number of providers required to provide a 2021 national average level of services.

Exhibit 21. % LPN Adequacy versus % RN Adequacy, 2035, by District Population Size



Note: Adequacy is defined as supply relative to the number of providers required to provide a 2021 national average level of services.

Several subtleties regarding health workforce adequacy are obscured in simple summary numbers and should be considered when interpreting these results.

- **Margin of error.** Given the nature of modeling and forecasting, all projections have some degree of imprecision. As a general rule, if supply is within ±5% of demand, then one might conclude the labor market is essentially in equilibrium. Imprecision arises because generalizations must be made. Data regarding healthcare use, health risk factors, healthcare provider hours worked per week, healthcare provider productivity, and other important modeling parameters are unavailable at local levels and must be estimated with national values.

- **Geographic imbalances in statewide supply and demand.** Nationwide and statewide projections of health workforce shortages overshadow the substantial geographic variation in supply adequacy. For this analysis, supply and demand were modeled at the county level, and aggregated to the district and state level. But even county- and district-level projections mask the adequacy experienced within counties/districts as healthcare markets can exist at a sub-county level and/or span (parts of) multiple counties/districts and even cross state lines. Furthermore, demand is assigned to where people reside although they may seek care where they work or in neighboring areas, and limited information regarding where nurses work geographically is available in the licensure data. Thus, supply adequacy projections tend to be more precise the larger the geographic area they cover.

- **Substitution between RNs, LPNs, and other health workers.** In areas facing a shortage of RNs, providers may be able to employ LPNs to help address staffing needs by shifting some duties. When a shortfall of LPNs and other health workers (e.g., phlebotomists) exists, RNs might be tasked with filling additional duties that otherwise would have been provided by these health workers. While adequacy of RN supply and LPN supply are projected separately, the combined information conveyed in projections for both professions provides a more complete picture of the state's nursing workforce.

- **Productivity differences between newly trained and experienced workers.** Employing average productivity patterns to all healthcare workers conceals productivity differences between experienced individuals and newer entrants. Thus, overall supply adequacy summaries can mask shortfalls in key areas that require specific experience—such as nursing in intensive care units, or mentoring roles.

- **The level of care for workforce adequacy.** For this study, surpluses are forecast when expected supply exceeds expected demand and shortages are forecast when expected demand exceeds expected supply. In the model, supply and demand are assumed to be in equilibrium nationally at baseline, which establishes a benchmark for adequacy, with shortages or surpluses determined *relative to the baseline (2021) national level of care*. To the extent that the baseline national average level of care is interpreted as using too few nurses, the magnitude of the projected shortages in Tennessee are greater than reported.

Select Allied Health Occupations

Among the allied health professions, hospitals report that shortages among respiratory therapists, lab technicians and technologists, EMTs, social workers, cardiac catheterization laboratory technicians, surgical technologists, and phlebotomists are particularly acute. Data limitations present challenges for modeling supply of and demand for many allied health occupations, and for cardiac catheterization laboratory technicians, surgical technologists, and phlebotomists, there is insufficient data to model supply. We discuss each occupation in turn.

Early in the COVID-19 epidemic, shortages of respiratory therapists gained national attention. In 2021, Tennessee had an estimated 2,170 FTE supply versus 3,110 FTE demand (Exhibit 22, Exhibit 39, and Exhibit 47). This equates to a 940 FTE shortfall relative to the number required to provide a national average level of care (or supply adequate to meet 70% of demand). By 2035, a 1,080 FTE shortfall is projected (or supply adequate to meet 72% of demand) by 2035 (Exhibit 47).

The number of new respiratory therapists expected to enter the Tennessee workforce is greater than the respiratory therapists expected to leave the workforce, such that overall supply is expected to increase through 2035 for all scenarios. Over the projection period, supply is expected to grow by 560 FTEs (26% total, or 1.7% per year) under the *Status Quo* scenario, with projected growth over the period between 370 FTEs (17%) under the *10% Fewer Entrants* scenario and 740 FTEs (34%) under the *10% More Entrants* scenario (Exhibit 47).

The *Status Quo* demand scenario models the continuation of baseline national patterns of care use and delivery, adapted to Tennessee's population and adjusted for net cross-state migration of hospital patients. *Status Quo* demand for respiratory therapists is estimated to increase from 3,110 FTEs at baseline to 3,810 by 2035, a 23% increase, or around two and a half times the rate of overall population growth (Exhibit 22). The *Reduced Barriers* scenario has marginal impact on the demand projections compared to the baseline results.

Exhibit 22. Respiratory Therapist Supply and Demand Projections, 2021-2035

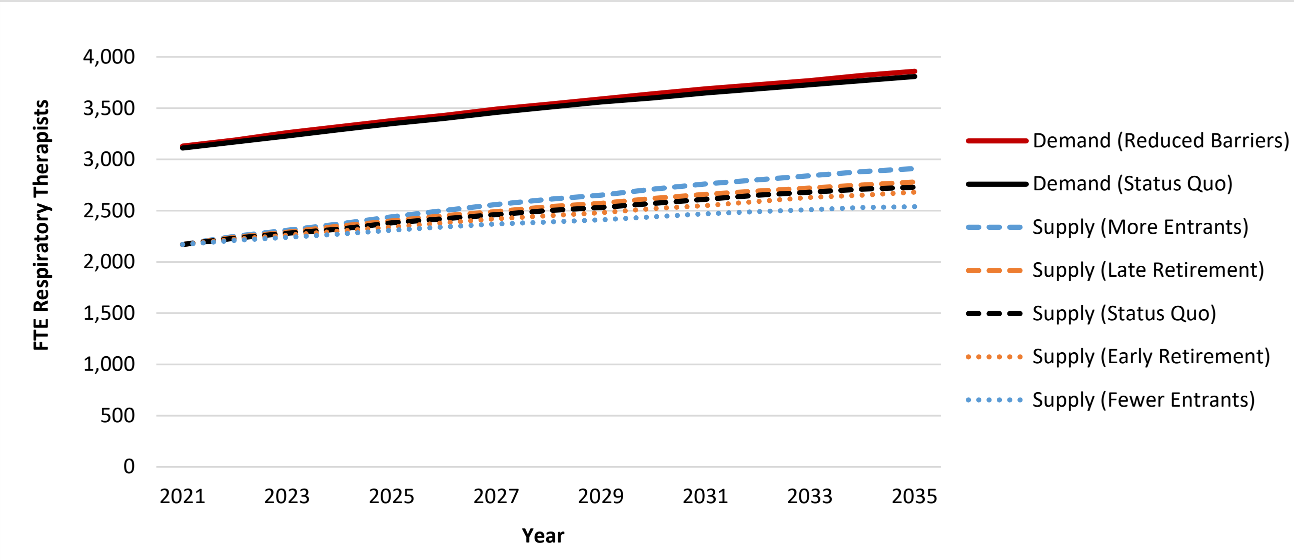
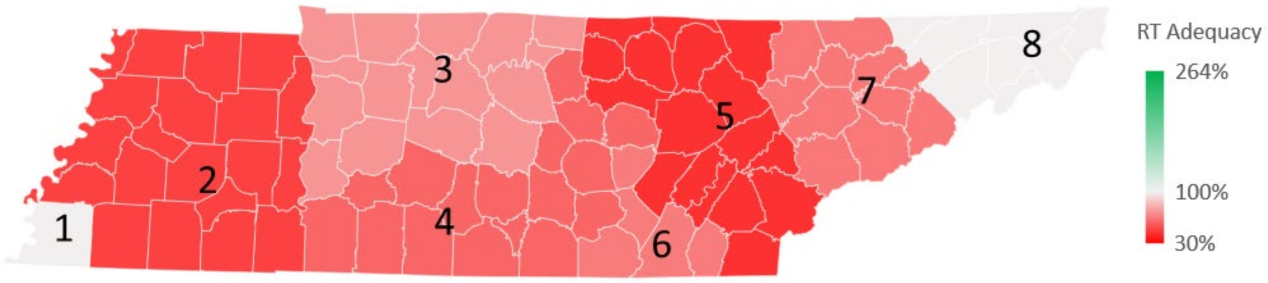


Exhibit 23 shows estimates of supply adequacy across THA districts. Counties located in almost all districts except 1 and 8 are among those with the lowest respiratory therapist adequacy. Memphis (District 1) and Johnson City (District 8) have supply adequate to provide a national average level of care to their resident population. However, to the extent that hospitals in these districts are caring for patients from outside their district, supply adequacy in these districts might be overstated.

Exhibit 23. Respiratory Therapist Supply Adequacy by District, 2021



Note: Supply is relative to the number of providers required to provide a 2021 national average level of services. Districts: 1 = Memphis; 2 = West; 3 = Middle; 4 = South Middle; 5 = Mid-East; 6 = Chattanooga; 7 = Knoxville; 8 = Northeast

Supply and demand for medical lab technicians and technologists are summarized in Exhibit 24, Exhibit 40, and Exhibit 48. Estimated demand for this occupation category in 2021 was 8,910 FTEs—i.e., the level required to provide a national average level of care to Tennessee's population. The Bureau of Labor Statistics estimates there were 9,010 filled positions (including full-time and part-time positions) in May 2021. These numbers would suggest that supply of medical lab technicians and technologists in Tennessee is approximately sufficient to provide a national average level of care—though a national average is simply a benchmark and might not be considered sufficient.

However, analysis of state licensure files indicates supply of only 4,600 in 2021 (sufficient to meet only 52% of estimated demand). The Tennessee Medical Laboratory Board states, "All medical laboratory personnel and special analysts in Tennessee must hold current Tennessee licensure, unless specifically exempt by statute or rules promulgated by the Board," which indicates all personnel within the medical lab technician and technologist category should be listed in the licensure files.[16] Because licensure data is the basis for starting supply projections, the extent to which currently employed medical lab technicians and technologists are exempt from licensure could cause the supply data to appear artificially low. Discussions with hospital administrators indicates that much of the lab work is sent to out-of-state testing facilities, which could explain why licensed supply is substantially below estimated demand.

Using data from the licensure files as starting supply, projected supply of medical lab technicians and technologists slightly decreases over the projection period (Exhibit 24**)**, with a 60 FTE (1.3% decline) by 2035 projected under the *Status Quo* scenario. Under alternative scenarios, clinical laboratory technician and technologist supply is expected to increase by 190 FTEs (4.0%) under the *10% More Entrants* scenario or decline by 290 FTEs (6%) under the *10% Fewer Entrants* scenario (Exhibit 48).

The *Status Quo* demand scenario models the continuation of baseline national patterns of care use and delivery, adapted to Tennessee's population and demographics. *Status Quo* demand for medical lab technicians and technologists is estimated to be approximately 8,910 FTEs at baseline and is projected to increase to 10,130 by 2035, a 13% increase over the projection period, which is slightly higher than the overall state population projections growth (Exhibit 24). Achieving the goal of reducing barriers to accessing care would increase demand for medical lab technicians and technologists by an additional 630 FTEs in 2021 and by 740 FTEs in 2035 (an increase of 7% compared to the *Status Quo* results).

Exhibit 24. Medical Lab Technicians and Technologists Supply and Demand Projections, 2021-2035

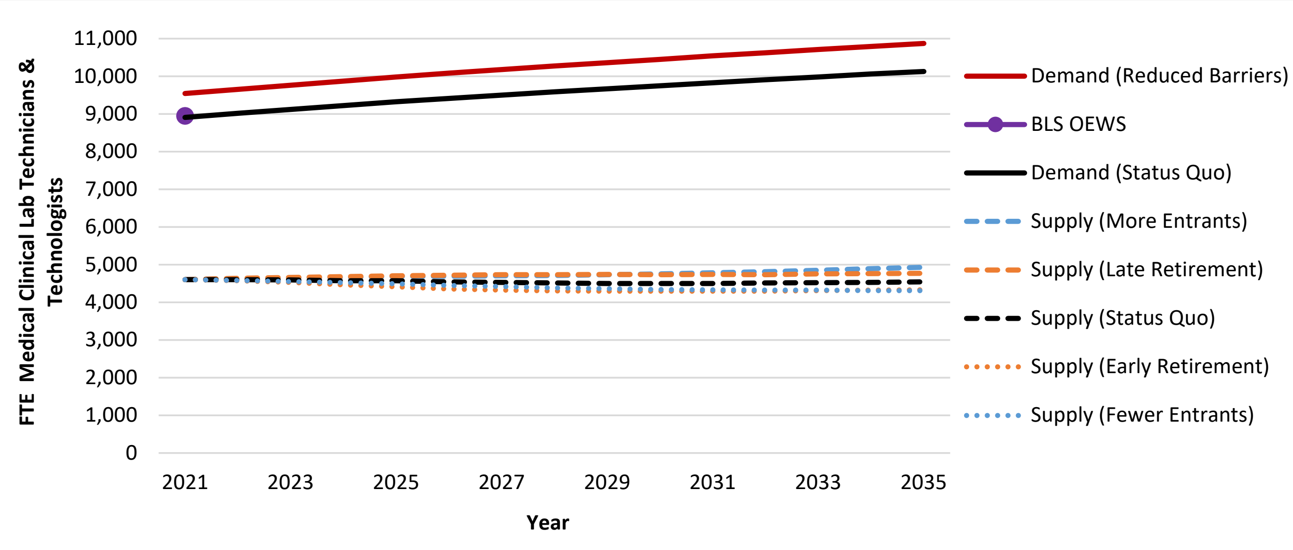
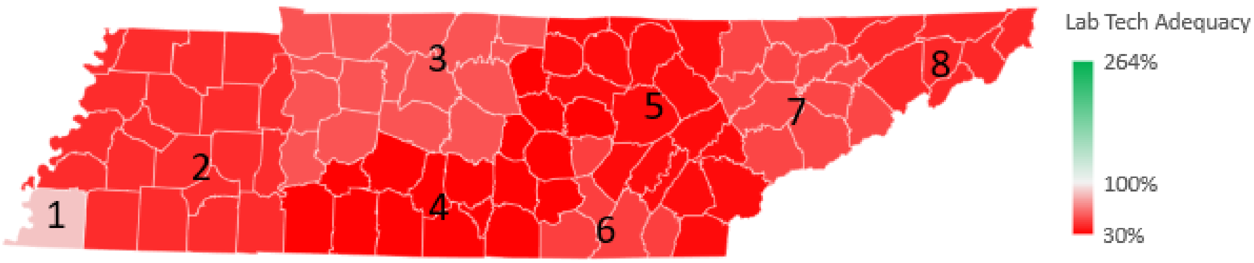


Exhibit 25 shows estimates of supply adequacy across THA districts (again, with supply based on licensure files). Because much of the state's lab work is sent to out-of-state testing facilities, the shortage is overstated but by what amount is unknown.

Exhibit 25. Medical Lab Technicians and Technologists Supply Adequacy by District, 2021



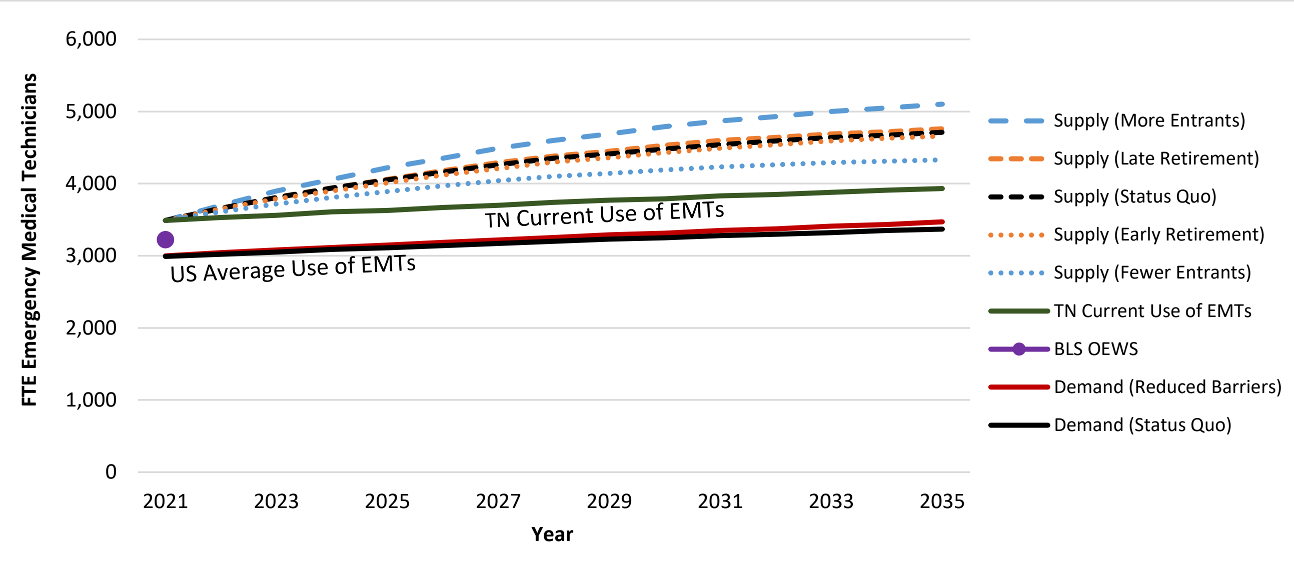
Note: Supply is relative to the number of providers required to provide a 2021 national average level of services. Districts: 1 = Memphis; 2 = West; 3 = Middle; 4 = South Middle; 5 = Mid-East; 6 = Chattanooga; 7 = Knoxville; 8 = Northeast

Supply and demand for emergency medical technicians are summarized in Exhibit 26, Exhibit 41, and Exhibit 49. Analysis of licensure files indicates supply of 3,490 in 2021—slightly higher than Bureau of Labor Statistics of 3,220 filled positions in May 2021 (with filled positions equally counting both full time and part time positions). To provide a national average level of services in 2021, we estimate demand for 2,990 FTE EMTs. The demand estimate is for employed EMTs only, and it is unclear from licensure files if licensed EMTs are employed as an EMT, work in a voluntary role as an EMT, or are licensed as an EMT but work in a non-EMT role.

Using licensure data as the starting supply, EMT supply is projected to increase over the projection horizon (Exhibit 26). *Status Quo* supply is projected to increase by 35% between 2019-2035, which translates to approximately 1,220 additional FTEs working in the state by 2035. The scenarios increasing and decreasing new entrants by 10% resulted in 2021-2035 projected supply increases of 46% and 24%, respectively, and the scenarios decreasing and increasing average retirement age by two years resulted in projected increases of 36% and 34%, respectively (Exhibit 49). As described earlier, we conservatively estimate annual attrition of 7.88% for EMTs based on analysis of national Current Population Survey data. The actual attrition rate could be higher, with high turnover in this occupation due in large part to EMTs leaving the profession to pursue jobs with better pay or benefits.

Status Quo demand for EMTs is estimated to be approximately 2,990 FTEs in 2021 and is projected to increase to nearly 3,370 by 2035, a 13% increase over the projection period (Exhibit 26). The projections incorporate national patterns of care applied to Tennessee's population and state-specific net migration trends of hospital patients. Achieving the goal of reducing barriers to accessing care has only a small impact on the demand projections.

Exhibit 26. Emergency Medical Technician Supply and Demand Projections, 2021-2035

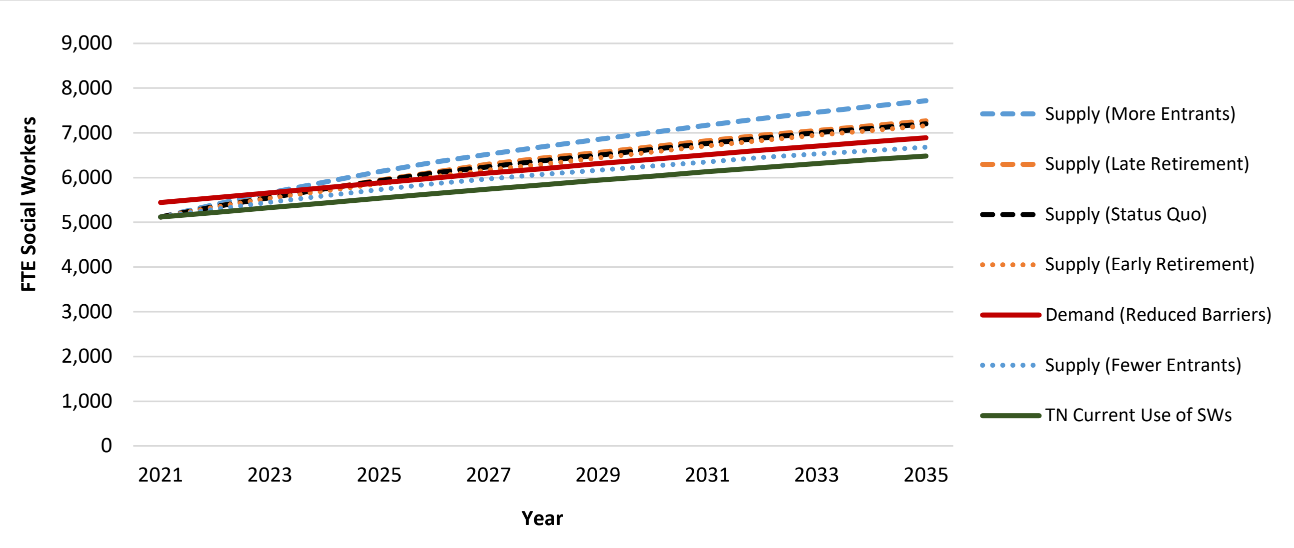


Supply and demand for social workers are summarized in Exhibit 27, Exhibit 42, and Exhibit 50. Modeling social worker projections is challenging due to the definitional differences across supply and demand modeling. In particular, demand for social workers nationally is based on types of social workers identified by occupation codes in the BLS survey, while supply is based on licensed social workers in Tennessee's licensure database. In an attempt to reconcile some of these definitional issues, demand is set even to Tennessee supply in 2021. This changes the interpretation of demand and supply adequacy. Demand is interpreted as the number of social workers required to provide a 2021 Tennessee average level of care, and supply adequacy is interpreted as the degree to which supply is sufficient to provide a 2021 Tennessee average level of care.

With the above caveats, the supply of social workers is projected to increase between 2021 and 2035. From a starting value of 5,120 FTEs, supply is expected to grow by 2,080 FTEs (41%) under the *Status Quo* scenario (Exhibit 50). The projected growth ranges from a low of 1,560 FTEs (30%) under the *10% Fewer Entrants* scenario to a high of 2,600 FTEs (51%) under the *10% More Entrants* scenario.

While the number of social workers required to provide a national average level of demand could not be calculated due to definitional issues, knowing where social workers are employed across the healthcare industry allows us to model the rate of growth in demand. Starting at the Tennessee level of care being provided in 2021 (5,120 FTEs), demand is projected to increase by 27% (equivalent to 1,360 FTEs) over the projection period. Achieving the goal of reducing barriers to accessing care would increase demand for social workers by an additional 6% (410 FTEs) in 2035 compared to the *Status Quo* projections.

Exhibit 27. Social Worker Supply and Demand Projections, 2021-2035



Data limitations prevented modeling supply of cardiac catheterization laboratory technicians, surgical technologists, and phlebotomists. Knowing where these occupations are employed and how demand for healthcare services is projected to grow across care delivery settings allows us to model the number of FTEs required to provide a national average level of care from 2021 through 2035.

BLS reports that in May 2021, the number of filled jobs (including full-time and part-time positions) in Tennessee was 1,470 cardiovascular technologists and technicians. Cardiovascular technologists work in a cardiac catheterization lab where they perform procedures such as stent implants, cardiac pacemakers, and defibrillators, and they perform tests to diagnose heart disease. Cardiovascular technicians specialize in performing electrocardiograms and stress tests. The 1,470 filled jobs in Tennessee includes 1,270 in hospitals and 200 in outpatient clinics. Based on national staffing patterns, we estimate demand for about 1,430 FTEs in Tennessee in 2021. Demand is projected to grow by 310 FTEs (22%), reaching 1,740 FTEs by 2035. The *Reduced Barriers* scenario, where access barriers to receiving care are reduced, would shift up demand by about 2-3% above the *Status Quo* scenario projections.

Exhibit 28. Cardiac Catheterization Laboratory Technician Demand Growth by Scenario

Scenario	2021	2035	Growth	% Growth
Demand				
Status quo[a]	1,430	1,740	310	22%
Reduced barriers	1,460	1,790	330	23%

Note: [a] FTEs required to provide a 2021 national average level of care.

BLS reports 1,920 surgical technologist positions filled in May 2021 in Tennessee, including 1,790 in hospitals and 130 in provider offices. Based on national staffing patterns and projected demand for surgical procedures in Tennessee, we estimate demand for 2,610 FTEs in 2021. Demand is projected to grow by 380 FTEs (15%), reaching 2,990 FTEs by 2035. The *Reduced Barriers* scenario, where access barriers to receiving care are reduced, would shift up demand for surgical technologists by about 10-11% above the *Status Quo* scenario projections.

Exhibit 29. Surgical Technologist Demand Growth by Scenario

Scenario	2021	2035	Growth	% Growth
Demand				
Status quo[a]	2,610	2,990	380	15%
Reduced barriers	2,880	3,330	450	16%

Note: [a] FTEs required to provide a 2021 national average level of care.

BLS reports 2,870 phlebotomists' positions filled in May 2021 in Tennessee. This number is about 230 (7%) below the estimated 3,100 FTEs required to provide a national average level of service. Demand is projected to grow by 460 FTEs (15%), reaching 3,560 FTEs by 2035. The *Reduced Barriers* scenario, where access barriers to receiving care are reduced, would shift up demand for phlebotomists by about 9-10% above the *Status Quo* scenario projections.

Exhibit 30. Phlebotomist Demand Growth by Scenario

Scenario	2021	2035	Growth	% Growth
Demand				
Status quo[a]	3,100	3,560	460	15%
Reduced barriers	3,390	3,910	520	15%

Note: [a] FTEs required to provide a 2021 national average level of care.

Advanced Practice Providers

This study modeled supply and demand for advanced practice providers (APPs), focusing on the NP and PA workforces. The physician workforce is outside the scope of this study, and because there is overlap in the services provided by physicians and APPs, study findings need to be interpreted in the context of Tennessee's supply adequacy of physicians. Prior work conducted by our team for the Health Resources and Services Administration (HRSA) reported the supply of physicians in Tennessee was substantially lower than levels required to provide a national average level of care. For example, supply of primary care physicians in Tennessee was estimated to be about 19% below demand.[17]

As noted previously, in 2021, Tennessee had 2.1% of the total U.S. population and also 2.1% of the population age 65 or older. In May 2021, NPs and PAs in Tennessee comprised 4.8% and 1.9%, respectively, of total NPs and PAs in the U.S. That is, on a simple provider-to-population ratio, Tennessee was slightly below the national average for PAs but over twice the national average for NPs. While the number of NPs in nursing homes is small, over half of the nation's NPs employed in nursing home were in Tennessee. Tennessee also seems to use a disproportionate number of NPs (relative to the national average) in residential care facilities, school health, and home health. In office, outpatient, and hospital settings—where the large majority of NPs are employed—Tennessee uses NPs at a much higher rate than would be expected based on Tennessee having 2.1% of the nation's population.

Exhibit 31. Tennessee Proportion of the Nation's NPs and PAs by Employment Setting

TN % of Total US APPs	Office	Outpatient	Hospital	Home Health	Nursing Home	Residential Care	School Health	Academia	Other	Total
Nurse Practitioners	4.9%	4.4%	3.3%	9.7%	55.1%	18.2%	17.1%	1.7%	4.6%	4.8%
Physician Assistants	2.4%	1.5%	1.0%	NA	NA	NA	NA	1.7%	0.7%	1.9%

Source: Analysis of Bureau of Labor Statistics May 2021 Occupational Employment and Wage Statistics.

With the above background that Tennessee uses NPs at a much higher rate than the national average but likely has substantially fewer physicians than would be required to provide a national average level of services, we summarize supply and demand for NPs in Exhibit 32, Exhibit 43, and Exhibit 51.

Estimated NP supply of 13,260 FTEs in 2021 exceed the estimated 5,960 FTEs required to provide a national average level of services. Between 2021 and 2035, NP supply is projected to grow rapidly, similar to the high rate of growth seen throughout the U.S. Supply is projected to grow 59% (or 7,820 FTEs) under the *Status Quo* scenario. Growth varies by scenario, ranging from 6,530 FTE (49%) growth under the *10% Fewer Entrants* scenario, to 9,120 FTE (69%) growth under the *10% More Entrants* scenario).

Under the *Status Quo* scenario, demand is projected to grow by 930 FTEs (16%) between 2021 and 2035. Under the *Reduced Barriers* scenario, demand for NPs would be approximately 6,500 FTEs (or almost 9% higher than under the *Status Quo* scenario) at baseline and 5,960 FTEs (also almost 9% higher than under the *Status Quo* scenario) in 2035. The NPs supply and demand projections described above suggest that in 2021 NPs supply was about 7,330 FTEs above the level required to provide a national average level of care. By 2035, the projected supply of NPs will be about 14,190 FTEs higher than required to maintain current national staffing ratios between physicians and APRNs (Exhibit 43). This is not to say that Tennessee will have an excess of NPs; rather, the additional supply of NPs beyond that required to maintain current national staffing ratios can help offset the shortfall of physicians.

Exhibit 33 shows NP supply adequacy by THA district in 2021. This map illustrates that availability and use of NPs varies by district.

Exhibit 32. NP Supply and Demand Projections, 2021-2035

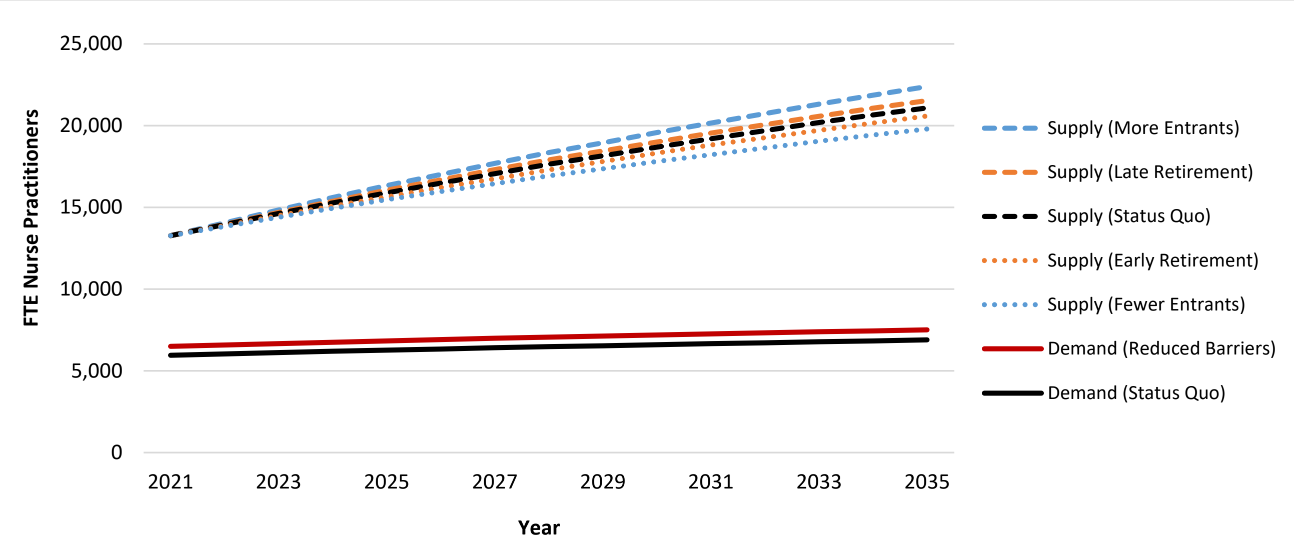
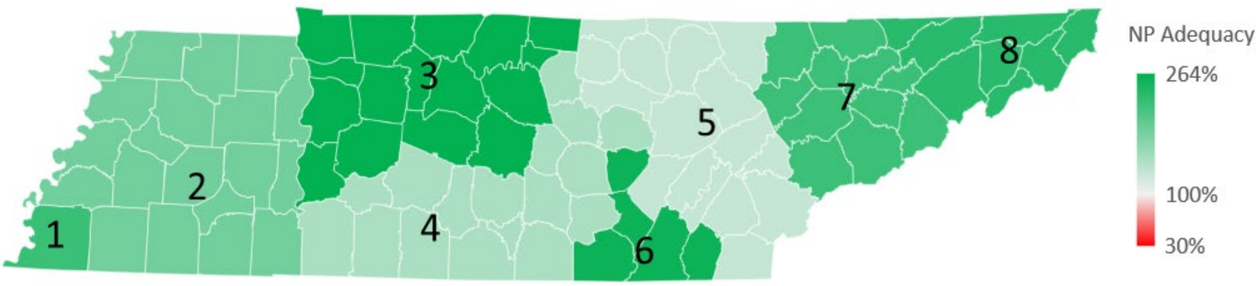


Exhibit 33. NP Supply Adequacy by District, 2021



Note: Supply is relative to the number of providers required to provide a 2021 national average level of services. Districts: 1 = Memphis; 2 = West; 3 = Middle; 4 = South Middle; 5 = Mid-East; 6 = Chattanooga; 7 = Knoxville; 8 = Northeast

PA supply and demand projections are summarized in Exhibit 34, Exhibit 44, and Exhibit 52. Estimated supply of 2,730 FTEs in 2021 was about 620 FTEs (19%) below the 3,350 FTEs that would be expected based on national patterns of care use and delivery. This shortfall appears to be offset by greater use of NPs in Tennessee. Over the projection period, PA supply is expected to grow 51% (or 1,380 FTEs) under the *Status Quo* scenario. This high rate of growth is in line with national projections of rapid growth in PA supply. Growth for PAs over the projection period varies from 1,120 (41%) under the *10% Fewer Entrants* scenario to 1,630 FTEs (60%) under the *10% More Entrants* scenario.

Under the *Status Quo* demand scenario, demand for PAs is projected to grow by 500 FTEs (15%) between 2021 and 2035. Under the *Reduced Barriers* scenario, demand for PAs would be approximately 320 FTEs (or almost 10%) higher than under the *Status Quo* scenario at baseline and 390 FTEs (almost 9%) higher than under the *Status Quo* scenario in 2035. The PA supply and demand projections described above suggest that by 2035, supply will be sufficient to provide 107% of the current national average level of PA services.

Exhibit 34. PA Supply and Demand Projections, 2021-2035

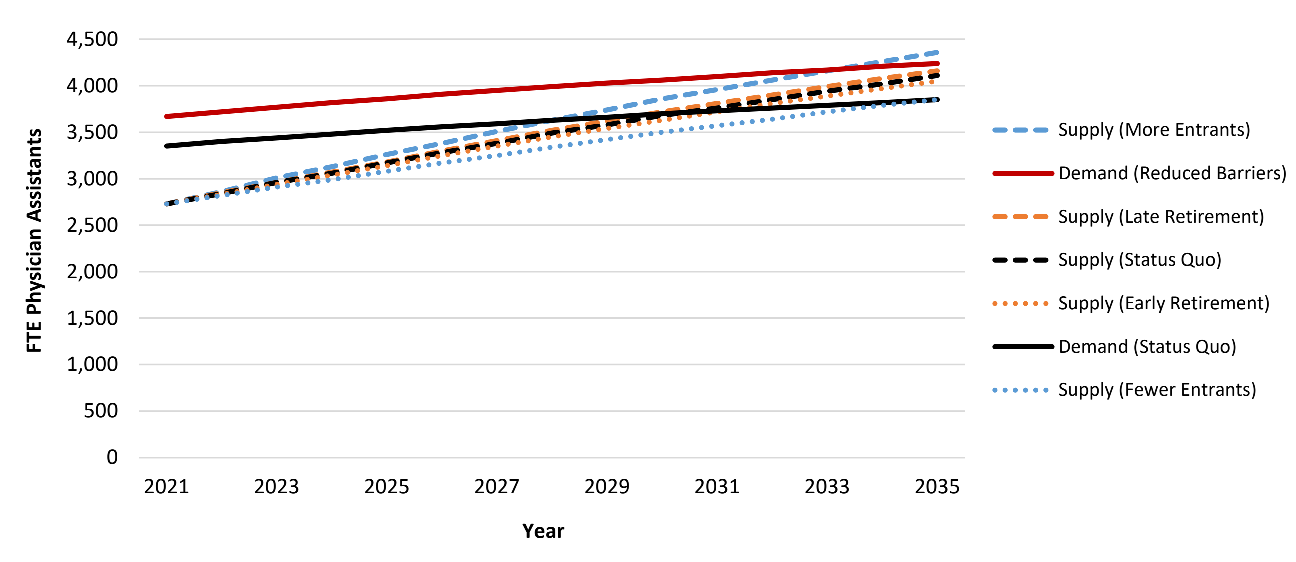
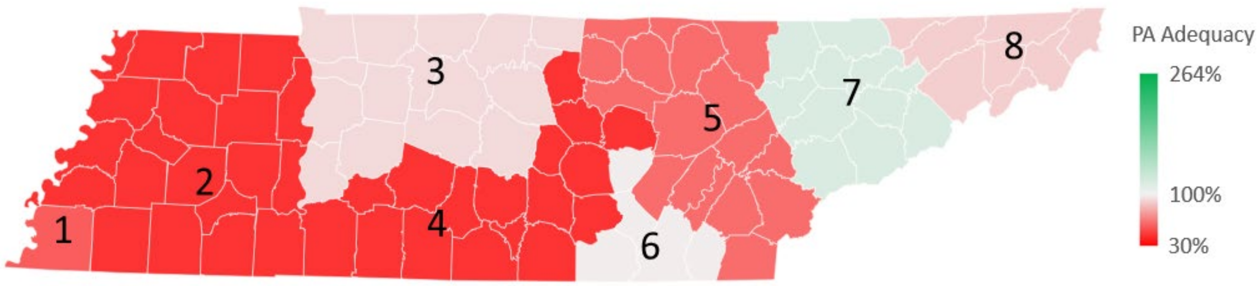


Exhibit 35 shows variation in PA availability and use across districts. In Knoxville (District 7), Chattanooga (District 6), and Middle (District 3), the supply of PAs is at or above the level required to provide a national average level of services. Interestingly, districts that have higher supply adequacy of PAs also are districts with higher supply adequacy of NPs. Districts 2, 4 and 5, which have lower supply adequacy of PAs, correlates with districts that have lower supply adequacy of NPs.

Exhibit 35. PA Supply Adequacy by District, 2021



Note: Supply is relative to the number of providers required to provide a 2021 national average level of services. Districts: 1 = Memphis; 2 = West; 3 = Middle; 4 = South Middle; 5 = Mid-East; 6 = Chattanooga; 7 = Knoxville; 8 = Northeast

Summary of Stakeholder Interviews

The supply and demand projections summarize how well Tennessee's projected supply of healthcare workers will meet national average levels of care in the future. However, workers with heavy workloads, hospital administrators grappling with worker vacancies, and patients facing longer wait times perceive the national average level of care as indicative of a healthcare worker shortage. To better understand the factors and dynamics underlying these perceptions, as well as the challenges stakeholders face in trying to address worker shortages, we interviewed people in the educational and training pipeline and hospital and health system administration.

Among hospital administrators, we interviewed six hospital/health system chief executive officers (CEOs) and five chief nursing officers (CNOs), along with two chief financial officers (CFOs) and a human resources director. From the education/training sector, we interviewed one department head from a social worker program and six deans or vice presidents of allied health or health science programs, and/or nursing schools. Interviewees represented perspectives from both urban and rural areas of the state. Their feedback was thoughtful and illuminating, and we thank all participants for their time and insight.

The overarching messages we heard from hospital administrators were that they struggle to attract and retain healthcare staff and labor costs have become unsustainable. Several themes emerged from the hospital administrator interviews as to reasons why healthcare staffing recently has been negatively impacted. These include wages, shift length, increasing patient acuity, public hostility toward healthcare workers, and media portrayals of hospital staff shortages, caregiver burnout, and violence toward healthcare workers. These issues steer new entrants away from hospital-based employment.

Staffing shortages during the height of the pandemic were not unique to hospitals, and as salaries rose for jobs in industries such as retail and food service, some healthcare workers traded long hospital-based shifts for jobs offering equal or higher wages for shorter shifts in other industries. Future workers in the healthcare education pipeline also saw these increased wages in other industries as an opportunity to earn a similar amount of income, without needing to invest additional time and expense in education and licensure or incur student loan debt. In addition, many workers in the hardest hit clinical occupations, including nurses and respiratory therapists, left hospital employers and worked as traveling professionals for higher pay and less disease risk to their families.

These market changes have put hospitals at a staffing disadvantage compared to other industries. Hospitals cannot compete long term with the higher wages offered by other industries, or the cost of hiring contract labor, due to the lack of reimbursement for increasing labor costs. The enhanced reimbursements that were available during COVID-19 are largely gone, but hospitals’ costs remain higher than pre-pandemic levels because of staffing shortages, supply chain issues, inflation in general, and wage inflation during COVID-19. Even when hospitals can offer higher pay to attract new employees, this contributes to wage compression—a phenomenon where newly hired, often less-experienced employees earn equal or greater pay than current employees—which creates discord and can drive more experienced staff out of the hospital. Administrators note that increasing hospital costs in a climate of stagnating (or decreasing) reimbursements have produced economic conditions that are not sustainable. Furthermore, younger workers and new entrants nationwide generally put more emphasis on work-life balance and flexibility in making labor market decisions, putting hospitals at a staffing disadvantage because they need to deliver care around the clock.

Because nurses are the largest component of hospitals’ clinical workforce, and the nursing shortage has been in the national spotlight, much of the discussion focused on nurses. Nursing shortages are not new, but issues in the already tenuous labor market for nurses were exacerbated by COVID-19. The underlying reasons for the nursing shortage are complex, involving the interplay of many factors that are both encouraging trained nurses to leave the field (or bedside care, at least) and discouraging new potential nurses from replacing them.

From interviews with all three groups—hospital administrators, CNOs, and academic leadership—there was a general sense that even pre-pandemic, nurses were feeling overworked and under-appreciated, causing increased attrition. This was the beginning of a negative feedback loop that intensified during the ebb and flow of COVID-19 surges, leading to increasing shortages, understaffing, and a perception by nurses of being overworked and burned out, which, in turn, caused more attrition.

Shortages in other healthcare occupations, and of personal protective equipment (PPE), contributed to increasing nurse risk and workload during COVID-19. For example, shortages of phlebotomists meant some nurses were tasked with drawing blood, and shortages of housekeeping staff and PPE meant some nurses were also cleaning patient rooms and delivering patient meals. The shortages of PPE and of workers across other occupations increased patient exposure and workload for nurses at a time when many employed nurses were increasingly stressed about staffing levels, patient deaths, and the disease risk for themselves and their families. Some chose to join travel nursing agencies for higher pay and often for the accommodations away from their families, reducing the disease exposure for loved ones. Other experienced nurses chose early retirement or needed to scale back available hours due to family commitments. Many academic nurse educators also noted that the recent high-profile case of a nurse being criminally convicted after a series of errors seemed to be impacting both entry into nursing and nurse retention.

Adding to nurse staffing challenges, administrators noted a long lag in getting newly trained nurses approved to sit for the NCLEX and fully licensed. Administrators indicated Tennessee seems to be slower than neighboring states in this regard.

Nurse educators noted that nurses have a great deal of influence on patient outcomes, but often little clout on the care team. For example, for various reasons, including an aging population, it was reported that average patient acuity is increasing in the hospital. Consequently, keeping staffing ratios constant produces an increased nurse workload. Nurses note their frustration at being left out of staffing and other decisions impacted by these dynamics. Some NPs also point to the lack of independent practice authority in Tennessee as a frustrating issue that could be easily improved.

With respect to pay, some CNOs and nurse educators pointed out that Tennessee nurse salaries are among the lowest in the country. Administrators discussed low levels of reimbursement across the board and an inability to maintain increased labor costs without increased reimbursement. Some hospitals also note a preference for hiring nurses with a bachelor of science in nursing (BSN) degree to those with an associate degree in nursing (ADN), but academic nurses were quick to point out that most hospitals offer no differential in pay for the more expensive and time-consuming educational training of BSNs.

However, comments from administrators suggest a shift in thinking that includes moving toward team-based care, which includes ADNs and LPNs. Shortages of ADNs and LPNs currently employed by hospitals and a reported inability to hire either at sufficient levels have limited trials of these new care models so far. Finally, nurses noted that with respect to career opportunities, nurses who work at the bedside have little opportunity for career advancement.

Administrators and CNOs discussed their awareness of the lack of career advancement for some bedside nurses, which often cause nurses to seek additional education to elevate themselves out of direct patient care, further exacerbating staffing shortages. Some hospitals have already put career ladders in place for RNs, while others are trying to address the issue with new programs that make staying in bedside care a more attractive long-term career option.

A common perception was that bachelor's level nurse education was de-emphasizing hands-on patient care training prior to COVID-19 and increasingly emphasizing more management and leadership training. This resulted in new BSN graduates expecting to move quickly to leadership/management roles despite having little patient care experience. This perception was also held by educators in the two-year colleges, who expressed that the difference between ADN and BSN nursing degrees was largely the leadership training the BSN nurses received in their final two-years of training. Some hospital administrators expressed frustration at this, feeling the educational system was training nurses away from hospital employment and contributing to the shortage of experienced floor nurses, while others expressed appreciation for nurses with leadership training, anticipating that in the future, nurses will be called upon to lead care teams.

In addition, because much of the usual clinical nurse training with live patients was not practical during the worst of the pandemic, many recently graduated nurses started their careers without bedside experience. Hospitals have had to step in and provide clinical training, and many started or expanded residencies, or mentorship programs to help new nurses acclimate. Still, it was reported that many new nurses were overwhelmed; and, given the dearth of experienced staff and mentors available to help them, many orientations failed. On the other hand, some hospitals reported that after investing time and money into clinical training for newly hired nurses, some left for more lucrative opportunities immediately following training.

The explosion in telehealth usage during COVID-19 also allowed more nurses to move away from the bedside to settings with less disease exposure and pressure. This not only intensified the shortage of bedside nurses but also fueled quick career progression of nurses who had not gained crucial bedside experience.

A key factor in employers' abilities to hire enough staff is the number of prospective workers flowing through the educational and training pipeline. Interviews with academic nursing and health sciences school leaders described a dwindling pipeline, driven by both the decreasing numbers of young adults in the high school and college age cohorts, as well as less interest in attending college and in healthcare careers among the young adult generations.

While these observations were robust across interviewees, they had a distinctly different flavor between 2-year and 4-year schools and programs. Those working with 4-year programs noted some decrease in applicants recently, but generally being able to fill available openings, or even having to turn prospective students away. In contrast, those working with 2-year programs noted that—despite 2-year public college generally being tuition-free in Tennessee—some programs struggle to fill their available student openings with qualified applicants.

Interviewees from 2-year programs noted their students struggled with affording childcare to allow them to take classes and work internship hours; accessing online classes during COVID-19; and paying for school fees, uniforms, and travel to clinical training sites. Additionally, educators report these students generally are not receptive to arrangements where potential employers pay their training costs in exchange for long-term commitments after school.

Interviewees related several factors they perceived to be related to declining interest in healthcare careers. The recent negative publicity regarding pay, work hours, and treatment of healthcare workers is impacting high school students' decisions regarding the kinds of careers for which they want to train. For many healthcare occupations, such as social workers, the pay is low relative to direct training costs (e.g., tuition and fees) and indirect training costs (e.g., foregone wages while in school). In addition, high school students simply do not know about the opportunities in many of the allied health occupations, with even fewer opportunities to introduce students to these fields during COVID-19. For example, while nursing is a well-known field, it was reported most social work students are transfers from other majors after learning about career opportunities in social work. Educators noted that the health professions in general need to do a better job of exposing middle and high school students to these fields to foment interest early. They note that when K-12 students are taken to medical settings or experience what healthcare jobs entail, interest increases substantially.

Even in training programs where students are plentiful, difficulties attracting and retaining faculty are reported. High faculty vacancy rates were reported, especially in the two-year nursing programs. Educators frequently mentioned difficulty filling vacancies due to low wages. Experienced nurses and other practitioners leaving clinical care (at an increased pace during COVID-19) represent an opportunity to build up the faculty ranks to teach new workers. But, to attract new faculty, these jobs must offer wages that will be competitive with other employment alternatives.

Finally, educators reported difficulties finding clinical partners for their academic programs. Even where partners were available, they sometimes struggled with convincing hospitals to take enough students to make the partnership financially feasible (i.e., train enough students to pay the salaries of the supervisory personnel that the schools provide). In one rural hospital, administrators noted having more capacity to provide clinical training but faced challenges with RN training programs hesitant to partner with smaller hospitals that could not offer the comprehensive experiences (specifically intensive care unit experience) available in larger hospitals. Administrators also reported increased competition for such arrangements from out-of-state, for-profit schools.

Discussion

This section summarizes key findings and implications, recommendations for addressing health workforce challenges in Tennessee, and study strengths and limitations.

Key Findings and Implications

Tennessee's healthcare workforce shares many similarities with the overall U.S. healthcare workforce but is also unique in numerous ways. Analysis of state licensure data, supplemented with analysis of national data sources and computer simulation, finds that Tennessee is facing substantial shortfalls of healthcare workers in some occupations while employing more healthcare workers in other occupations than would be expected based on national patterns of care delivery. Data limitations prevented supply modeling for some occupations—particularly occupations that do not require licensure—and also complicated comparison of supply estimates from state licensure files to national benchmarks.

For this study, we modeled a *Status Quo* demand scenario that extrapolates current national patterns of care use and delivery to Tennessee's current and projected future population. We also modeled a hypothetical *Reduced Barriers* demand scenario to quantify the increase in demand for healthcare services and providers if historically underserved populations (racial/ethnic minority, uninsured, resides in nonmetropolitan county) had care use patterns like a population with fewer access barriers. For some modeled health occupations, including RNs, there is a projected shortfall in 2035 to provide even current levels of care to the future population (as modeled under the *Status Quo* scenario). Such shortfalls will hinder achieving goals of reducing access barriers to care. For example, Medicaid expansion as envisioned under the American Rescue Plan could increase Medicaid enrollment in Tennessee by an estimated 339,000 people.[18] While additional funding for Medicaid expansion can assist in hiring additional healthcare workers, such workers need to be available for hire.

Exhibit 36 provides a summary of how Tennessee supply of modeled health workers compares to estimates of the number of health workers that would be required to provide a 2021 national average level of services. Estimates of supply, demand, and supply adequacy for all years (2021-2035) under the scenarios modeled are available in the appendix.

Exhibit 36. Supply Adequacy: 2021, 2025, 2030 & 2035, by Occupation

Occupation	Supply - Demand (2021)[a]	Supply Adequacy (2021)[b]	Supply - Demand (2025)[a]	Supply Adequacy (2025)[b]	Supply - Demand (2030)[a]	Supply Adequacy (2030)[b]	Supply - Demand (2035)[a]	Supply Adequacy (2035)[b]
Registered Nurses	-15,700	80%	-13,800	83%	-10,900	88%	-8,500	91%
Licensed Practical Nurses	7,500	150%	5,400	133%	3,000	117%	1,000	105%
Respiratory Therapists	-940	70%	-970	71%	-1,030	71%	-1,080	72%
Clinical Laboratory Technologists & Technicians	-4,310	52%	-4,750	49%	-5,250	46%	-5,590	45%
Emergency Medical Technicians	500	117%	940	130%	1,230	138%	1,340	140%
Social Workers	NA	NA	390	107%	600	110%	720	111%
Nurse Practitioners	7,300	222%	9,620	253%	12,080	283%	14,190	306%
Physician Assistants	-620	81%	-350	90%	-20	99%	260	107%

Note: * See appendix for further information on supply adequacy for all years 2021-2035, by occupation. [a] FTEs required to provide a 2021 national average level of care. [b] Adequacy of 100% equates to the national average, except for social workers which compares projected adequacy to the Tennessee 2021 state average.

Key findings include the following:

- Changing demographics of Tennessee's population will contribute to growing demand for healthcare services and will place constraints on the ability to grow the supply of healthcare workers. Between 2021 and 2035, overall population growth of 9.7% is projected. This includes projected growth of 13.3% for the population aged 65-74 and 54.1% for the population aged 75 and older. Growth in demand for healthcare services and personnel will be particular high for healthcare delivery settings and occupations that predominantly serve an older population. At the same time, the population aged 18-44 has projected growth of 5.5% and the population aged 45-64 has projected growth of 4.1%. Low growth among the population of working-age adults could present challenges to expanding health workforce supply to meet the future demand for services.

- In 2021, the state faced a shortfall of 15,700 RNs, with supply of 62,900 FTEs versus an estimated 78,600 FTEs required to provide a national average level of services. If current supply numbers and patterns continue, by 2035 RN staffing patterns in Tennessee will look more like national patterns—though an RN shortfall of 8,500 is projected. RN supply adequacy relative to national norms will rise from 80% to 91% over this period.
- The shortfall of RNs may account for the much greater use of LPNs in some settings relative to national staffing patterns—particularly in offices of healthcare providers, home health, school health, and residential care facilities. LPN supply of 22,500 FTEs exceeded by 7,500 the estimated 15,000 LPNs required to provide a national average level of services. The state's reliance on LPN's is considered to be a temporary solution to the current RN shortage as supply and demand for both professions is predicted to change drastically in the coming years. LPN supply adequacy relative to national norms will fall from 150% to 105% over this period.
- The 2,170 FTE supply of respiratory therapists in 2021 fell short of the estimated 3,110 FTE demand, suggesting that supply was sufficient to meet 70% of expected demand. This shortfall is projected to continue, with a projected shortfall of 1,080 FTEs in 2035 and supply adequate to meet 72% of demand.
- Demand for 8,910 FTE medical laboratory technologists and technicians in 2021 compares to 9,010 filled positions (including full-time and part-time positions) in May 2021 as reported by the BLS. This count far exceeds the 4,600 professionals listed in state licensure files. Hospital administrators indicated that much of the lab work is sent to out-of-state testing facilities, which could explain why licensed supply is substantially below estimated demand. Demand is projected to grow by 1,220 (14%) between 2021 and 2035 while supply is projected to decline by 60 FTEs (-1%). This portends a growing shortfall in this occupation.
- Hospitals report challenges hiring and retaining EMTs in their communities. An estimated 2,990 FTEs would be required to provide a national average level of services in 2021, compared to an estimate of 3,490 FTEs in state licensure files. However, the demand estimate is for employed FTEs and state licensure files do not indicate if the licensed EMT works as a paid EMT, works as an EMT in a voluntary role, or works in a non-EMT role. BLS reports 3,220 EMT positions filled in May 2021 (including full-time and part-time positions). The number of new EMTs entering the workforce each year should be sufficient to meet future demands for services, but national sources indicate a high annual attrition rate as EMTs seek employment with better pay and benefits.
- State licensure files indicate an estimated supply in 2021 of 5,120 FTE social workers. Data limitations prevent development of a national benchmark to estimate demand—as federal databases use a different definition to categorize social workers and do not collect data on licensure status. Based on the healthcare settings where social workers are employed, demand is projected to increase by 27% (equivalent to approximately 1,360 FTEs) between 2021 and 2035. Tennessee, like the nation, is training a sufficient number of social workers to meet future demand for services. However, low pay and lack of employment opportunities contribute to many trained professionals leaving this field.
- In 2021, Tennessee had 2.1% of the nation's total population and 2.1% of the nation's population age 65 or older. Tennessee also had 4.8% of the nation's NPs. Across almost all care delivery settings, Tennessee employed NPs at close to double the rate of the national average. Estimated supply of 13,260 FTEs in 2021 compared to estimated requirements of 5,960 FTEs required to

provide a national average level of NP services. Although analysis of the physician workforce is outside the scope of this study, other studies indicate a shortfall of physicians in Tennessee. Hence, the abundance of NPs appears to be helping offset the shortfall of physicians. NP supply in Tennessee, and throughout the U.S., is projected to grow rapidly. Coupled with a growing national shortage of physicians[1], Tennessee might continue to have to rely more heavily on the NP workforce (relative to the national average) to meet future demand for healthcare services.

- The PA supply of 2,730 FTEs in 2021 was about 620 FTEs (19%) below the 3,350 FTEs that would be expected based on national patterns of care use and delivery. Although PAs and NPs have different qualifications, educational backgrounds, and responsibilities, the lower availability of PAs in the state appears to be offset by greater use of NPs.
- Hospital administrators report struggling to attract staff to healthcare positions because of the low pay for long hours during unpopular shifts in a high-stress environment. Personnel and other costs are rising faster than reimbursement rates.
- Deans of nursing and allied health/health sciences schools described a dwindling pipeline, driven by both the decreasing numbers of younger adults in the high school and college age cohorts, as well as less interest in both college in general as well as healthcare careers specifically. Dwindling pipeline is particularly noticeable for 2-year programs—despite 2-year public college generally being tuition-free in Tennessee—as they struggle to fill their available student openings with qualified applicants.
- Many of the trends affecting the health workforce—such as high levels of burnout and challenges attracting and retaining personnel—existed before COVID-19 but have been exacerbated by the pandemic.

Recommendations

Interviews with stakeholders in the healthcare workforce suggest educators and employers are devising creative ways to make do with the current workforce shortages, and that these efforts are helpful in bridging the gap in the short run. However, the overarching message is the current system is not sustainable in the long term and will continue to deteriorate without significant systemic changes. These workforce shortages are created by a combination of increasing demand for providers (as the aging population requires more care), and a dwindling pipeline of healthcare workers. Interviewees suggest the shortages will be resolved only by expanding the worker pipeline, retaining the existing workforce, and maximizing technology to increase staff efficiency and decrease workload. These shortfalls cannot be resolved without beefing up the pipeline because the current and future levels of demand cannot be met without more personnel. Raising wages to retain current staff and remain competitive in the industry will not fully solve the problem and may exacerbate financial challenges hospitals are already facing. Recruiting new employees into the pipeline is essential to fully address hospital and healthcare workforce shortages. However, interviewees noted that even significant boosting of the worker pipeline simply will not produce enough personnel without accompanying technology to make workers more efficient. Additionally, healthcare costs continue to rise with little or no increase in reimbursements and with reimbursement changes not linked to the factors that providers use in making their staffing and other managerial decisions. Thus, changes to healthcare finance are also required for a long-term solution. To boost the pipeline, interviewees suggest several approaches. More resources are needed to cultivate awareness of, and interest in, healthcare careers. They note that when middle and high school students are exposed to healthcare professions (especially immersion in delivery settings and technology), many students develop goals of training for healthcare careers. For many who want to work in healthcare occupations, the costs of training can be out of reach, and for others, the costly investment in training relative to the low payoff in future income can dissuade them from entering the field. For these students, programs that include tuition assistance, paid internships, loan forgiveness, and help with childcare can help.

To aid in retention, the nonstandard work hours often required in healthcare can be mitigated to some extent with perks such as concierge and travel agent services, in-house gyms, childcare and/or elder care, and flexibility on shifts that allows workers to participate in more family-related or social activities of import to them. Re-envisioning career paths with more respect, prestige, and upward mobility could also help retain workers. Other states have also proposed policies and programs to address workplace violence. Understandably, resources have been concentrated on simply weathering the COVID-19 storm. As the impact of the pandemic and the great resignation subside, reasons for mass workforce exodus in healthcare should be explored in depth to provide employers and other impacted stakeholders the information they need to address the root causes. Because such an inquiry would benefit so many stakeholders, such research might most efficiently be funded publicly or jointly by stakeholders. Additionally, the precision of workforce supply projections could be improved with the collection of data during the licensure process regarding retirement intentions and status as well as hours worked.

Expanding the worker pipeline, either by reducing barriers to joining the worker pool and/or by directly injecting more potential workers, can ease shortages and facilitate efficient employment of healthcare delivery resources. Joining the licensure compact for social workers is one way to increase the potential social worker pool. Helping the Board of Nursing with resources needed to expedite screening of NCLEX applicants might also improve efficiency in the nurse labor market. Other states have proposed removing arbitrary barriers to internationally trained providers joining the workforce or providers licensed in other states providing telehealth, as well as implementing policies to encourage transitioning of ex-military personnel with relevant experience into the health workforce.

Boosting the pipeline will require sufficient amounts of trainers as well as trainees. Because advanced degrees are required for faculty in many of the healthcare professions, difficulties luring professors from higher paying industry jobs at teacher salaries were reported. Review of both faculty pay policies, especially in public schools where legislators can influence wages, as well as training and experience requirements may yield legislative options for boosting training faculty.

Comments by interviewees in both the educational and delivery sectors suggested that increased coordination among the organizations in both sectors could be helpful. For example, hospital administrators noted shifting goals for provider mix and educators noted issues matching the skills providers were demanding. Educators and employers could coordinate more closely on the optimal mix of BSNs, ADNs, LPNs, and other occupations included in new care models designed to leverage skills along the whole spectrum of workers in team-based care; training should be organized to produce an optimally trained mix of workers.

Based on input from stakeholder interviews, assessments of the current and projected healthcare workforce in Tennessee, and a review of recommendations by other states,[19,20] national organizations and experts[21–23], we recommend the following:

Expanded workforce pipeline for nursing and select allied health occupations in short supply

- Action item 1: Create a statewide awareness campaign to highlight the variety of hospital careers available and resources to assist in training and education for those careers.

- Action item 2: Develop programs to educate middle and high school students about career opportunities in healthcare.
- Action item 3: Create or augment existing programs that provide stipends or financial incentives (e.g., tuition assistance, paid internships, loan forgiveness, and help with childcare) to pursue careers in high demand healthcare fields.
- Action item 4: Increase availability of clinical sites for nurse training.
- Action item 5: Increase supply of qualified faculty and resources for nursing programs.
- Action item 6: Explore joining the licensure compact for social workers.
- Action item 7: Provide the Board of Nursing with resources needed to expedite screening of NCLEX applicants.
- Action item 8: Build career pathways to support education and training for existing staff to accelerate career advancement into high-demand positions.

Retention of Healthcare Workforce

- Action item 9: Address social and economic drivers that cause healthcare workers to leave the profession, including the cost and availability of child and elder care.
- Action item 10: Establish a statewide workplace violence prevention consortium to provide training and support and recommend policy changes.

New Models of Care

- Action item 11: Explore new models of care focused on relieving professional staff of tasks that can be delegated to other assistive personnel.
- Action item 12: Maximize technology to increase staff efficiency and decrease workload.

Geographic Distribution

- Action item 13: Focus on expansion of training programs into underserved communities.

Data Collection

- Action item 14: Implement a survey of healthcare workers at time of license renewal, as has been implemented in several other states, to collect data on labor force participation, intentions to remain in the workforce, and factors contributing to labor force participation decisions.

Study Strengths and Limitations

The study approach and data used have many strengths. The microsimulation models used to produce the supply and demand projections have been developed and refined for over 10 years and have been documented in peer-reviewed journals and presented at national conferences. The results of these models have been trusted for both health workforce and strategic planning by the federal government and state governments, hospitals and health systems, healthcare associations, and other stakeholders.

Where possible, Tennessee-specific data sources are used as modeling inputs. For supply modeling, we used licensure data obtained from the Tennessee Department of Health, including information on the base year supply of workers, and the number and characteristics of new entrants to the workforce. Labor force participation estimates come from Tennesseans who responded to the 2015-2019 ACS. For demand modeling, Tennessee-specific data are used to provide population characteristics (e.g., demographics, disease and health behavior prevalence, and socioeconomic information) by county, as well as information regarding the expected size and demographics of the future population in the state.

The model produces supply and demand projections at the county level, which allows for sub-state analysis of the adequacy of projected health workforce supply.

Interviews conducted with hospital administrators and deans of nursing and allied health programs in Tennessee provide insights into the dynamics driving the workforce shortages as well as possible ways these may be addressed.

Modeling and projecting into the future involve simplifying assumptions and data limitations that preclude perfect precision in forecasting. Even with careful optimization of models, data, and study approach employed, the results must be interpreted within the context of necessary limitations. Study limitations reflect both data gaps and uncertainty of care use and delivery patterns, as well as how health professionals career decisions might change in the future. Key limitations are the following:

Workforce implications resulting from COVID-19 are still unclear. The pandemic is still ongoing, and it is impossible to know with certainty what workforce implications will arise as a result. COVID-19 may change amounts of demand (e.g., due to increased healthcare needs of people with "long COVID"), and/or affect the way care is delivered (e.g., increased use of telehealth). Likewise, COVID-19 might have long-term implications on health workforce supply (e.g., if the public's treatment of nurses during the pandemic made nursing less attractive to potential nurses). The supply scenarios modeled reflecting early and delayed retirement, as well as increased and decreased new entrants, may provide insights into the potential effects of possible long-term pandemic-related changes to retirement and new entrants. Many of the immediate effects of the pandemic—e.g., healthcare workers leaving the workforce, and excess mortality—are incorporated into modeling inputs with a 2021 initial forecasting year.

National data are used to fill gaps in Tennessee-specific data. National data sources employed in supply modeling include the ACS and NSSRN datasets, which are used to provide information on hours worked retirement, and migration patterns. National data sources are used for demand modeling to provide information regarding population healthcare use patterns as well as nurse staffing patterns. To the extent that the Tennessee population uses services at a different rate than the national average or Tennessee providers staff health workers at levels different from the national average, error may be introduced into Tennessee health workforce supply and demand projections.

Information regarding locations of workers' places of employment is not fully available. The licensure data for Tennessee includes information on practice location by state and by county, with county information missing to varying degree. For RNs, LPNs, and NPs the Tennessee Board of Nursing

GIS application was used to sample the available information on practice location and complete cases where information on practice county was unavailable. There is no information on practice county for EMTs in the licensure data, and a secondary source was not available at the time of this report. Therefore, supply of EMTs was modeled at the state level. For all other occupations of interest, missing practice county information was sampled from the available practice county information in the licensure data, by occupation.

Projections do not account for regional differences in staffing and service delivery. Results are presented by districts within Tennessee, though data limitations necessitated modeling healthcare use and delivery patterns for the state as a whole. To the extent that care utilization and delivery and/or staffing patterns vary within the state, district projections may be impacted. In general, the state-level workforce projections tend to be more accurate than sub-state-level projections.

Demand projections model the continuation of baseline levels of healthcare use and delivery patterns. Projections into the future do not capture shifts in factors such as technological innovations, national or state-level health policies, patient preferences, or payer or provider policies that change the way care is consumed or delivered. In reality, these patterns will continue to evolve over time, but in ways that cannot be known at the time of the modeling. For example, if the pandemic has accelerated the trend of shifting hospital care from inpatient to outpatient settings, any staffing implications due to this acceleration would not be accounted for in the projections reported here. Similarly, increased use of telemedicine services, more rigorous discharge planning and other changes to the way care is delivered due to the pandemic may not factor into the projections. Recently published work on the physician workforce indicates that some components of an evolving care delivery system increase demand for healthcare services (e.g., increased access to care), other components decrease demand (e.g., increased emphasis on preventive care), and some components simply redirect care (e.g., from inpatient care to appropriate ambulatory settings).[1] Thus, the net effect of evolving care delivery on demand might be small.

The numbers of new entrants entering the health workforce annually are assumed to be constant over the projection period. The *Status Quo* supply scenario models the implications if the number of individuals entering the workforce remains constant over time. The scenario does not allow for market forces that help correct surpluses and shortages over time. Rather, this scenario helps inform policies to increase the education pipeline of new entrants being trained. If Tennessee's health workforce shortage becomes too severe relative to national levels, the increased job opportunities could increase the net inflow of nurses from other states. Still, for many occupations—including nurses and physicians—national projections of growing shortfalls suggest that Tennessee will be competing with other states to attract and retain healthcare workers.

Despite these limitations, the workforce projections presented offer best estimates given the information available. Understanding that the supply of health workers in Tennessee is projected to grow slower than demand for nursing services in the state can inform nurse workforce planning, as well as highlight career opportunities for people considering nursing as a career. Nurse workforce modeling aids in determining whether existing workforce programs and policies are producing a sufficient supply of nurses to provide patients with access to high quality care. In light of the limitations described and an ever-changing healthcare system, workforce projections should be updated periodically to use the most current data and other updated information.

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Appendix: Additional Tables

Exhibit 37. Registered Nurse Supply, Demand, and Supply Adequacy, 2021-2035

Year	Supply	Demand[a]	Adequacy (#)[a]	Adequacy (%)[b]
2021	62,900	78,600	-15,700	80%
2022	64,400	79,800	-15,400	81%
2023	66,100	80,900	-14,800	82%
2024	67,700	82,000	-14,300	83%
2025	69,300	83,100	-13,800	83%
2026	70,900	84,100	-13,200	84%
2027	72,500	85,100	-12,600	85%
2028	74,100	86,100	-12,000	86%
2029	75,600	87,100	-11,500	87%
2030	77,100	88,000	-10,900	88%
2031	78,600	88,900	-10,300	88%
2032	80,000	89,700	-9,700	89%
2033	81,300	90,600	-9,300	90%
2034	82,500	91,400	-8,900	90%
2035	83,700	92,200	-8,500	91%

Note: [a] FTEs required to provide a 2021 national average level of care. [b] Adequacy of 100% equates to the national average.

Exhibit 38. Licensed Practical Nurse Supply, Demand, and Supply Adequacy, 2021-2035

Year	Supply	Demand[a]	Adequacy (#)[a]	Adequacy (%)[b]
2021	22,500	15,000	7,500	150%
2022	22,300	15,300	7,000	146%
2023	22,000	15,600	6,400	141%
2024	21,800	15,900	5,900	137%
2025	21,600	16,200	5,400	133%
2026	21,400	16,500	4,900	130%
2027	21,100	16,800	4,300	126%
2028	20,900	17,000	3,900	123%
2029	20,700	17,300	3,400	120%
2030	20,500	17,500	3,000	117%
2031	20,300	17,800	2,500	114%
2032	20,100	18,000	2,100	112%
2033	20,000	18,300	1,700	109%
2034	19,800	18,500	1,300	107%
2035	19,700	18,700	1,000	105%

Note: [a] FTEs required to provide a 2021 national average level of care. [b] Adequacy of 100% equates to the national average.

Exhibit 39. Respiratory Therapist Supply, Demand, and Supply Adequacy, 2021-2035

Year	Supply	Demand[a]	Adequacy (#)[a]	Adequacy (%)[b]
2021	2,170	3,110	-940	70%
2022	2,230	3,170	-940	70%
2023	2,280	3,230	-950	71%
2024	2,320	3,290	-970	71%
2025	2,380	3,350	-970	71%
2026	2,420	3,400	-980	71%
2027	2,460	3,460	-1,000	71%
2028	2,500	3,510	-1,010	71%
2029	2,530	3,560	-1,030	71%
2030	2,570	3,600	-1,030	71%
2031	2,610	3,650	-1,040	72%
2032	2,650	3,690	-1,040	72%
2033	2,680	3,730	-1,050	72%
2034	2,710	3,770	-1,060	72%
2035	2,730	3,810	-1,080	72%

Note: [a] FTEs required to provide a 2021 national average level of care. [b] Adequacy of 100% equates to the national average.

Exhibit 40. Clinical Laboratory Technologists and Technicians Supply, Demand, and Supply Adequacy, 2021-2035

Year	Supply	Demand[a]	Adequacy (#)[a]	Adequacy (%)[b]
2021	4,600	8,910	-4,310	52%
2022	4,600	9,020	-4,420	51%
2023	4,590	9,120	-4,530	50%
2024	4,570	9,220	-4,650	50%
2025	4,570	9,320	-4,750	49%
2026	4,540	9,410	-4,870	48%
2027	4,530	9,500	-4,970	48%
2028	4,510	9,590	-5,080	47%
2029	4,500	9,670	-5,170	47%
2030	4,500	9,750	-5,250	46%
2031	4,500	9,830	-5,330	46%
2032	4,510	9,910	-5,400	46%
2033	4,520	9,980	-5,460	45%
2034	4,530	10,060	-5,530	45%
2035	4,540	10,130	-5,590	45%

Note: [a] FTEs required to provide a 2021 national average level of care. [b] Adequacy of 100% equates to the national average.

Exhibit 41. Emergency Medical Technicians Supply, Demand, and Supply Adequacy, 2021-2035

Year	Supply	Demand[a]	Adequacy (#)[a]	Adequacy (%)[b]
2021	3,490	2,990	500	117%
2022	3,660	3,020	640	121%
2023	3,810	3,050	760	125%
2024	3,940	3,090	850	128%
2025	4,050	3,110	940	130%
2026	4,160	3,140	1,020	132%
2027	4,260	3,170	1,090	134%
2028	4,350	3,200	1,150	136%
2029	4,410	3,230	1,180	137%
2030	4,480	3,250	1,230	138%
2031	4,540	3,280	1,260	138%
2032	4,590	3,300	1,290	139%
2033	4,640	3,320	1,320	140%
2034	4,670	3,350	1,320	139%
2035	4,710	3,370	1,340	140%

Note: [a] FTEs required to provide a 2021 national average level of care. [b] Adequacy of 100% equates to the national average.

Exhibit 42. Social Worker Supply, Demand, and Supply Adequacy, 2021-2035

Year	Supply	Demand[a]	Adequacy (#)[a]	Adequacy (%)[b]
2021	5,120	5,120	0	100%
2022	5,350	5,220	130	102%
2023	5,550	5,330	220	104%
2024	5,750	5,430	320	106%
2025	5,930	5,540	390	107%
2026	6,100	5,640	460	108%
2027	6,240	5,740	500	109%
2028	6,380	5,840	540	109%
2029	6,500	5,940	560	109%
2030	6,630	6,030	600	110%
2031	6,760	6,130	630	110%
2032	6,880	6,220	660	111%
2033	7,000	6,310	690	111%
2034	7,100	6,400	700	111%
2035	7,200	6,480	720	111%

Note: [a] FTEs required to provide a 2021 national average level of care. [b] Adequacy of 100% equates to the national average.

Exhibit 43. Nurse Practitioner Supply, Demand, and Supply Adequacy, 2021-2035

Year	Supply	Demand[a]	Adequacy (#)[a]	Adequacy (%)[b]
2021	13,260	5,960	7,300	222%
2022	13,940	6,040	7,900	231%
2023	14,620	6,120	8,500	239%
2024	15,270	6,200	9,070	246%
2025	15,890	6,270	9,620	253%
2026	16,480	6,340	10,140	260%
2027	17,060	6,410	10,650	266%
2028	17,630	6,480	11,150	272%
2029	18,150	6,540	11,610	278%
2030	18,680	6,600	12,080	283%
2031	19,200	6,660	12,540	288%
2032	19,690	6,720	12,970	293%
2033	20,180	6,780	13,400	298%
2034	20,640	6,830	13,810	302%
2035	21,080	6,890	14,190	306%

Note: [a] FTEs required to provide a 2021 national average level of care. [b] Adequacy of 100% equates to the national average.

Exhibit 44. Physician Assistant Supply, Demand, and Supply Adequacy, 2021-2035

Year	Supply	Demand[a]	Adequacy (#)[a]	Adequacy (%)[b]
2021	2,730	3,350	-620	81%
2022	2,840	3,400	-560	84%
2023	2,960	3,440	-480	86%
2024	3,060	3,480	-420	88%
2025	3,170	3,520	-350	90%
2026	3,280	3,560	-280	92%
2027	3,380	3,590	-210	94%
2028	3,490	3,630	-140	96%
2029	3,580	3,660	-80	98%
2030	3,680	3,700	-20	99%
2031	3,760	3,730	30	101%
2032	3,850	3,760	90	102%
2033	3,940	3,790	150	104%
2034	4,020	3,820	200	105%
2035	4,110	3,850	260	107%

Note: [a] FTEs required to provide a 2021 national average level of care. [b] Adequacy of 100% equates to the national average.

Exhibit 45. Registered Nurse Supply and Demand Growth and Adequacy by Scenario

Scenario	2021	2035	Growth	% Growth
Demand				
Status quo[a]	78,600	92,200	13,600	17%
Reduced barriers	81,500	95,800	14,300	18%
Supply				
Status quo	62,900	83,700	20,800	33%
10% Fewer Entrants	62,900	78,600	15,700	25%
10% More Entrants	62,900	88,800	25,900	41%
***Early Retirement* (2 years earlier)**	62,900	81,600	18,700	30%
***Delayed Retirement* (2 years later)**	62,900	85,500	22,600	36%
Supply Adequacy vs. *Status Quo* Demand[a]				
Status quo	-15,700	-8,500		
10% Fewer Entrants	-15,700	-13,600		
10% More Entrants	-15,700	-3,400		
***Early Retirement* (2 years earlier)**	-15,700	-10,600		
***Delayed Retirement* (2 years later)**	-15,700	-6,700		
Supply Adequacy vs. *Reduced Barriers* Demand				
Status quo	-18,600	-12,100		
10% Fewer Entrants	-18,600	-17,200		
10% More Entrants	-18,600	-7,000		
***Early Retirement* (2 years earlier)**	-18,600	-14,200		
***Delayed Retirement* (2 years later)**	-18,600	-10,300		

Note: [a] FTEs required to provide a 2021 national average level of care.

Exhibit 46. Licensed Practical Nurse Supply and Demand Growth and Adequacy by Scenario

Scenario	2021	2035	Growth	% Growth
Demand				
Status quo[a]	15,000	18,700	3,700	25%
Reduced barriers	15,500	19,400	3,900	25%
Supply				
Status quo	22,500	19,700	-2,800	-12%
10% Fewer Entrants	22,500	18,500	-4,000	-18%
10% More Entrants	22,500	20,800	-1,700	-8%
***Early Retirement* (2 years earlier)**	22,500	19,200	-3,300	-15%
***Delayed Retirement* (2 years later)**	22,500	20,100	-2,400	-11%
Supply Adequacy vs. *Status Quo* Demand[a]				
Status quo	7,500	1,000		
10% Fewer Entrants	7,500	-200		
10% More Entrants	7,500	2,100		
***Early Retirement* (2 years earlier)**	7,500	500		
***Delayed Retirement* (2 years later)**	7,500	1,400		
Supply Adequacy vs. *Reduced Barriers* Demand				
Status quo	7,000	300		
10% Fewer Entrants	7,000	-900		
10% More Entrants	7,000	1,400		
***Early Retirement* (2 years earlier)**	7,000	-200		
***Delayed Retirement* (2 years later)**	7,000	700		

Note: [a] FTEs required to provide a 2021 national average level of care.

Exhibit 47. Respiratory Therapist Supply and Demand Growth and Adequacy by Scenario

Scenario	2021	2035	Growth	% Growth
Demand				
Status quo[a]	3,110	3,810	700	23%
Reduced barriers	3,100	3,830	730	24%
Supply				
Status quo	2,170	2,730	560	26%
10% Fewer Entrants	2,170	2,540	370	17%
10% More Entrants	2,170	2,910	740	34%
***Early Retirement* (2 years earlier)**	2,170	2,680	510	24%
***Delayed Retirement* (2 years later)**	2,170	2,780	610	28%
Supply Adequacy vs. *Status Quo* Demand[a]				
Status quo	-940	-1,080		
10% Fewer Entrants	-940	-1,270		
10% More Entrants	-940	-900		
***Early Retirement* (2 years earlier)**	-940	-1,130		
***Delayed Retirement* (2 years later)**	-940	-1,030		
Supply Adequacy vs. *Reduced Barriers* Demand				
Status quo	-930	-1,100		
10% Fewer Entrants	-930	-1,290		
10% More Entrants	-930	-920		
***Early Retirement* (2 years earlier)**	-930	-1,150		
***Delayed Retirement* (2 years later)**	-930	-1,050		

Note: [a] FTEs required to provide a 2021 national average level of care.

Exhibit 48. Medical Laboratory Technologist and Technician Supply and Demand Growth and Adequacy by Scenario

Scenario	2021	2035	Growth	% Growth
Demand				
Status quo[a]	8,910	10,130	1,220	14%
Reduced barriers	9,540	10,870	1,330	14%
Supply				
Status quo	4,600	4,540	-60	-1%
10% Fewer Entrants	4,600	4,310	-290	-6%
10% More Entrants	4,600	4,790	190	4%
***Early Retirement* (2 years earlier)**	4,600	4,330	-270	-6%
***Delayed Retirement* (2 years later)**	4,600	4,770	170	4%
Supply Adequacy vs. *Status Quo* Demand[a]				
Status quo	-4,310	-5,590		
10% Fewer Entrants	-4,310	-5,820		
10% More Entrants	-4,310	-5,340		
***Early Retirement* (2 years earlier)**	-4,310	-5,800		
***Delayed Retirement* (2 years later)**	-4,310	-5,360		
Supply Adequacy vs. *Reduced Barriers* Demand				
Status quo	-4,940	-6,330		
10% Fewer Entrants	-4,940	-6,560		
10% More Entrants	-4,940	-6,080		
***Early Retirement* (2 years earlier)**	-4,940	-6,540		
***Delayed Retirement* (2 years later)**	-4,940	-6,100		

Note: [a] FTEs required to provide a 2021 national average level of care.

Exhibit 49. Emergency Medical Technician Supply and Demand Growth and Adequacy by Scenario

Scenario	2021	2035	Growth	% Growth
Demand				
***Status quo*[a]**	2,990	3,370	380	13%
Reduced barriers	3,000	3,400	400	13%
Supply				
Status quo	3,490	4,710	1,220	35%
10% Fewer Entrants	3,490	4,330	840	24%
10% More Entrants	3,490	5,100	1,610	46%
***Early Retirement* (2 years earlier)**	3,490	4,660	1,170	34%
***Delayed Retirement* (2 years later)**	3,490	4,760	1,270	36%
Supply Adequacy vs. *Status Quo* Demand[a]				
Status quo	500	1,340		
10% Fewer Entrants	500	960		
10% More Entrants	500	1,730		
***Early Retirement* (2 years earlier)**	500	1,290		
***Delayed Retirement* (2 years later)**	500	1,390		
Supply Adequacy vs. *Reduced Barriers* Demand				
Status quo	490	1,310		
10% Fewer Entrants	490	930		
10% More Entrants	490	1,700		
***Early Retirement* (2 years earlier)**	490	1,260		
***Delayed Retirement* (2 years later)**	490	1,360		

Note: [a] FTEs required to provide a 2021 national average level of care.

Exhibit 50. Social Worker Supply and Demand Growth and Adequacy by Scenario

Scenario	2021	2035	Growth	% Growth
Demand				
***Status quo*[a]**	5,120	6,480	1,360	27%
Reduced barriers	5,440	6,890	1,450	27%
Supply				
Status quo	5,120	7,200	2,080	41%
10% Fewer Entrants	5,120	6,680	1,560	30%
10% More Entrants	5,120	7,720	2,600	51%
***Early Retirement* (2 years earlier)**	5,120	7,160	2,040	40%
***Delayed Retirement* (2 years later)**	5,120	7,270	2,150	42%
Supply Adequacy vs. *Status Quo* Demand[a]				
Status quo	0	720		
10% Fewer Entrants	0	200		
10% More Entrants	0	1,240		
***Early Retirement* (2 years earlier)**	0	680		
***Delayed Retirement* (2 years later)**	0	790		
Supply Adequacy vs. *Reduced Barriers* Demand				
Status quo	-320	310		
10% Fewer Entrants	-320	-210		
10% More Entrants	-320	830		
***Early Retirement* (2 years earlier)**	-320	270		
***Delayed Retirement* (2 years later)**	-320	380		

Note: [a] FTEs required to continuing providing the average level of care in Tennessee in 2021. FTEs to provide a national average level of care is unavailable due to differences in how social workers are defined in federal surveys and how licensed social workers are defined in state licensure files.

Exhibit 51. Nurse Practitioner Supply and Demand Growth and Adequacy by Scenario

Scenario	2021	2035	Growth	% Growth
Demand				
Status quo[a]	5,960	6,890	930	16%
Reduced barriers	6,500	7,510	1,010	16%
Supply				
Status quo	13,260	21,080	7,820	59%
10% Fewer Entrants	13,260	19,790	6,530	49%
10% More Entrants	13,260	22,380	9,120	69%
***Early Retirement* (2 years earlier)**	13,260	20,580	7,320	55%
***Delayed Retirement* (2 years later)**	13,260	21,530	8,270	62%
Supply Adequacy vs. *Status Quo* Demand[a]				
Status quo	7,300	14,190		
10% Fewer Entrants	7,300	12,900		
10% More Entrants	7,300	15,490		
***Early Retirement* (2 years earlier)**	7,300	13,690		
***Delayed Retirement* (2 years later)**	7,300	14,640		
Supply Adequacy vs. *Reduced Barriers* Demand				
Status quo	6,760	13,570		
10% Fewer Entrants	6,760	12,280		
10% More Entrants	6,760	14,870		
***Early Retirement* (2 years earlier)**	6,760	13,070		
***Delayed Retirement* (2 years later)**	6,760	14,020		

Note: [a] FTEs required to provide a 2021 national average level of care.

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Exhibit 52. Physician Assistant Supply and Demand Growth and Adequacy by Scenario

Scenario	2021	2035	Growth	% Growth
Demand				
Status quo[a]	3,350	3,850	500	15%
Reduced barriers	3,670	4,240	570	16%
Supply				
Status quo	2,730	4,110	1,380	51%
10% Fewer Entrants	2,730	3,850	1,120	41%
10% More Entrants	2,730	4,360	1,630	60%
***Early Retirement* (2 years earlier)**	2,730	4,050	1,320	48%
***Delayed Retirement* (2 years later)**	2,730	4,160	1,430	52%
Supply Adequacy vs. *Status Quo* Demand[a]				
Status quo	-620	260		
10% Fewer Entrants	-620	0		
10% More Entrants	-620	510		
***Early Retirement* (2 years earlier)**	-620	200		
***Delayed Retirement* (2 years later)**	-620	310		
Supply Adequacy vs. *Reduced Barriers* Demand				
Status quo	-940	-130		
10% Fewer Entrants	-940	-390		
10% More Entrants	-940	120		
***Early Retirement* (2 years earlier)**	-940	-190		
***Delayed Retirement* (2 years later)**	-940	-80		

Note: [a] FTEs required to provide a 2021 national average level of care.

Exhibit 53. Tennessee County-to-District Crosswalk

District 1: Memphis	District 4: South Middle	District 6: Chattanooga
Shelby	Bedford	Bradley
District 2: West	Cannon	Hamilton
Benton	Coffee	Marion
Carroll	Dekalb	Sequatchie
Chester	Franklin	Van Buren
Crockett	Giles	**District 7: Knoxville**
Decatur	Grundy	Anderson
Dyer	Lawrence	Blount
Fayette	Lewis	Campbell
Gibson	Lincoln	Claiborne
Hardeman	Marshall	Cocke
Hardin	Maury	Grainger
Haywood	Moore	Hamblen
Henderson	Smith	Jefferson
Henry	Warren	Knox
Lake	Wayne	Sevier
Lauderdale	White	Union
Madison	**District 5: Mid-East**	**District 8: Northeast**
McNairy	Bledsoe	Carter
Obion	Clay	Greene
Tipton	Cumberland	Hancock
Weakley	Fentress	Hawkins
District 3: Middle	Jackson	Johnson
Cheatham	Loudon	Sullivan
Davidson	McMinn	Unicoi
Dickson	Meigs	Washington
Hickman	Monroe	
Houston	Morgan	
Humphreys	Overton	
Macon	Pickett	
Montgomery	Polk	
Perry	Putnam	
Robertson	Rhea	
Rutherford	Roane	
Stewart	Scott	
Sumner		
Trousdale		
Williamson		
Wilson		