Research Report

Identifying Strategies for Strengthening the Health Care Workforce in the Commonwealth of Virginia

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About This Report

Shortages in the nursing, primary care, and behavioral health workforces are an ongoing and widespread issue in the United States. This report assesses shortages in these health care workforces in the Commonwealth of Virginia and identifies potential interventions to address these shortages. The report is the culmination of the second and third phases of a larger study. In the first phase of the study, the Virginia Health Workforce Development Authority and its partners focused on initial data collection and analysis related to challenges faced by Virginia's health care workforce. This report extends the first phase to identify specific interventions for (1) retaining existing health care workers, (2) recruiting first-time future health care workers, and (3) maximizing the ability of the Virginia health care workforce to meet the Commonwealth's needs via structural efficiencies—for example, better geographic distribution of the Commonwealth's workforce via economic and social policy interventions or telehealth practice. We identified interventions to improve retention, recruitment, and structural efficiency based on an environmental scan of peer-reviewed and grey literature; primary multi-stakeholder conference, interview, focus group, and survey data; and statistical analysis and simulation based on data from the Commonwealth and other relevant sources. Importantly, a wide variety of Virginia health care workforce stakeholders participated in and supported the research by attending the study conference, participating in interviews, focus groups, and serving on the study's advisory board. The participation of these Virginia stakeholders was critical to identifying solutions that better fit Virginia's specific health care workforce landscape and population needs.

Appendixes A–H to this report, which provide details on the methods and analysis used for this research, are contained a separate annex, available at www.rand.org/t/RRA2093-1.

This research was funded by the Virginia Health Workforce Development Authority (VHWDA) and carried out within the Access and Delivery Program in RAND Health Care. The Virginia General Assembly established VHWDA in 2010 in order to identify and address health workforce issues in the Commonwealth. As a public entity, VHWDA exercises public and essential governmental functions to secure the health, welfare, convenience, knowledge, benefit, and prosperity of Virginians. VHWDA's mission is to "facilitate the development of a statewide health professions pipeline that identifies, educates, recruits, and retains a diverse, geographically distributed and culturally competent quality workforce" (VHWDA, undated-a). VHWDA accomplishes this through core functions outlined in the Code of Virginia (Virginia's Legislative Information System, undated-c).

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We extend our appreciation to reviewers of this report, Christina Brooks and RAND's Federico Girosi, Jeanne Ringel, and Paul Koegel, whose expertise and insights helped improve this work.

We dedicate this report to the health workers of the United States—a national treasure. We hope that the results of this work can help health care workers in the Commonwealth and other states thrive in their work lives and pave the way for others to join their ranks.

Summary

Issue

Like the United States as a whole, Virginia faces a significant shortage of health care workers in primary care and behavioral health care across a range of health care settings. For example, 102 of 133 Virginia counties and equivalents are federally designated primary care Health Professional Shortage Areas (HPSAs), accounting for 29 percent of the Commonwealth's population. Many of these shortage areas are in urban and rural regions, as opposed to suburban areas (U.S. Department of Health and Human Services, 2023). Similarly, 93 of Virginia's 133 counties (and equivalents) are federally designated mental health care HSPAs, and about 32 percent of Virginians live in these areas (Virginia's Legislative Information System, 2023; Virginia Health Care Foundation, 2022a; Virginia Health Care Foundation, 2022b).

In response to these health care workforce shortages, Virginia has passed nearly 60 related bills over the past ten years, with a notable increase in the number of health care workforce bills in 2023–2023 (BillTrack50, undated; National Conference of State Legislatures, 2023). Recently enacted legislation includes interstate compacts (i.e., agreements) for licensing and scope-of-practice regulations for behavioral health professionals, medical assistance payment for remote patient monitoring, expanded midwife practice agreements, and more.

Because of the limited evaluation research on existing practices, programs, and policies (hereafter "interventions"), it is unclear whether past and current interventions are likely to succeed in addressing the workforce shortages in Virginia. An evidence-based approach that carefully evaluates interventions across different contexts is needed to identify the most promising interventions to help retain and expand the health care workforce in Virginia.

The objective of this study was to identify interventions that can help the Virginia Health Workforce Development Authority (VHWDA) address nursing, primary care, and behavioral health workforce challenges and to define the role that the authority can play in facilitating such solutions. To accomplish this goal, we applied an analytic framework to existing or potential interventions for retaining, recruiting, and improving the structural efficiency (i.e., the efficient allocation of workers within a given health care system and efficient health care output using technology, policy changes, or other structural adjustments) of the nursing, primary care, and behavioral health workforces in Virginia. In this report, we highlight which interventions VHWDA should prioritize based on its desired outcomes and policy goals.

Overarching findings are shown in Box S.1.

Box S.1. Overarching Findings

1. Team-based care needs to be promoted and supported in Virginia through regulatory and reimbursement reform.
2. To help populate teams for team-based care, "health care highways" need to be embraced to help create career ladders for upward movement.
3. Barriers to pursuing health care careers need to be removed, including the number of supervised training hours and related trainee expenses—particularly in behavioral health professions.
4. Tuition support and other incentives need to be expanded—especially for students in most need—and effectively advertised.
5. Support for faculty and clinical preceptors needs to be enhanced and more flexibility needs to be built in such positions.

Approach

We used results from a review of peer-reviewed and grey literature and analysis of multidisciplinary conference, interview, focus group, and quantitative data sources to arrive at recommendations for promising interventions to be implemented in Virginia for health care workforce retention, recruitment, and structural efficiency. Furthermore, we developed a system dynamics economic model to assess the shortages of nurses, primary care practitioners, and behavioral health providers in the next five, ten, and 15 years at baseline (i.e., if the status quo persists) and if (1) retention barriers (such as fatigue, distress, and disengagement) are decreased, (2) recruitment is increased, (3) wages are increased, or (4) all three interventions are implemented.

Key Findings

The results from the system dynamics model show that, if current trends persist, nursing, primary care, and behavioral health workforce shortages will increase across Virginia.

We forecast that, by reducing the barriers that cause reluctance to remain working in the field of nursing by half—barriers such as workplace violence, trauma, and stress—Virginia can effect a rapid increase in the number of registered nurses (RNs) retained in the field. However, over a period of 15 years, increased recruitment will have a more dramatic effect on workforce numbers, surpassing the effect of decreased barriers to retention. Increasing nurse wage growth from an average 2 percent annual growth to 3 percent annual growth also increases the number of nurses retained and recruited, though not as much as the other interventions do. As expected, a combination of all three interventions has the largest effect on the forecast of nurse employment, boosting the total number of full-time equivalent nurses employed in 2038 by a little more than 10,000 above the baseline projection.

Unlike our forecasts for RNs, our forecast for the number of active primary care workers in the Commonwealth shows a decline under baseline conditions, making the future shortfall in primary care workers even more severe than for nursing alone. Similar to our model for nursing, the largest immediate boost to the workforce would come from cutting in half the number of barriers that make workers reluctant to remain working in the field. Over the course of 15 years, the effect on total employment of increasing wage growth catches up to the effect of decreasing retention barriers. The effect of increasing recruitment is more modest because baseline recruitment begins at very modest levels. An ambitious combination of all three interventions (the multi-intervention scenario) would boost total employment by more than 2,000 workers, forecast to slowly decline in the coming years. Implementing any one of the three interventions promises to keep the existing workforce numbers at 2023 levels, but only by combining all three interventions can Virginia produce a sustainable increase in the number of behavioral health workers employed.

Recommendations

VHWDA should convene and lead a coalition of key stakeholders to implement the following recommendations to retain and expand the nursing, primary care, and behavioral health workforces in Virginia. These stakeholders include, but are not limited to, the Virginia legislature, state agencies, health care organizations, and educational entities. Implementation of many of the proposed interventions will require cross-sector, including public-private, collaboration. To ensure effective and efficient implementation of these recommendations, VHWDA should serve as the coordinating center for the coalition to help gather the needed collaborations, data, and funds and to leverage other political and social capital in the Commonwealth.

The guide to intervention recommendations by strength of evidence found in this study is outlined in Table S.1. Tables S.2 and S.3 list retention and recruitment interventions, respectively.

Table S.1. Guide to Intervention Tiers

	Tier 1 interventions are strongly supported by the analyses. The interventions are supported by the literature review (evaluation studies) *and* were identified multiple times across the multi-stakeholder conference, interviews, and/or focus group data.*
	Tier 2 interventions are moderately supported by the analyses. These interventions are supported by the literature review (non-evaluation studies) and were identified multiple times across the multi-stakeholder conference, interviews, and/or focus group data.
	Tier 3 interventions have some support in the literature review *or* were identified in the multi-stakeholder conference, interviews, and/or focus group data.

* Support for an intervention in the qualitative work indicates that the intervention has valence—or is deemed an attractive option by interviewees—but it does not indicate whether the intervention will have a positive effect on retention, recruitment, or productivity.

Table S.2. Interventions for Health Care Workforce Retention

Tier	Retention Intervention Category (Key Implementation Stakeholders)	Specific Intervention
Tier 1	Resiliency and well-being (health care organizations)	1. **Implement programs to address mental health and well-being among health care workers**—especially in behavioral health professions 2. **Address underlying causes of health care worker stress and burnout**, such as inappropriate patient-provider ratios, throughput requirements, documentation requirements, low and/or differential compensation for care provided, and lack of basic supplies.
Tier 1	Scope of practice and practice agreement (Legislature)	1. **Reevaluate license restrictions for physician assistants (PAs) and NPs** to increase the appeal of primary care for these health professionals and to expand primary care capacity.
Tier 2	Team-based care (Health care organizations)	1. **Implement team-based care** to mitigate the stresses of high patient-to-provider ratios and large patient panels and take patient complexity and acuity into account when assigning patients to providers.
Tier 2	Pay increase and other incentives (health care organizations)	1. **Increase pay for nursing, primary care, and behavioral health** providers and provide appropriate benefits—including health insurance coverage commensurate with risks involved in health care delivery (e.g., exposure to disease, despair, and violence). Provide assistance with transportation, child care, and housing.
Tier 2	Documentation burden (health care organizations, systems, legislature)	1. **Evaluate technologies**—such as voice recognition and artificial intelligence—that may assist with reducing documentation burden.* 2. **Revisit documentation requirements** to identify areas of redundant and/or unnecessary documentation that could be removed from documentation requirements.
Tier 2	Workplace diversity (health care organizations, educational entities)	1. **Develop retention strategies centered around creating more diverse workplaces** for nursing, primary care, and behavioral health.*
Tier 2	Personal/professional development (health care organizations)	1. **Invest in making professional development opportunities** available to staff and increase recognition efforts.
Tier 3	Workplace violence (health care organizations, legislature)	1. **Evaluate legislation to increase legal consequences related to violence toward health care providers**—on par with those currently in place for assaulting prehospital providers and first responders.* 2. **Evaluate health care organization policies** around violence toward health care providers and identify strategies for more strict enforcement of those policies.
Tier 3	Cross-sector collaboration (health care organizations, educational entities)	1. **Identify and leverage opportunities for cross-sector collaboration** between the health care sector, educational organizations, and public and private entities to increase opportunities and funding for nursing, primary care, and behavioral health exposure and training.
Tier 3	Continuing education (health care organizations, educational entities)	1. **Evaluate mechanisms to increase continuing education opportunities and funding**—especially through leveraging collaboration between health care organizations and educational entities.

* Designates an innovative intervention.

Table S.3. Interventions for Health Care Workforce Recruitment

Tier	Recruitment Intervention Category (Key Implementation Stakeholders)	Specific Intervention
Tier 1	Scholarship, loan forgiveness, and other support (private entities, health care organizations, educational entities)	1. Increase **scholarships opportunities** in Virginia. 2. Raise **public awareness** of loan forgiveness and scholarship opportunities. 3. Develop mechanisms for rural applicants and first-generation students to receive **loan forgiveness** up front.* 4. Include **support for housing, transportation, and food** for rural and first-generation students.
Tier 1	Wages and regulations for educators (private entities, health care organizations, educational entities, Virginia Department of Health Professions)	1. **Increase wages for nursing faculty and preceptors** to levels similar to engineering, business, and other faculty that receive higher wages. 2. **Loosen strict behavioral health preceptorship/licensed supervising requirements**, such as educational degree requirements for preceptors, preceptor-to-student ratios, and need for preceptors in community settings.* 3. **Create mechanisms to pay for behavioral health preceptorship and licensed supervisors** to remove this financial burden from students/trainees.*
Tier 1	Work-based learn and earn (health care organizations, educational entities)	1. **Offer work-based learning, paid and unpaid.** Health care occupations have historically included more work-based learning in education and training than other occupations (e.g., clinical rotations, clinical intern or clerkships, and residencies). Health care stakeholders are increasingly interested in expanding these options across different health care occupations—particularly in nursing.
Tier 2	Recruiting youth and members of underserved communities (health care organizations, educational entities)	1. **Develop (and/or expand on current programs) to expose K–12 children to health professions.** Such programs should include collaboration between educational and health care entities. 2. **Specific outreach strategies for youth from underrepresented communities are needed.** Such interventions should aim to include both children and their parents in outreach efforts and should, ideally, be delivered by health care professionals from similar backgrounds.*
Tier 3	Preceptor/licensed supervisor capacity (health care organizations, educational entities)	1. **Leverage nursing and behavioral health retirees** to increase pool of preceptors/licensed supervisors.* 2. **Create mechanisms to compensate preceptors/licensed supervisors**—including ability to bill for supervised visits.*
Tier 3	Outreach and public image (health care organizations, educational entities)	1. **Change the image of health professions through public education campaigns.** Such efforts should focus on highlighting the rewarding nature of nursing and behavioral health work, and removing the stigma associated with becoming a behavioral health professional.
Tier 3	Online instruction (health care organizations, educational entities)	1. **Increase opportunities for online learning** to increase access and flexibility to local and nonlocal clinical introductory level education.
Tier 3	New pathways (health care organizations, educational entities)	1. **Create multiple entry ramps and educational pathways** to nursing and behavioral health careers as a recruitment strategy. This includes developing academic programs at different levels, such as associate and bachelor's degrees for behavioral health, to provide more immediate relief to the workforce shortage. 2. **Offer paid internships at the high school level** so students can be exposed to health professions; match undergrads with medical students and promote mentorship alongside internship.

Tier	Recruitment Intervention Category (Key Implementation Stakeholders)	Specific Intervention
Tier 3	Licensing exam and licensure (Department of Health professions)	1. **Significantly truncate the duration of application for licensure** in behavioral health fields and allow students that need to retake the licensure exam to have **more frequent opportunities to sit for the examination**.
Tier 3	Advanced education/training technology (health care organizations, educational entities)	1. Increase access to **simulation-based learning** in nursing. 2. Increase access to **training opportunities** in telepsychology.

* Designates an innovative intervention.

Interventions for Increasing Structural Efficiency and other Innovations

In addition to retention and recruitment interventions, the Commonwealth should consider strategies that optimally use the current workforce through increasing structural efficiency. Some of the interventions that we identified have little evidence behind them to determine whether they increase the number of available health care professionals or otherwise address critical health care workforce issues (e.g., burnout). Nonetheless, some are innovative and worth considering:

- Incentivizing existing nursing, primary care, and behavioral health workers to move from areas of more provider capacity to those of less capacity in Virginia may help to achieve an allocation of labor that maximizes overall health outcomes.
  - In the case of primary care and behavioral health, some of this reallocation of labor may be achieved by increasing opportunities for telehealth for providers, effectively (though not physically) moving labor to the locations with the highest need.
- Removing work barriers—such as reducing documentation, reporting, and regulatory requirements and/or leveraging technologies such as voice recognition and artificial intelligence to help with these tasks—can both create efficiency and potentially increase worker job satisfaction to reduce attrition.
- One strategy that can help increase structural efficiency in both primary care and behavioral health is to increase locations in the Commonwealth that offer both services in the same setting—implementing a team-based approach to more efficiently address related mental health illnesses.

Transitioning service members (as well as military spouses)—many of whom are qualified health care experts—into civilian employment and anchoring them in Virginia is a strategy that may help retain talent in the Commonwealth and expand the health care workforce.

Furthermore, regular health care workforce data-tracking may be an effective strategy to inform interventions for retention, recruitment, and structural efficiency and to pivot as needed to ensure that the health care needs of Virginia residents are met. Health care workforce data exist in Virginia Commonwealth University's Virginia Ambulatory Care Outcomes Research Network (ACORN) (Virginia Commonwealth University, undated-a), in the Virginia Longitudinal Data System (Virginia Longitudinal Data System, 2023), and at the George Mason University Center

for Health Workforce (Mason Center for Health Workforce, 2023). Similar data-tracking should be implemented by health professions colleges and universities to inform strategies to retain graduates in the Commonwealth.

Also, although there are promising programs in Virginia focused on health care workforce retention and recruitment, there is currently no mechanism for tracking and disseminating these programs. A clearinghouse for tracking and sharing current practices and programs can facilitate dissemination of promising interventions. The newly established Virginia Department of Workforce Development and Advancement will play a key role in supporting workforce data infrastructure across different industries.

Health Care Workforce Retention and Recruitment in Rural Settings

Many of the identified interventions apply to urban, suburban, and rural settings in Virginia. However, there are some unique considerations for health care workforce development in Virginia's rural communities.

- Recruiting of local students from these communities as a retention strategy to bolster rural workforces—rather than convincing providers from elsewhere to move. Such recruitment would be most effective if it is paired with providing up-front financial support for education and life-expenses.
- Developing infrastructure, such as housing, transportation, and child care, in rural areas as both a retention and recruitment tool.

VHWDA should consider convening and leading a coalition of key stakeholders to implement the above recommendations to retain and expand the nursing, primary care, and behavioral health workforces in Virginia. These stakeholders include, but are not limited to, the Virginia legislature, state agencies, health care organizations, and educational entities. Implementation of many of the proposed interventions will require cross-sector, including public-private, collaboration. To ensure effective and efficient implementation of these recommendations, VHWDA should serve as the coordinating center for the coalition to help gather the needed collaborations, data, and funds and to leverage other political and social capital in the Commonwealth.

In closing, Virginia can address these shortages by implementing practical strategies to enhance retention and recruitment, and by changing (or removing) rules, regulations, and policies that degrade efficiency, make it difficult for eager students to enter the workforce, or pull dedicated and experienced nurses, primary care, and behavioral health professionals away from what they do best: caring for patients.

Contents

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Figures, Tables, and Boxes

Figures

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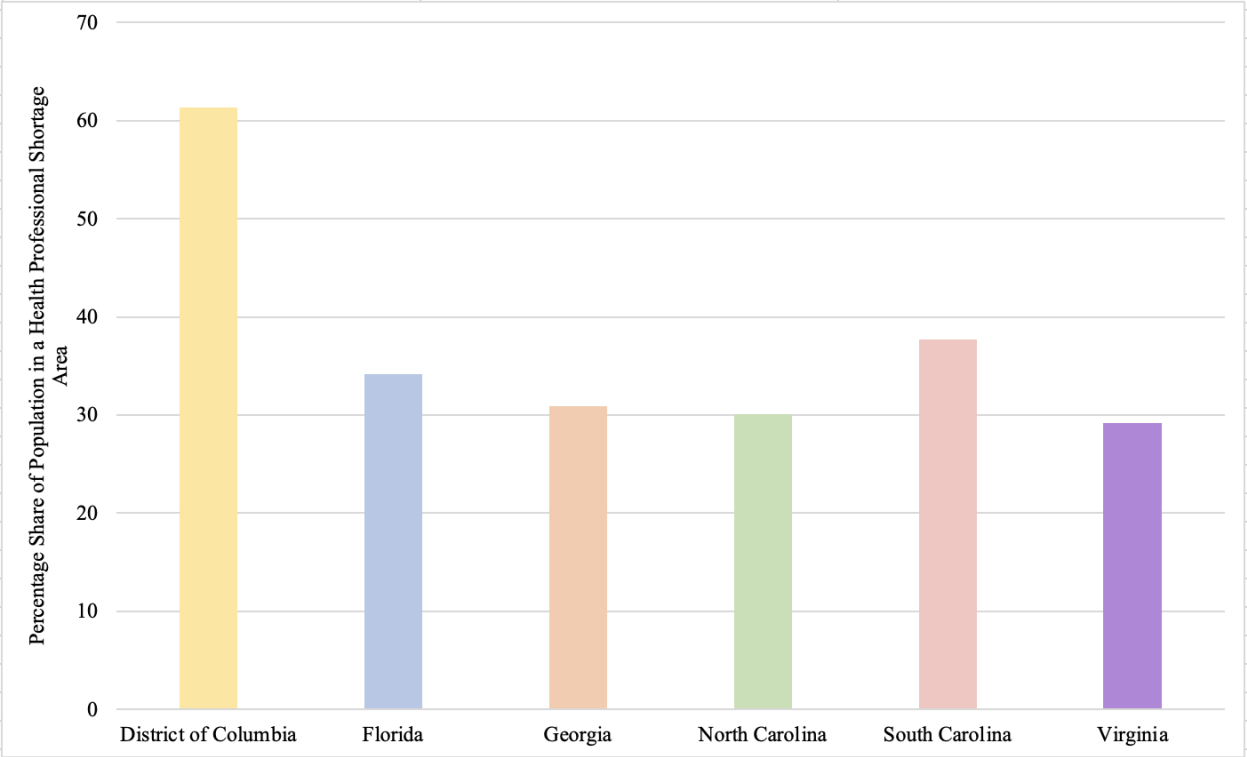
Chapter 1. Background, Objectives, and Approach

Introduction

The United States needs more than 17,000 additional primary care health workers and 8,000 additional behavioral health care workers just to meet current demand (U.S. Department of Health and Human Services, 2023). According to the American Medical Association, the United States will need an additional 17,800 to 48,000 primary care physicians by 2034. By 2030, there will likely be a national nursing shortage of over 63,000 registered nurses (National Center for Health Workforce Analysis, 2022). Behavioral health worker shortages are less severe, in absolute numeric terms, in comparison to those projected for physicians and nurses; however, the U.S. Department of Health and Human Services' Health Resources and Services Agency highlights shortages in psychiatrists and addiction counselors, in particular (Health Resources and Services Administration, 2022). Shortages in the U.S. health care workforce will likely pose an ongoing challenge into the near future (Institute of Medicine, 2011; Zhang et al., 2020; Duquesne University School of Nursing, undated; Mensik, 2023). Rural areas and areas with high proportions of children and aging adults are particularly susceptible to the effects of these shortages (Nguyen et al., 2016; Bennett et al., 2021).

The Commonwealth of Virginia faces a significant shortage of health care workers in nursing, primary care, and behavioral health across a range of settings. For example, 102 of 133 counties and equivalents are federally designated primary care Health Professional Shortage Areas (HPSA), accounting for 29 percent of the Commonwealth's population. Many of these locations are urban and rural areas (U.S. Department of Health and Human Services, 2023). Compared with other mid-Atlantic states and West Virginia (Figure 1.1), Virginia has a smaller percentage share of its population living in a primary care HPSA (Kaiser Family Foundation, undated-b).

Figure 1.1. Percentage Share of Populations Living in a Primary Care Profession Shortage Area, Mid-South Atlantic States Plus West Virginia and the District of Columbia, 2022

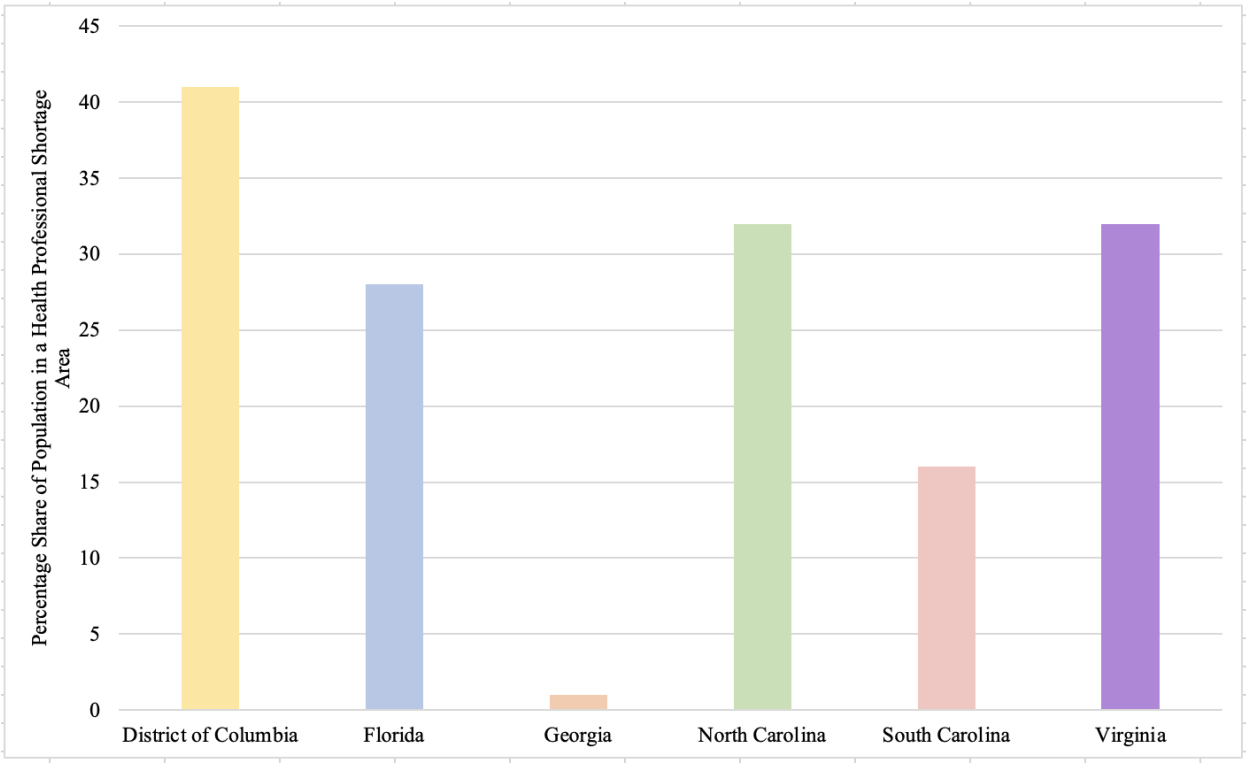


SOURCE: Features data from Kaiser Family Foundation, undated-b.

Similarly, 93 of Virginia's 133 counties (and equivalents) are federally designated mental health care HSPAs, and about 32 percent of Virginians live in these areas (Virginia's Legislative Information System, 2023; Virginia Health Care Foundation, 2022a; Virginia Health Care Foundation, 2022b).

A notably larger share of Virginia's population lives in a mental health care HPSA than in Georgia and South Carolina; the share of Virginia's population living in a mental health care HPSA is comparable to that of Florida and North Carolina; and the share of Virginia's population in a mental health care HPSA is much lower than that of the District of Columbia (Figure 1.2). A similar percentage share of Virginians lives in a mental health care HPSA as in a primary care HPSA (Kaiser Family Foundation, undated-b).

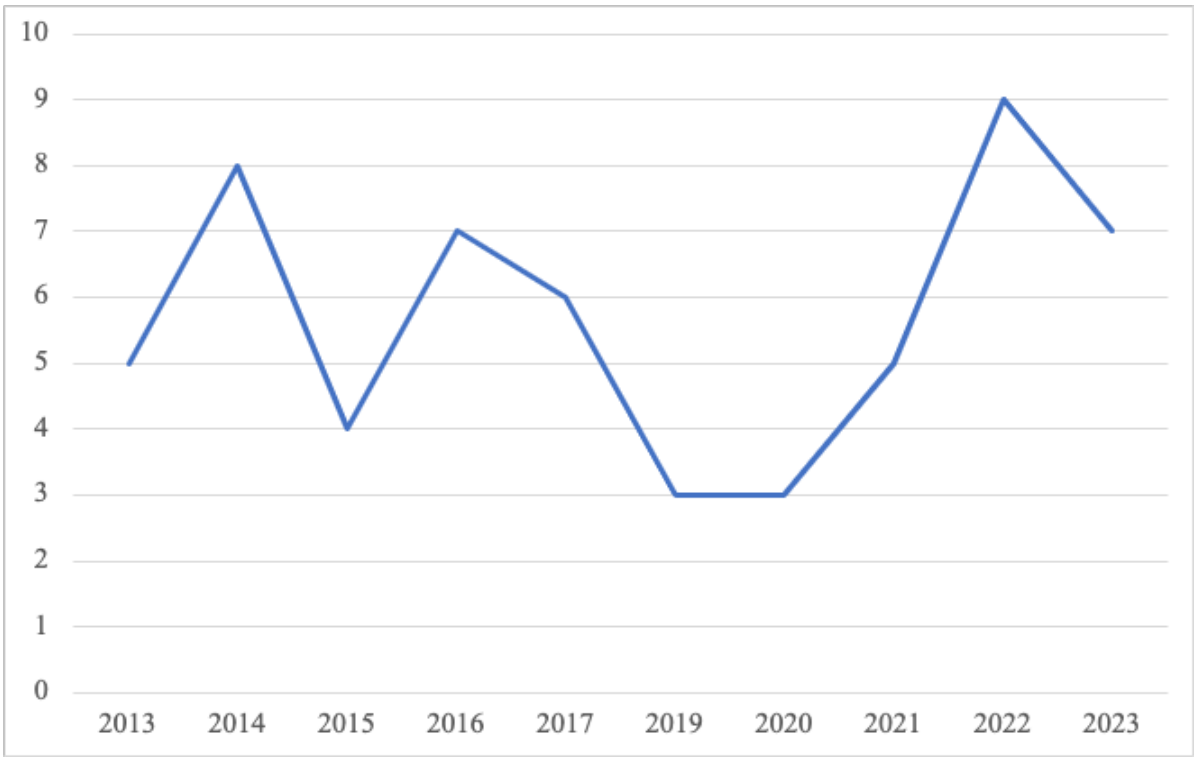
Figure 1.2 Percentage Share of Populations Living in a Mental Health Care Profession Shortage Area, Mid-South Atlantic States Plus West Virginia and the District of Columbia, 2022



SOURCE: Features data from Kaiser Family Foundation, undated-b.

In response to its health care workforce shortage, the Commonwealth of Virginia has passed nearly 60 related bills in the past ten years (Figure 1.3) (BillTrack50, undated), with a notable increase in the number of health care workforce bills in 2022–2023 (National Conference of State Legislatures, 2023). Recent legislation includes interstate compacts for licensing and scope of practice regulations for behavioral health professionals, medical assistance payment for remote patient monitoring, and expanded midwife practice agreements, among others.

Figure 1.3. Number of Bills Passed in Virginia Related to the Health Care Workforce, by Calendar Year



SOURCE: Features data from BillTrack50, undated.

The Virginia budget also included important measures to expand support to the health care workforce, including an increase in the Medicaid reimbursement rate from 70 to 80 percent of the federal rate for primary care services in 2022 (Masters, 2022). This measure was adopted to improve the state's low spending rank in comparison with other Medicaid state programs and to address the concern that Virginia tends to allocate 3 to 5 cents of every dollar spent on health care to primary care, compared with an average of 7 to 8 cents in other states (Masters, 2022).

Other stakeholders, including private foundations, have taken similar steps to address the health care worker shortage through scholarships and other means. For example, Carilion Clinic, a health care system, has initiated a training program in Virginia to support junior nursing staff in registered nurse (RN) training (Carilion Clinic, undated).

Because of the limited evaluation research on existing practices, programs, and policies (hereafter "interventions"), it is unclear whether past and current interventions are likely to succeed in addressing the workforce shortages in Virginia. An evidence-based approach that carefully evaluates interventions across different contexts is needed to identify the most promising interventions to bolster the health care workforce in Virginia.

The objective of this study is to identify interventions that can help the Virginia Health Workforce Development Authority (VHWDA) address primary care, behavioral health, and

nursing workforce challenges and to define the role the authority can play in facilitating such solutions. To accomplish this goal, we apply in this report an analytic framework to existing or potential interventions for retaining, recruiting, and improving the structural efficiency (i.e., the efficient allocation of workers within a given health care system and efficient health care output using technology, policy changes, or other structural adjustments) of the nursing, primary care, and behavioral health workforces in Virginia. We then highlight which interventions VHWDA should prioritize based on its desired outcomes and policy goals.

Overview of Approach

We employed a mixed methods approach that included a review of peer-reviewed and grey literature (i.e., environmental scan) and the analysis of qualitative interview, focus group, and quantitative data. We first identified a broad array of potential interventions in Virginia and beyond, based on the environmental scan, multi-stakeholder conference, interview, focus group, and survey data collection and analysis. Additionally, we reviewed readily available federal data and data collected by other organizations in the Commonwealth to evaluate and project regional and statewide supply of several occupational categories in the nursing, primary care, and behavioral health workforces. We used a systems framework (discussed in greater detail below) to organize our analyses, findings, and recommendations. This framework, a system flows model, is rooted in demography, economics, and systems science and provides a structure for thinking about and understanding the current stock or supply of health care worker output and the ways in which this stock or supply might change over time with new workers entering health care, existing workers leaving health care, or structural changes that affect the health outcomes ("output") per hour worked. Retaining existing workers, recruiting new workers, and increasing structural efficiency are all often cited by analysts as distinct factors critical for helping to ensure that the Commonwealth's health care workforce can meet Virginians' health care needs. For example, when modeling how "better health care" can be delivered in the primary care setting, systems researchers Homer and Hirsch have separately modeled "recruitment" and "increased efficiency" (Homer and Hirsch, 2006).

In the remainder of this chapter, we discuss key definitions used in the research and provide an overview of the health care workforce as a system.

Key Definitions and Scope

Definitions of Key Occupations Evaluated

Primary care refers to health services that emphasize "health promotion, disease prevention, health maintenance, education and rehabilitation" (Starfield, Shi, and Macinko, 2005; van Weel and Kidd, 2018; American Nurses Association, undated). In this report, the primary care workforce includes internal medicine, family medicine, internal medicine, pediatrics, and

obstetrics and gynecology. For the primary care workforce, we include physicians (medical and osteopathic doctors), nurse practitioners (NPs), and physician assistants (PAs).

Behavioral health refers to health services that emphasize the "prevention, diagnosis, and treatment of mental health and substance use disorders, life stressors and crises, and stress-related physical symptoms" (American Medical Association, 2022). In this report, we include psychiatrists, psychologists, counselors, psychiatric nurses, and social workers in defining the behavioral health workforce.

In this report, *nursing* is mainly focused on RNs.

Scope of Analyses and Recommendations

This study's *analyses* focus on both Commonwealth-wide and region-specific insights and interventions. However, the *recommendations* in this study primarily focus on those that confer Commonwealth-wide net benefits. In other words, if an intervention helps one region by moving personnel from another region, we consider this to be a neutral intervention from the state perspective (no net gain of workers), unless that redistribution of labor carries a net statewide efficiency gain, such as instances in which workers can be encouraged to move from areas of more supply (e.g., urban and suburban communities) to areas of less supply (e.g., rural communities).

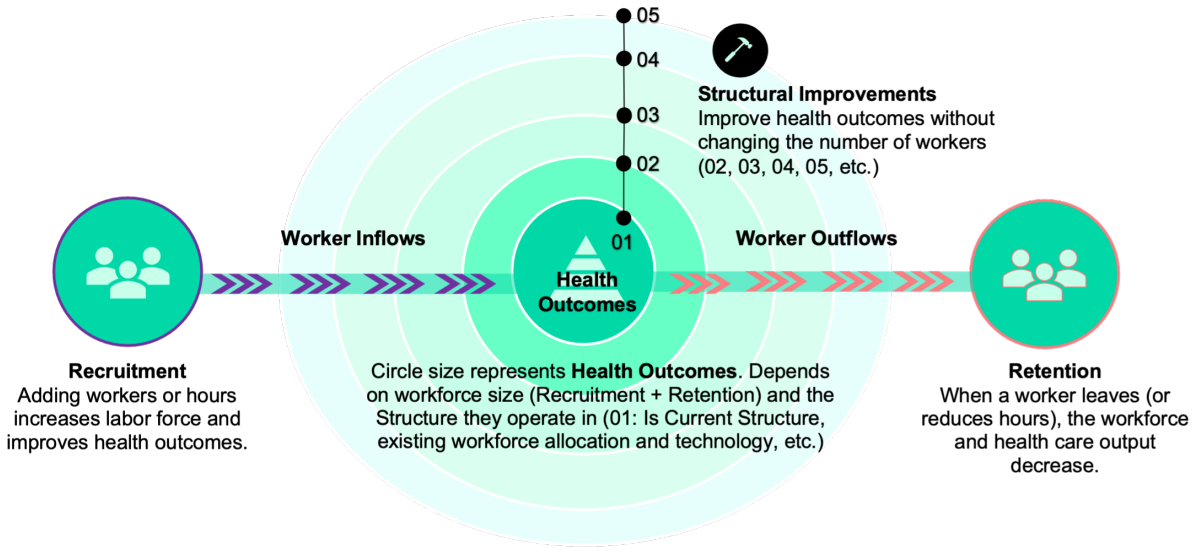
The Health Care Workforce as a System: Supply Outflows, Inflows, and Structural Efficiency

Any workforce, including the health care workforce, can be understood as a dynamic system that evolves over time, depending on key characteristics of the system, such as the number of worker hours in a given occupation group and the structural context (organization, technology, and policies) of that system (Homer and Hirsch, 2006; Rutter et al., 2017; El-Sayed and Galeo, 2017). The structure of a system refers to the existing distribution of occupations and staff, how they work within their organizations' team structures, protocols, and what technology and other infrastructure facilitates their work (Dussault and Dubois, 2003; Yeow and Goh, 2015; Jithitkulchai, 2022). In Figure 1.4, we present a schematic model of the health care workforce system that emphasizes three key dynamics that determine the amount of health care delivered by a given number of workers functioning within the existing structure during a given period of time:

- Worker outflow: the exit of workers from a given health care workforce geography or specialty
- Worker inflow: the inflow or entry of workers into a given health care workforce
- The structural environment that influences worker productivity: structural factors that can increase or decrease the health care outcomes produced by the workforce, even if the number of full-time equivalent (FTE) workers remains the same.

Note that the first two bullets refer to decreases or increases of FTE employees, who are assumed to increase that workforce's health care output when labor is added or to decrease health outcomes when less labor is available. We define worker output as the positive effect the workforce has on improving Virginians' health, not necessarily workers' ability to see more patients.

Figure 1.4. The Health Care Workforce System: How Inflows, Outflows, and Structural Efficiency Relate to Health Outcomes



Describing the health care workforce system in this way elucidates the main challenges policymakers and other stakeholders face:

- **The Retention Challenge:** The more workers who exit a particular workforce geography or specialty (by reducing hours worked, moving out of state, leaving their field of practice, etc.), the larger the reduction in that workforce's health care output.
- **The Recruitment Challenge:** A workforce's inflow mainly originates from newly trained health care workers but also includes workers moving to Virginia from another location or switching from part-time work to full-time work. The larger the inflow of worker FTEs, the larger the workforce's health care output.
- **The Efficiency Challenge:** The third dynamic, structural efficiency, refers to increasing the efficient allocation of workers within a given health care system or increasing their health care output using technology, policy changes, or other structural adjustments. Structural efficiency may be produced when some retention or recruitment challenges are addressed directly through changes to the context of a health care workforce and its structural characteristics.

The number of current worker hours (i.e., the workforce supply) depends on both inflow and outflow of workers in a health care workforce system. Currently, many health care workforce systems face a large number of retiring workers, and too few individuals are in training, either to

replace retiring workers or to serve the growing health care needs of the U.S. population (Gamble, 2021).

The number of needed workers (i.e., workforce demand) partially depends on the structural efficiency of the system in which they operate and also depends on the population's need for health care (i.e., the demand for health care). If new technologies reduce the physical demands of a health care occupation, or if technologies increase efficiency in other ways, fewer individuals could perform the same amount of work. The reduced burden on individuals could also inspire more workers to remain in or enter the health care workforce. For example, technologies to assist in lifting patients can reduce physical strain on personal care aides, potentially allowing some workers to remain in the field longer with fewer injuries or allowing individuals with physical impediments to provide more personal care. Such technologies can allow a given number of workers to produce greater health outcomes—an increase in structural efficiency that allows more "output" per worker.

Many other structural improvements can potentially affect the supply of and demand for health care workers, including improvements in the efficiency of licensing and regulation, improved education and training, and increased financial compensation. The extent to which a community values a workforce (i.e., the "social value" of health care) is also part of the system or structure in which the health care workforce operates.

Methods

Our research was determined to be exempt from oversight by the RAND Corporation Human Subjects Protection Committee. As a first step, we convened a nine-person multi-stakeholder advisory board—including representatives of nursing and labor/workforce and a past Commonwealth health official, among others—who provided input into the study focus, interview and focus group guide, and other aspects of the study.

Environmental Scan

We conducted an environmental scan following methods defined by the Institute of Medicine (2011). We followed six steps: (1) define the research team for the environmental scan, (2) collect user and stakeholder input, (3) identify the topic and research questions in the scan, (4) develop and implement a review protocol (including the study screening and selection process), (5) screen and select studies, and (6) appraise and synthesize selected studies, including evaluating the quality of evidence. We reviewed peer-reviewed and grey literature related to strategies for health care workforce retention and recruitment. for the years 2013–2023. The environmental scan search strategy, search terms, and other methodological details are included in Appendix B.

Multi-Stakeholder Conference

In collaboration with the VHWDA, we held an in-person, two-hour, multi-stakeholder conference in Richmond, Virginia, on June 9, 2023. The conference was attended by over 40 invited attendees, including nursing, primary care, and behavioral health providers; administrators; educators; current and past Commonwealth health officials; and other key stakeholders. The conference included five PowerPoint presentations in which we shared preliminary findings from the study, including promising interventions for health care workforce retention and recruitment. Each 10-to-15-minute presentation was followed by up to 10 minutes of question-and-answer (Q&A). We recorded the Q&A sessions and prepared transcriptions based on the recordings. We analyzed the Q&A session data using rapid qualitative analysis techniques (Watkins, 2017), identifying challenges and potential strategies for health care workforce retention and recruitment in the Commonwealth.

Interviews and Focus Groups

We conducted and analyzed data from 15 interviews and group discussions that involved a total of 34 individuals, including Virginia nursing, primary care, and behavioral health practitioners; educators; labor experts; and other key stakeholders. Interviews included between one and three people, and focus groups included between four and ten people. One focus group was dedicated to nursing workforce development, one to behavioral health, and one to workforce development in Virginia rural settings. We developed one guide for both interviews and focus groups, which was informed by the results of the study environmental scan, experts on our research team, and the study's advisory board (Appendix C). We used snowball sampling to identify and recruit participants with practical experience and/or expertise in health care labor, administration, and education for these discussions. Some of the interviewees also attended the June 9, 2023, multi-stakeholder conference. All sessions were conducted remotely over the Microsoft Teams platform. Interviews spanned about an hour, and focus groups between one and two hours. All sessions were recorded and transcribed for analysis. We used rapid qualitative analysis techniques (Watkins, 2017) to analyze the transcriptions and generate themes and subthemes based on topics represented in the interview/focus group guide.

Survey

Between July and August 2023, we fielded an electronic survey to 20 hospitals in the Commonwealth over a four-week period, with assistance from the Virginia Hospital and Healthcare Association. The survey included two questions (Appendix D): one regarding strategies hospitals use to retain nurses and another focused on use of technology, or other practices, to support flexible nurse staffing models.

Quantitative Analyses

Utilizing data from multiple sources (refer to Appendixes E, F, G, and H), we constructed a system dynamics economic model to assess the shortages of nurses, primary care practitioners, and behavioral health providers in Virginia at both statewide and regional levels. The model employs a set of differential equations that are numerically integrated to track the dynamics of supply, demand, wages, and the impacts of perceived barriers on health care workforce engagement. The model assumes that wages adjust slowly to changes in labor market conditions and incorporates the interaction between work reluctance (because of fatigue, distress, and disengagement) and wage (compensating wage differential theory) to address the necessity of raising wages in response to heightened perceived barriers, ensuring a sustained supply. Our model is designed to help Virginia policymakers better understand the relative scale of the workforce shortfall by region and by job category over the next five, ten, and 15 years. In addition to illustrating the current and future scale of the workforce shortfalls, we model the extent to which various interventions can contribute to reducing these shortfalls. These analyses can provide insight into the relative importance of different categories of interventions (e.g., wage effects on supply compared with recruitment effects on supply).

Additionally, we analyzed available surveys of health care sector students and workers, labor data, and student loan repayment data (see Appendix A) to better understand the economic and demographic context of Virginia's workforce challenges.

Organization of this Report

The remainder of this report consists of three chapters. In Chapter 2, we present key findings from the environmental scan, multi-stakeholder conference, interviews and focus groups, and quantitative analyses. We start by outlining health care workforce development challenges and potential solution levers for nursing, primary care, and behavioral health. Then we list and discuss specific interventions for retention, recruitment, and increasing structural efficiency. In Chapter 3, we offer recommendations by strength of evidence, and in Chapter 4 we outline an implementation strategy for the recommendations. We provide details on our methods and analysis in Appendixes A–H, which are contained in a separate annex, available at www.rand.org/t/RRA2093-1.

Chapter 2. Key Findings

Overall, Virginia has a robust menu of existing interventions designed to improve retention, recruitment, and structural efficiency in the health care workforce. Current interventions include student loan forgiveness, expanded scope of practice, license transfer, more flexible practice models (e.g., increasing the types of medical professionals who can supervise practice of midwives), more flexible clinical training models (increasing the number of students a preceptor/licensed supervisor can supervise) (BillTrack50, 2021), early health care training and career development (e.g., secondary school scholarships and support for students interested in health care professions such as the Claude Moore Behavioral Health Scholars; Claude Moore Charitable Foundation, 2023), and higher Medicaid reimbursement rates. Additionally, the newly established Department of Workforce Development and Advancement will serve as a coordinating body for workforce support across different industries in the Commonwealth. However, attendees of the study's June 9, 2023, conference indicated that, while many innovative health care workforce development interventions are being implemented in the Commonwealth, they are not disseminated effectively.

Virginia is also beginning to implement or propose new ways to support health care workforce retention, recruitment, and structural efficiencies. These include expanded student loan forgiveness, use of primary care technicians and associate physicians, increased license transfer, and a nursing apprenticeship. These efforts involve significant investments in the Commonwealth's broadband infrastructure based on the Infrastructure Investment and Jobs Act Fund (Virginia Department of Housing and Community Development, 2023). Such investments can support telehealth, helping the roughly one-third of Virginians living in HPSAs to access medical care in other areas of the Commonwealth and, if need be, beyond Virginia.

In the context of Virginia's ongoing efforts to address health care workforce shortages, we summarize findings from our mixed methods analysis in this chapter, including a description of challenges regarding nursing, primary care, and behavioral health workforce. We also discuss interventions that the Virginia legislature, state agencies, health care organizations, educational entities, VHWDA, and other key stakeholders in Virginia might consider implementing in the near term to enhance retention, recruitment, and structural efficiency in these fields. The list of interventions below is not exhaustive—there are others that Virginia could consider to address health care workforce shortages—but we focus on those that are most pertinent to retention, recruitment, and structural efficiency.

Importantly, the discussion below includes interventions whose effectiveness has not been previously evaluated using rigorous methods and relevant workforce outcome metrics. Conducting such evaluations would provide the evidence necessary to assist the Commonwealth

in planning and implementing targeted and cost-effective strategies for strengthening its health care workforce (Harvard Catalyst, undated).

Retention interventions mainly aim to enhance the number, composition, and career duration of licensed professionals working in a given health care occupation. **Recruitment interventions** focus on enhancing the number and/or composition of individuals who enter into and complete education and training for a given health care occupation prior to practicing as a (licensed) professional in that occupation. **Interventions focused on structural efficiency**—that is, the efficient allocation and use of resources (Jithitkulchai, 2022)—attempt to fully leverage the existing workforce pool through use of technology (e.g., telehealth) (Yeow and Goh, 2015), geographic redistribution of the workforce, or other changes (Dussault and Dubois, 2003) to the structural context in which workers operate.

Health Care Workforce Development Challenges and Solution Levers

Stakeholders representing Commonwealth nursing, primary care, and behavioral health workforces described many challenges to retaining, recruiting, and enhancing structural efficiency of the health care workforce. In addition to the challenges outlined below, nursing, primary care, and behavioral health in Virginia's rural communities face very specific retention and recruitment challenges because of insufficient infrastructure, including housing, transportation, and child care services. Detailed data and analyses on employment, wages, and other statistics—including quantitative forecasts based on those data—provide additional context for understanding workforce challenges in these fields. Identified challenges for retention and for recruitment that underlie workforce shortages are summarized, respectively, in Tables 2.1 and 2.2. Additional details and supporting data are then presented for nursing, primary care, and behavioral health challenges.

Table 2.1. Identified Retention Challenges in Nursing, Primary Care, and Behavioral Health in Virginia

Challenges	Nursing	Primary Care	Behavioral Health
Regulations and documentation			
Insurance documentation and billing		✓	✓
Provider licensing and documentation	✓	✓	✓
Care documentation (e.g., electronic health record)	✓	✓	✓
Provider licensing fees	✓		✓
Regulation and documentation of care site		✓	
Public health insurance reimbursement		✓	✓
Compensation			
Compensation differentials, providers	✓	✓	
Business costs of a practice		✓	
Wage/salary compensation	✓	✓	✓
Insurance benefits	✓		
Other benefits (e.g., flexible scheduling, housing)	✓	✓	✓
Workload			
Patient throughput rates	✓		
Overall patient acuity	✓		
Patient-provider ratios	✓	✓	✓
Work-life balance	✓	✓	✓
Burnout	✓	✓	✓
Workplace setting			
Violence	✓		
Insufficient supplies	✓		
Provider turnover	✓	✓	✓
Retirements, early and overall	✓		✓

SOURCE: Multidisciplinary conference, interview, and focus group data for Virginia stakeholders, RAND Corporation, July–August 2023.

Table 2.2. Identified Recruitment Challenges in Nursing, Primary Care, and Behavioral Health in Virginia

Challenges	Nursing	Primary Care	Behavioral Health
Training			
Insufficient clinical placements	✓	✓	✓
Insufficient number of educators, nonclinical	✓		✓
Insufficient number of educators, clinical	✓	✓	✓
Insufficient number of preceptors/licensed supervisors	✓		✓
Cumbersome and rigid education requirements			✓
Compensation differentials, educators	✓		✓
Lack of career pathways	✓	✓	✓
Time to initial certification			✓
Public perceptions and opinions			
Poor public image of work in health care	✓		✓
Public awareness of financial assistance	✓		✓
Public awareness of health care careers		✓	✓
Financial aid			
Costs of education, initial	✓	✓	✓
Available financial assistance, initial education	✓		✓
Expensive licensing fees, initial	✓		✓
Costs of clinical supervision			✓

SOURCE: Multidisciplinary conference, interview and focus group data for Virginia stakeholders, RAND Corporation, July–August 2023.

Nursing Challenges and Solution Levers

Analysis of a variety of data sources confirms that Virginia will continue to face a shortage of RNs even as the number of active RNs working in the Commonwealth continues to climb. According to National Nursing Workforce Surveys (2017, 2020, 2022), the number of active RNs working in Virginia has steadily increased in each year since at least 2017. Their data indicate that the number of RNs active in the Commonwealth rose by almost 1 percent per year from 2017 to 2020, and then rose at more than twice that rate from 2020 to 2022 (at a 2.3 percent annual rate of increase). Despite this rate of increase, Nursing Solutions Inc. (NSI) Retention & RN Staffing Reports indicate that nationwide vacancy rates for RN positions continued to increase, suggesting that demand for RNs is rising even faster than the available RN workforce is growing. The 2019 NSI report showed an RN vacancy rate of 8 percent, which rose to 9.9 percent by 2020 and to 15.7 percent in 2022. These most recent vacancy statistics partially

reflect a spike in demand for RNs caused by COVID-19, but they also reflect an increasing nurse attrition. A September 2022 McKinsey Frontline Workforce Survey showed that 31 percent of surveyed nurses indicated they intend to leave their current direct care positions within the next year, implying a continuing retention crisis.

Looking beyond 2022, our model forecasts nurse employment in Virginia to shed light on whether this nursing labor shortage will worsen and the degree to which various interventions might help. (See Appendixes E and F for more information about the model, including the data and assumptions used to build the model and its scenarios.) As illustrated in Figure 2.1, if current trends continue (the baseline scenario), the Commonwealth may continue to add nurses to the workforce (Figure 2.1) but at a rate that may prove insufficient to meet demand for nursing labor (Figure 2.2).

Both figures also display how our forecasts change if ambitious interventions related to wages, recruitment, and the work environment are implemented. Each intervention represents improvements that we assessed to be ambitious, but possible:

- **Reduced barriers:** In the baseline scenario, we modeled three barriers to retention and recruitment: fatigue, distress, and disengagement as a single parameter named *work reluctance*. In this scenario, we assume that each of these three barriers is cut in half (during the first year and continues at that level for all subsequent years), which results in more retention and more recruitment mostly accomplished early in the simulated period.
- **Increased recruitment rate:** In this scenario, we assume that the rate of recruitment rises from the 2,000 FTE nurses per year (baseline) to 2,500 FTE nurses per year, a 25 percent increase compared with the baseline.
- **Elevated wage growth rate:** Here we assume that average real wages rise for nurses in Virginia by 3 percent per year instead of 2 percent per year (baseline), which results in more retention and more recruitment.
- The **multi-intervention** scenario combines all three of the above interventions.

Figure 2.1. Full-Time Equivalent Nurses Employed in Virginia 2023–2038 Median Forecast in Five Scenarios

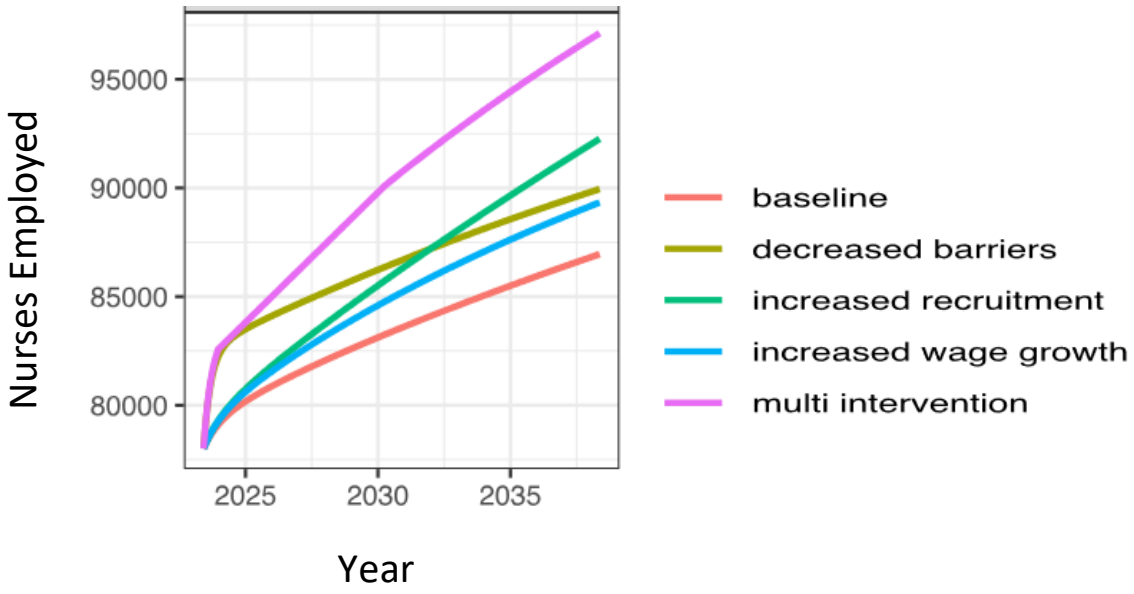


Figure 2.1 suggests that the number of nurses entering the Virginia health care workforce will continue to grow even under current conditions, and that ambitious interventions could speed up this increase in nurses employed in the Commonwealth. We forecast that a 50 percent reduction of the barriers that cause reluctance to work in the field of nursing will result in a rapid increase in the number of nurses employed, mainly because of the positive effects on retention. However, over a period of 15 years, increased recruitment has a more dramatic effect on workforce numbers, surpassing the effect of decreased barriers. Increasing nurse wage growth from an average of 2 percent annual growth to 3 percent annual growth also increases the number of nurses retained and recruited, but not as much as the other interventions do. As expected, a combination of all three interventions has the largest effect on the forecast of nurse employment, boosting the total number of FTE nurses employed in 2038 by a little more than 10,000 above the baseline projection.

Figure 2.2. Gap Between Employment and Demand for Nurses Employed in Virginia 2023–2038 Median Forecast in Five Scenarios

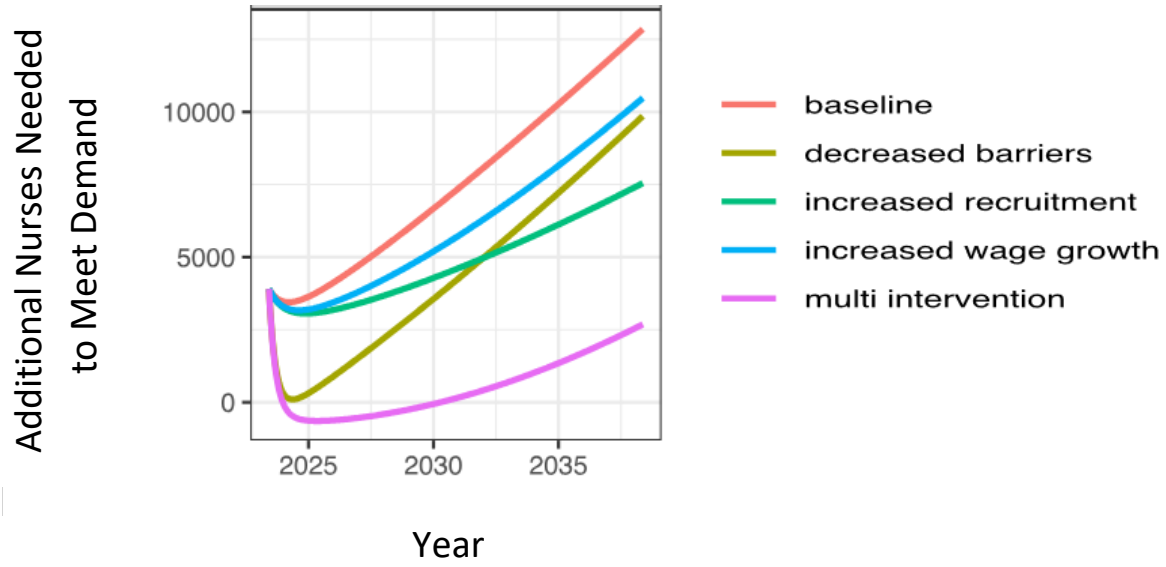


Figure 2.2 suggests that, even if Virginia aggressively intervenes to boost the number of nurses employed in the Commonwealth, the current shortfall of nurses (the gap between employment and demand for nurses) is likely to persist in the coming 15 years. If current "baseline" trends continue, the shortfall will continue to expand, but it will expand more slowly if any one of the interventions we have modeled is aggressively implemented. The model suggests that if all three interventions are implemented (the multi-intervention scenario), the nursing workforce shortfall can be entirely eliminated, at least through 2030, at which time even more aggressive recruitment, wage growth, or reduction of barriers would need to be implemented for supply to match demand.

Our interviews and focus groups with nurses and other health care professionals confirm that Virginia is experiencing a shortage of nurses, which places additional pressures on the existing workforce in nursing and beyond. Various challenges appear to drive Virginia's nurse workforce shortage. During and in the aftermath of the pandemic, many nurses left the bedside because of stressful experiences and burnout. As one practicing nurse remarked, "Nurses survived some awful stuff." Older nurses in the Commonwealth retired early during the pandemic, costing the profession many experienced hands that might have helped guide newer nurses with more limited experience. This follows a national trend (Weston, 2022). As one practicing nurse indicated, "When I was a newbie nurse there were a lot of people looking out for me. The younger nurses have no one looking out for them. They don't know what they don't know."

Multiple interviewees cited high patient-to-nurse ratios as a major challenge for retention. Many indicated that, because patient-to-nurse ratios typically do not consider patient acuity (i.e.,

how sick a patient is) or the level of experience and expertise of the nurse, patient-to-nurse ratios are a "farce" as a tool to determine nurse staff workload.

Participants cited both high patient-to-nurse ratios and high documentation burdens as contributing to nurse burnout. Interviewees said that the documentation requirements take nurses away from the bedside and patient interaction—the reasons many people go into nursing—with nurses spending "70 to 80 percent of their shift in front of the screen."

Fewer experienced nurses in the face of early retirements or other nursing workforce exits (overall and in acute care settings like emergency departments and hospitals), high patient-to-nurse ratios, and high documentation requirements all contribute to burnout. Burnout was cited as "the number one driver" for staff leaving. As one participant put it,

> What [nurses] soon discover is that they are entering an overburdened, heavily compressed profession where being perpetually short-staffed means juggling unsafe nurse/patient ratios while maintaining safety expectations.
>
> *—Nursing representative*

The likelihood of burnout only increases in a work context characterized by a rise in throughput and patient acuity. Some of the strategies that hospitals use to deal with these challenges raised concerns among nursing stakeholders. One practicing nurse shared an example of her hospital directing floor nurses to take care of critically ill patients in intensive care units even though the nurses did not have the expertise or experience to care for such patients. The pandemic also revealed significant pay differences in nursing, leading nurses to take positions with higher pay. Although nursing stakeholders noted that "you can't just throw money at the problem," nurses need supplies, equipment, and training to do their jobs well. Nursing stakeholders expressed frustration that newly hired nurses with many fewer years of experience were getting paid much more than more experienced nurses. In reference to traveling nurses, one participant expressed that the "traveling nurse has been renumerated at unsustainable levels." Hospitals have been forced to adopt an unsustainable model of hiring more expensive travel nurses to ease staffing shortages caused by the pandemic (Coombs, 2023; Lucas, 2022). Recently, travel nurse salaries are trending toward a decrease, but they are still generally higher than the average salaries of registered nurses (Kusterbeck, 2022). The growing gap in salary between travel and staff nurses has led to frustrations, increased turnover, and exacerbated shortages (Coombs, 2023; Lucas, 2022).

Two interviewees indicated that health insurance coverage for nurses has become more restrictive and expensive. A nurse stakeholder reported that

> A for-profit hospital chain with a large footprint in Virginia modified its health insurance plan to require employees to cover 20 percent to 40 percent of their in-network health care expenses on top of their co-pays. Hourly wages can be

> increased, and bonuses can be doled out, but it doesn't take long for staff to realize that their earning power is lessening.
>
> *—Nurse representative*

The rise in workplace violence—especially since the start of the COVID-19 pandemic, with many people having a "shorter fuse"—was also cited as a major barrier to retention. This sentiment is shared by nurses more generally, with significant consequences for retention (Lin et al., 2023). The following comment by a nurse stakeholder captures the sentiments expressed by a number of interviewees:

> As an ER [emergency room] nurse, I was punched, slapped, bit, kicked, spit on, thrown into a wall hard enough to crack the sheetrock, had urine, blood, and feces thrown at me, and confronted multiple knives and guns. With every one of these situations, although hospital leadership preached a zero-tolerance policy to workplace violence, I was discouraged from reporting (a common practice, per nursing organizations and social media posts). Nursing retention is difficult if the threat of physical harm is present every day.
>
> *—Nurse representative*

The "bad public image" that nursing and other health care professions gained during the pandemic—given the public discourse around the stresses and burnout related to the work—does not help with recruitment efforts.

The nursing education and training pipelines also pose significant challenges to recruitment. There are not enough clinical placements for nursing students—largely because of the limited number of preceptors—and some clinical instructors have limited experience. Furthermore, there is a lot of emphasis on simulation in education and training and not enough in-person time in the clinical setting. As an expert in labor issues in the Commonwealth put it:

> [There is a] shortage of faculty preceptors to train nurses in the classroom. It is not a paid opportunity, so to get people to volunteer is challenging. This is a huge break in the system because we cannot get people to licensing because there is nobody to supervise them, leading to staff shortage and burnout.
>
> *—Labor representative*

Nursing stakeholder interviewees expressed that some nursing schools have to turn away "thousands of qualified and eligible applicants" because of shortages in nurse faculty and/or space in clinical facilities. They also said that other faculty (for example, engineering and business school faculty) get paid "way more" than nursing faculty, making preceptorship "not a particularly enticing career opportunity." On the other hand, some interviewees said that more consistent messaging on how one can become a successful nursing health care worker (and how to access related educational funds) is needed in the Commonwealth. This suggests that such efforts may currently vary across regions.

Primary Care Challenges and Solution Levers

Greater supply availability of primary care has been associated with multiple benefits, including better health outcomes, lower mortality, reduced disparities, and lower health care costs (Basu et al, 2019; Shi, 2012), and while research supports increasing the supply of primary care physicians, it may be necessary to pair this investment with other interventions, such as payment reforms for physicians and reduced administrative burden (Song and Gondi, 2021). As with nursing, national data from HRSA provided in Chapter 1 (Figures 1.1 and 1.2) confirm that Virginia struggles to employ a sufficient number of primary care physicians (medical and osteopathic doctors), NPs, and PAs to meet demand. Based on our study's Virginia-specific simulations, which evaluated primary care workforce projections under different intervention scenarios, Virginia will likely continue to face primary care workforce shortages in the coming years. Unlike our forecasts for RNs, our forecast for the number of active primary care workers in the Commonwealth shows a decline (Figure 2.3) under baseline conditions, making the future shortfall (Figure 2.4) in primary care workers even more severe than for nursing alone. Similar to our model for nursing, the largest immediate boost to the workforce would come from cutting in half the barriers that make workers reluctant to work in the field. Over the course of 15 years, the effect on total employment of increasing wage growth catches up to the effect of decreasing barriers. The effect of increasing recruitment is more modest because baseline recruitment begins at very modest levels, and the lag time for recruitment is greater in primary care than it is for nursing, given longer related education and training times for primary care. An ambitious combination of all three interventions (the multi-intervention scenario) would boost total employment by more than 2,000 workers.

Figure 2.3. Full-Time Equivalent Primary Care Workers Employed in Virginia 2023–2038 Median Forecast in Five Scenarios

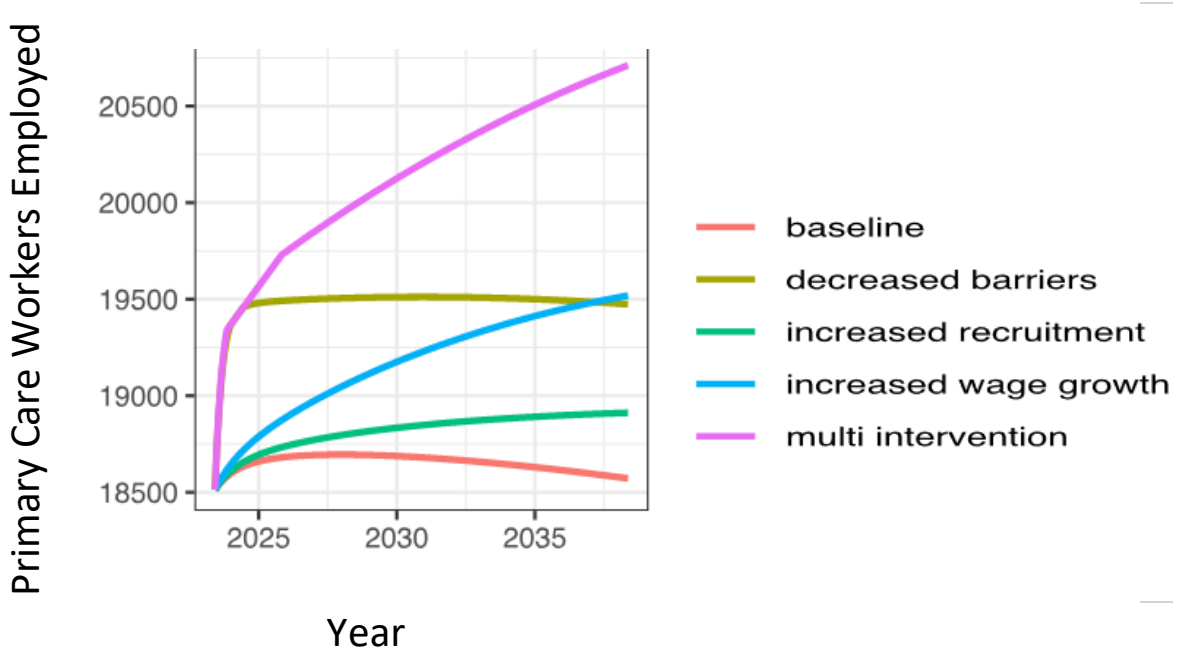
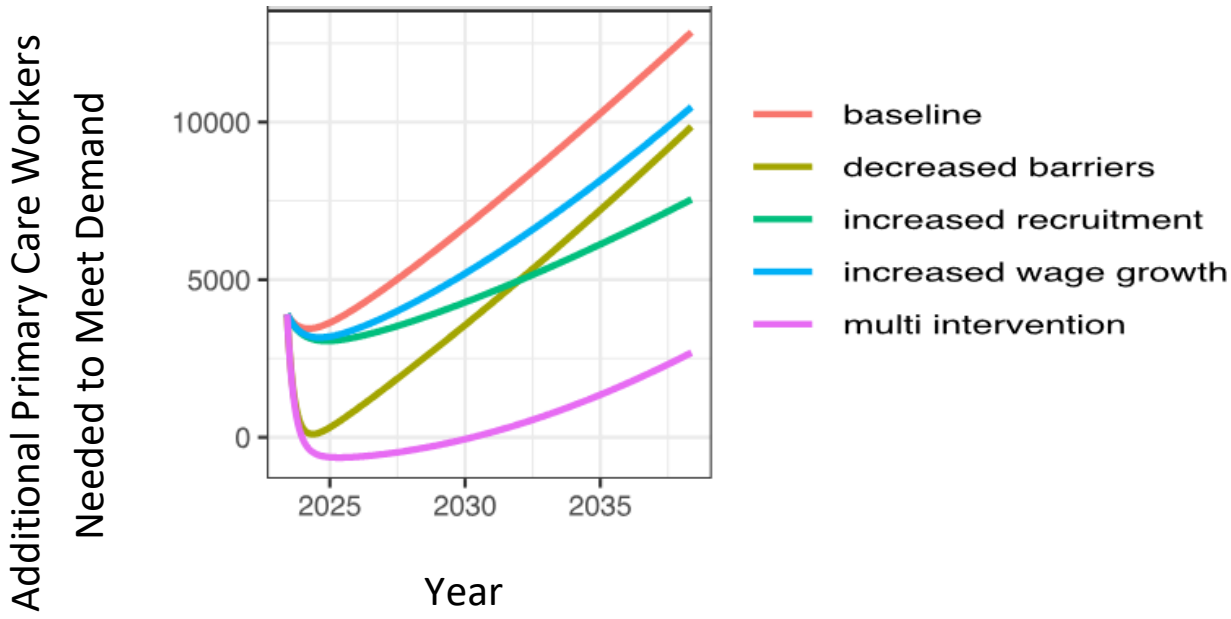


Figure 2.4. Gap Between Employment and Demand for Primary Care Workers in Virginia, 2023–2038 Median Forecast in Five Scenarios



Interviewees indicated that, since the pandemic, many health care workers have left the (aging) primary care workforce because of being overworked in already understaffed health care delivery settings. They also mentioned that the lower the pay for a primary care provider, the

easier it is to leave for a less demanding health care setting, another career, or caring for their children, for example. Importantly, simulations of the supply of available primary care providers in Virginia indicate that increased compensation is more important for increasing the number of available primary care workers (relative to other individual simulations) than it is for increasing the overall number of available RNs.

Other key issues raised by stakeholders were pay parity and cost inflation. One participant noted the disparity in pay between male and female providers as a barrier to retention. Richmond, Virginia, was recently identified as one of the ten cities where female physicians earn the least annual compensation (Doximity, 2023). Similarly, Virginia Beach ranked as having one of the lowest average annual salaries for female physicians (Doximity, 2020). Nationally, gender pay differences for physicians may be declining—especially in primary care (Kane, 2023). However, large gender pay differences remain, as do other gender differences related to work-life balance and other complex factors (Lo Sasso et al., 2020). Another cited barrier to retention was provider expectation for pay, which often outpaces employer organization revenue, especially for smaller health care organizations.

Interviewees raised concerns about the underfunding of Medicaid programs (Cover Virginia, undated; Kaiser Family Foundation, undated-a) for all providers in Virginia in spite of "well over a million" residents being on Medicaid. This is in spite of a recent increase in Virginia Medicaid reimbursement rates (Masters, 2023). Interviewees also said that Medicare, Medicaid, and private insurance are difficult to bill—so more and more physicians are opting for a sliding scale model or going into concierge practice, "impacting how many providers are in play." We also heard from participants that the shortage of PAs and NPs leads to increasing patient-to-provider ratios (i.e., larger patient panels per provider).

Participants said that public primary care clinics have additional regulatory requirements that create more retention challenges. As one interviewee explained,

> There is a lot of regulation and red tape that involves not enough people doing it, not enough pay, and it becomes a cumbersome process to get reimbursed. The pay disparity between public and private entities was also noted as a major issue contributing to high provider vacancy rates in public settings.
>
> —*Community health representative*

Interviewees indicated that lack of preceptorship/licensed supervisor capacity contributes to retention and recruitment challenges. As one interviewee put it,

> Before things became primarily revenue driven, it was a privilege to coach and mentor students. There has been a shift from the stress and burnout in health care. The pressure is on to do more visits, generate revenue. No one has time for mentoring or preceptorships, or they are exhausted.
>
> —*Community health representative*

Primary care stakeholders raised concerns over the high cost of education and low return on investment when entering the field. This was cited as one cause of not having enough people

entering the field. Low compensation in primary care compared with medical specialty and surgical fields was also cited as a recruitment challenge.

Stakeholders said that another root cause of people not pursuing primary care is lack of awareness of primary care professions in communities and particularly in schools. Participants noted that this is a missed opportunity. Primary care stakeholders also noted that the departure of providers from the field has reduced the supply of practitioners. As one primary care provider and educator noted, "People are leaving at an increased rate and not enough people to backfill." One primary care provider/educator also noted, "We don't have nurses and physicians in settings where they are most needed."

Interviewees cited a lack of career pathways as a barrier to recruitment of younger personnel:

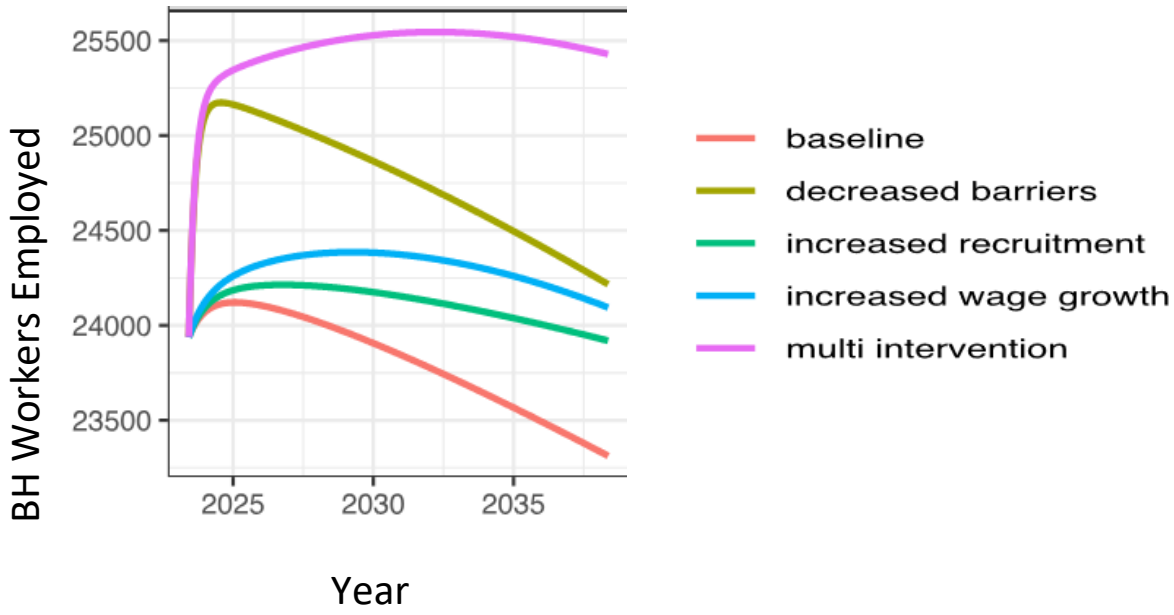
> The younger generation wants to know what the [health care career] trajectory extends to five to ten years from now; Gen Z is definitely asking these questions.
>
> —*Labor representative*

One of the biggest barriers noted was the lack of an equitable pipeline.

Behavioral Health Challenges and Solution Levers

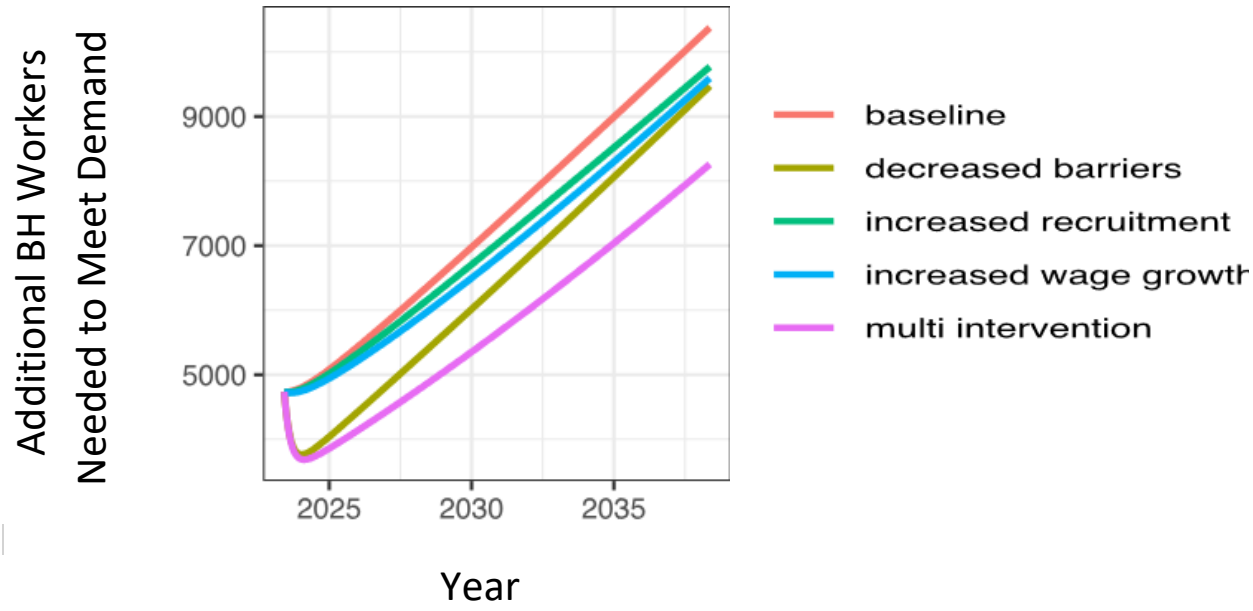
Virginia health care faces similar challenges in employing a sufficient number of behavioral health workers to meet rising demand. If current conditions persist (the baseline scenario), the number of behavioral health workers employed in Virginia is forecast to slowly decline in the coming years. Implementing any one of the three interventions promises to keep the existing workforce numbers at 2023 levels, but only by combining all three interventions can Virginia produce a sustainable increase in behavioral health workers employed, as illustrated in Figure 2.5.

Figure 2.5 Full-Time Equivalent Behavioral Health Workers Employed in Virginia, 2023–2038 Median Forecast in Five Scenarios



Because demand for behavioral health care is rising, all of our forecasts indicate an increasing shortfall of behavioral health workers during the next 15 years (Landi, 2023). Figure 2.6 shows that each intervention produces similar modest improvements, and the combination of all three interventions still leads to a widening gap between employment and demand for behavioral health workers.

Figure 2.6 Gap Between Employment and Demand for Behavioral Health Workers in Virginia, 2023–2038 Median Forecast in Five Scenarios



Interview and focus group participants also reported that there is a significant shortage of behavioral health providers, including psychiatrists, psychologists, social workers, and counselors, making it difficult to meet Virginia's demand for behavioral health services. They indicated that a large percentage of behavioral health providers are at retirement age and attributed some of this shortage to the high cost of graduate degrees in mental health professions and the need to take out significant loans to afford these programs. Furthermore, participants indicated that the lack of funding and limited financial support for students pursuing mental health degrees can deter potential professionals from entering the field.

Interviewees also noted that the compensation and reimbursement rates for behavioral health services may not be sufficient to attract and retain qualified professionals, leading to a higher turnover rate and understaffed facilities. The administrative and regulatory burdens faced by behavioral health professionals—including "excessive" paperwork and documentation—were noted by participants as a barrier to retention. Also, secondary trauma and burnout among the behavioral health workers because of the nature of the work was also noted as one of the causes of high turnover in the field by interviewees. One interviewee noted that "mental health deserts" are leading to delayed care and sicker patients, inflicting "moral injury" to providers who practice in those settings.

Behavioral health stakeholders indicated that there are not enough faculty in behavioral health because they do not get paid enough. They also noted that the revenue-generating requirements of existing faculty in larger institutions create problems because faculty cannot generate sufficient revenue while overseeing students and trainees. The limited number of

psychiatry residency slots was also cited as a barrier. One behavioral health stakeholder put it this way:

> The national bodies only give you certain slots. The general assembly got focused on child psychiatry and ten more seats opened up for residencies. But it is piecemeal. It is not a silver bullet. . . . Paying for more slots is helpful, but getting national boards to allow more slots is important.
>
> *—Behavioral health stakeholder*

Behavioral health stakeholders also identified overregulation of education and training as another significant barrier to recruitment. For example, at the bachelor of science education level, faculty have to be masters-prepared or ask for a temporary exception.

Participants said that stigma surrounding mental health also serves as a barrier to recruitment. They noted that this stigma not only affects the willingness of individuals to seek care but also affects the desire of certain communities, particularly communities of color, to pursue careers in behavioral health. One participant expressed that, in community settings, experiences should not be limited by ratios, as these are important opportunities for student learning. They also noted that there is a requirement of a minimum of 500 practice hours but that some people will reach competency at fewer hours and some will need more hours to reach competency.

Interviewees highlighted challenges related to regulations around becoming a licensed clinical social worker, noting that "there are a lot of hoops to jump through." One interviewee said,

> For people who want to become LCSWs [licensed clinical social workers] and licensed professional counselors, they are thwarted by paying for the required supervision on their own that they have to go through to get a license. . . . A lot of people who want to become therapists and are motivated, and have the aptitude, cannot run that financial gauntlet while we have a mental health crisis.
>
> *—Behavioral health stakeholder*

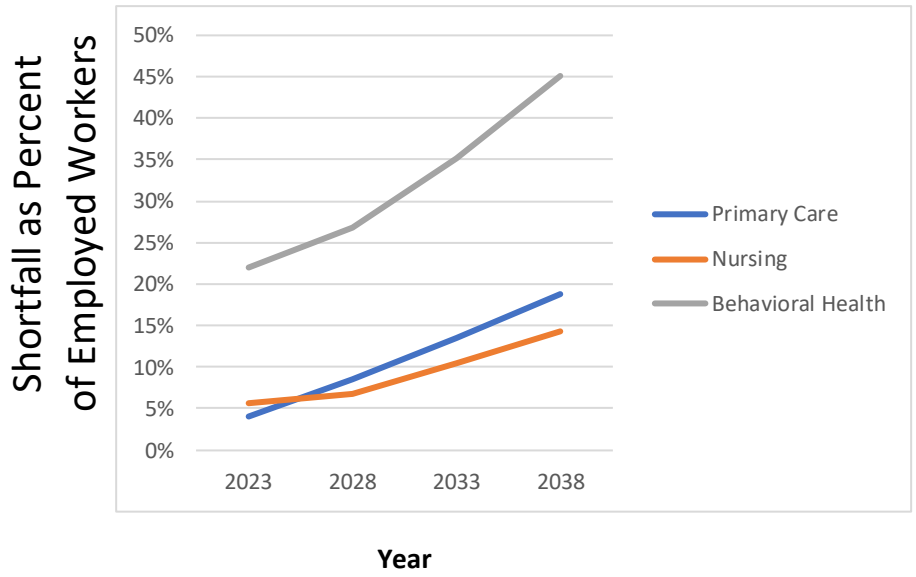
Social workers need to complete a significant portion of clinical hours before they can take the licensing exam. If an examinee fails, they will have to wait 90 days before they can retake the test. Any clinical work until that time involves paid supervision. One interviewee indicated that "some work multiple jobs to pay for supervision which is a big financial and mental health burden."

Participants also noted that the licensing process for behavioral health professions is very cumbersome and very expensive. By the time many graduate from their program, they may still need a few thousand hours of supervised work, for which they have to pay out of pocket. Furthermore, interviewees noted that the time it takes from licensure application submission to getting licensed is unreasonably long. Interviewees also noted the importance of loan forgiveness for retention and recruitment but expressed that many people are not aware of behavioral health loan forgiveness programs (Guan et al., 2023).

Nursing, Primary Care, and Behavioral Health Workforce Shortages

Our projections, based on nursing, primary care, and behavioral health workforce data from the United States, Virginia, and Virginia Area Health Education Centers (AHEC) regions, illustrate the scope of Virginia's health care workforce shortages and the extent to which three interventions could reduce these shortages during the next five, ten, and 15 years. Our model suggests that nursing, primary care, and behavioral health workforce shortages will increase across Virginia if current conditions persist (Figure 2.7) and that the percentage shortfall in behavioral health personnel is even more severe than the shortfalls in primary care and nursing. The behavioral health shortfall is also the most difficult one to reverse by applying the interventions we modeled.

Figure 2.7. Statewide Nursing, Behavioral Health, and Primary Care Workforce Shortages as a Share of Each Respective Workforce, 2023–2038 Baseline Projections



As illustrated in Figures 2.5–2.7, our statewide model forecasts suggest that the shortfall of behavioral health workers is also more difficult to reverse by raising the rate of wage growth, reducing barriers, and increasing the rate of recruitment.

Analysis of regional differences in the same three health care workforces does not indicate significant differences in the trajectory of the workforce shortages among Virginia regions (see Appendixes E, F, and G for regional model results), but this finding is likely the result of the dearth of region-specific data feeding our models. Currently, this model differentiates only regional wage levels for each job category and does not include other regional variations, such as demographic trends and supply shortfalls. We would need more data to better differentiate region-specific differences in the numbers of workers employed, as well as differences in perceived barriers, as measured by our work reluctance metric, to gain greater region-specific

insights into health care workforce shortages. Data related to age demographics, interstate workforce flows, perceived benefits, regional nuances, interconnections between regions, and current work allocation efficiencies will significantly enhance our model's ability to provide insights and projections to regional differences in health care workforce shortages and related dynamics.

We modeled the extent to which real wage increases could change the relative trajectories of workforce shortages and found that speeding up real wage increases from the national average of 2 percent per year to 3 percent per year would decrease the nursing shortage in Virginia by 21.7 percent in five years, 23.8 percent in ten years, and 22.3 percent in 15 years, compared with the baseline. Compared with 2023, the gap between employment and demand would increase to 291 percent in the baseline scenario and 226 percent in the increased wage scenario in 15 years.

Similar wage increases among primary care physicians appear to have a similar relative effect on reducing their workforce shortages (20.5 percent in five years, 23.7 percent in ten years, and 23.3 percent in 15 years) but are less significant for behavioral health specialists (7.9 percent, 8 percent, 5.9 percent, respectively). Compared with 2023, the gap between employment of and demand for primary care providers would increase to 459 percent in the baseline scenario and 352 percent in the increased wage scenario in 15 years; for behavioral health specialists, the gap would increase to 198 percent in the baseline scenario and 186 percent in the increased wage scenario in 15 years.

We also modeled the effect of "cutting in half" the number of barriers to working in nursing. Unlike modeling the effects of wage increases, changes in barriers are more challenging to quantify. For our reduced barriers scenario, we assumed that each of the three barriers (fatigue, distress, and disengagement) is cut in half, which results in more retention and more recruitment. The result of decreasing those barriers by 50 percent is to reduce the nursing workforce shortage by 49.1 percent in five years, 33.2 percent in ten years, and 25.5 percent in 15 years, compared with the baseline. Compared with 2023, the gap between employment and demand would increase to 291 percent in the baseline scenario and 217 percent in the increased wage scenario in 15 years.

Similar reductions in barriers among primary care physicians (25.9 percent in five years, 17.9 percent in ten years, and 14.2 percent in 15 years) and behavioral health specialists (8.8 percent, 5.5 percent, 3.5 percent, respectively) appear to have a smaller relative effect on reducing their workforce shortages. Compared with 2023, the gap between employment of and demand for primary care providers would increase to 459 percent in the baseline scenario and 394 percent in the increased wage scenario in 15 years; for behavioral health specialists, the gap would increase to 198 percent in the baseline scenario and 191 percent in the increased wage scenario in 15 years.

Interventions targeting retention, recruitment, and structural efficiencies are key to addressing demonstrated current and projected health care workforce shortages in Virginia. In the sections that follow, we evaluate specific interventions for each, in Virginia and beyond.

Interventions for Workforce Retention

Retention at all stages of a health care professional's career is critical to ensuring a robust health care workforce (Sermo, 2023). For example, the first five years of practice are the most critical for retention for all physicians, regardless of practice specialty, gender, race, urban-rural status, or HPSA status (Boydstun and Cossman, 2016). One interviewee described the importance of attention to, and investment in, retention as follows,

> Speaking as a bedside RN, I would certainly like for more high school and college students to consider a career in health care, particularly nursing; however, recruitment is one thing, retention is another. An organization can engage in aggressive hiring practices to fill the void, but if equal measures are not applied to retention, it will continue to bleed personnel. You cannot right a sinking vessel by bailing water without plugging the leak.
>
> *—Nursing stakeholder*

Improving retention in the health care workforce depends on interventions that address key challenges to retention in Virginia, including the financial burdens of education and training, resiliency and well-being, limited professional development, and siloed and unrealistic work demands (Brennan and McGrady, 2015; Eden, Jabbarpour, et al., 2020; Eden, Chesluk, et al., 2020). Model projections for nursing, primary care, and behavioral health care workforce under different types of interventions presented above similarly demonstrate the importance of removing work barriers and improving wage compensation to ensure that the future supply of health care workers meets the needs of Virginians (see Figures 2.5–2.8).

In the subsections below, we discuss different interventions in Virginia and elsewhere that address challenges to health care workforce retention.

Pay Increases and Other Incentives

Nursing, primary care, and behavioral health stakeholders repeatedly emphasized the need for better pay and other incentives as a key strategy for retention. Increased pay, benefits (including good health insurance coverage), and assistance with transportation and housing were all mentioned as important incentives. Stakeholders shared,

> Offer good health care, good pay/benefits, good working conditions. I will go to wherever has the best of these.
>
> *—Practicing nurse*

> The Medicaid population in Virginia is well over a million and is underfunded for all providers.
>
> *—Labor representative*

> If you work for the X County, incentive is if you buy a house up to a certain amount, they pay for the down payment. Assist with down payment, tax credit for X, etc.
>
> *—Community health representative*

The electronic survey that we administered in partnership with the Virginia Hospital and Healthcare Association was sent to 20 hospitals, and five completed the survey (20 percent response rate). We asked about strategies that hospitals use to retain nurses. All respondents indicated that they offer bonuses; more flexibility in work hours; convenient and/or free parking; mental health services for staff; diversity, equity, and inclusion strategies; and changed patient flow or staffing models. Eighty percent of respondents indicated that they offer on-site child care, job training to improve and/or expand skillsets, educational advancement opportunities as part of employment, and supervisory training or an ombudsman program to address employee concerns. Sixty percent of respondents indicated that they offer educational loan repayment and implemented strategies to promote teamwork. Forty percent of respondents indicated that they increased nurse salaries, and 20 percent indicated that they offer transportation vouchers. None of the respondents indicated that they offered subsidized housing costs, meal coverage, or covering the cost of maintaining licensure.

A survey respondent indicated that their hospital implemented scheduling software that allows for a flexible staffing schedule, giving users the "ability to schedule via multiple technologies (e.g., mobile versus PC) and provides greater visibility into open shifts in four-, eight-, and ten-hour segments.

Interviewees shared concerns around Medicaid being underfunded for primary care and behavioral health and identified challenges associated with these as barriers to workforce retention:

> They should pay (or pay more) for mental health through Medicaid. Has worked well for post-partum care.
>
> *—Primary care physician/educational leader*

> States and the federal government [need to] create rates that cover the cost to deliver the service. You can increase compensation, do one time funding for recruitment and retention bonuses. All those kinds of things . . . . stops the

> bleeding right now, but the sustainable, long-term solution is to actually increase rates, so that it makes sense from a business perspective.
>
> *—Community health/behavioral health representative*

A primary care physician shared concerns about the disparity in pay between primary care and specialty care as a retention challenge:

> Hurts to see other specialties getting so much more than primary care right out of residency.
>
> *—Primary care physician/educational leader*

Team-Based Care

Our nursing, primary care, and behavioral health interviewees identified high patient-to-provider ratios as a major barrier to retention in these workforces and noted that this needs to be replaced with team-based nursing. Nursing stakeholders indicated that patient-to-nurse ratios need to be replaced with patient-to–*provider team* ratios and stressed that both patient acuity and a nurse's experience level need to be factored into patient assignment to nurses. A nursing stakeholder suggested recruiting ancillary staff—such as respiratory therapist and phlebotomists—to decrease nurse workload. Interviewees shared,

> Look more at "team nursing" enhance techs, phlebotomy, unit clerk. . . . Look at scope and practice of LPNs [licensed practical nurses] in Virginia ("how can we use LPNs again") so RNs can practice at the top of their license.
>
> *—Nurse leader/educator*

> The pure nurse-to-patient ratio is a farce. Staff up and down based on patient acuity.
>
> *—Practicing nurse*

> I can't take on one more patient because it's not safe for my other five.

Similar concerns regarding the negative impact of high patient to provider ratios and the need for team-based care were expressed by primary care and behavioral health stakeholders:

> My second-year resident in primary care went from a panel of 120 patients to 150 overnight. Need support staff to get their work done.
>
> *—Primary care physician/educational leader*

> When you are fully staffed, people are happier, retention relies on recruitment. Lower patient to provider ratio would make a difference.
>
> *—Community health/behavioral health representative*

A hospital respondent to the electronic survey that we administered in partnership with the Virginia Hospital and Healthcare Association indicated that they were using robotics, virtual nursing, and "adding back" LPNs for team-based nursing.

Documentation Burden

All stakeholder groups—nursing, primary care, and behavioral health—indicated that tremendous documentation requirements result in burnout (National Academy of Medicine, 2022) and are a major barrier to retention. Many indicated that documentation requirements are often excessive and redundant and that they take providers away from direct patient care. Furthermore, some interviewees expressed the need to leverage technology to reduce documentation burdens. Interviewees shared,

> Reduce the documentation expectations. Going through inboxes doesn't add value—it's the interactions with people. EHR [electronic health record] was developed as a billing device and not for patient care. The amount of clicking in each shift . . . each click takes a bit of your soul from you.
>
> *—Primary care provider/academic leader*

> Reprioritize what we really want to know. What is truly important? What do we truly need? Weigh benefit against costs in time and level of burden. Ask why you need to assess for bed sores every shift as a nurse. Having policies has not allowed for variation SUD [substance use disorder] screening is a good example. "Horrifically inefficient" . . . Need to pass the sniff test of "Why am I doing this?"
>
> *—Primary care physician/Educational leader*

Another interviewee had a different take on documentation challenges:

> It is the way it is, until we harness the true power of technology. It is a part of the job. If you like the job and serving people, it comes with the job. Of course, you don't want to duplicate work.
>
> *—Community health center leader*

This interviewee also added,

> A company in Nashville—Prediction Health—makes technology for dictation using voice recognition that providers can use during bedside assessment. We stopped using them. We're going to be using scribes. People weren't happy with that. There's still a human component that needs to check [the transcription].
>
> *—Community health center leader*

Regulatory and Reporting Burden

A 2022 report from the National Academies flagged reducing compliance, regulatory, and policy barriers in the daily work of health care providers as a key mechanism for addressing health care workforce shortages in the United States (National Academy of Medicine, 2022). Virginia stakeholders echoed this objective in interviews and focus groups. Primary care stakeholders noted the need to reduce reporting and regulatory burdens, especially in the public sector. One interviewee noted,

> There are regulation and reporting requirements specific to public entities that the private sector is not responsible for. Also, the pay disparity between public and

> private is huge, and as a result there is a high vacancy rate for those [public] positions.
>
> —*Community health representative*

One interviewee shared insights on the implications of reporting burden and red tape, particularly in reference to reimbursement:

> Medicare/Medicaid/private insurance are difficult to bill so more and more physicians are opting for sliding scale model. We are losing a lot of qualified clinicians to concierge practices. Lot of primary care [providers] are going into concierge practice where they have more autonomy over deciding number of case load and how much time they will spend, and how they bill. That can impact how many providers are in play.
>
> —*Labor representative*

Workplace Violence

Nursing stakeholders in our interviews and focus groups expressed significant concern about workplace violence as a barrier to retention. Interviewees shared,

> Implement *and adhere to* zero tolerance for workplace violence.
>
> —*Nursing stakeholder*

> Implement state-level policies that penalize those that assault health care workers similarly to prehospital workers and first-responders.
>
> —*Nursing stakeholder*

> We need to have legislation with teeth behind it. Many in the general assembly do not want to tell judges what to do. If you aren't protecting the team, why would you want to come to work? Why would I stay in this environment? I can go to the clinic, telework, do research.
>
> —*Nursing stakeholder*

Cross-Sector Collaboration

Nursing, primary care, and behavioral health stakeholders identified cross-sector collaboration as key to workforce retention. Nursing stakeholders noted that health system–academic partnerships can be leveraged to create pathways to careers in nursing. An interviewee noted,

> I think we will draw more nurses into the bedside and recruit more nurses into the profession if they see multiple pathways over the life of their career,

> educational opportunities and career advancement by pursuing further education and certifications.
>
> *—Nursing stakeholder*

> Earn as you Learn retains practice-ready nurses because they feel more prepared. VA can attract and retain more if they pay for time commitment.
>
> *—Nursing stakeholder*

Behavioral health stakeholders noted that building cross-sector collaborations can work to strengthen mental health services delivery. One interviewee commented,

> Need to build collaborative structures that bring together various stakeholders, including public and private providers, businesses, schools, and concerned citizens, to strengthen the mental health workforce and support the community.
>
> *—Behavioral health representative*

> Efforts to create more entryways and on-ramps into the behavioral health workforce should be accompanied by partnering with employers to ensure there are sufficient job opportunities for newly trained professionals.
>
> *—Behavioral health representative*

The multi-stakeholder conference attendees discussed the importance of rebranding and improving the perception of current health care jobs among young people through partnership between the Virginia Department of Education; school-based providers, such as high school counselors; and community colleges.

Workforce Diversity

Interview and focus group participants stressed the importance of having a diverse workforce in order to increase retention—particularly with respect to populations in health care from underrepresented communities—and in order to arrive at health care solutions that may be achieved by including varied perspectives in the health care workplace. Participants shared many thoughts on the importance of a diverse health care workforce:

> A workforce that mirrors the community can improve the care of everybody. Goes back to the pathways. Why don't we have enough diversity in residency? We still don't have enough diversity in med schools. You have to make it a core value and truly believe.
>
> *—Primary care physician/educational leader*

Some interviewees noted that addressing diversity, equity, and inclusion issues in Virginia may require different approaches for different regions of the Commonwealth. One interviewee noted,

> We need to treat everyone with dignity. Northern Virginia is different from other parts of the state as far as tolerance. What does dignity mean? Detail it to where

> you are. It's an easier conversation to have if you approach it from a civility standpoint. Meeting individual people where they are at.
>
> —*Primary care physician/educational leader*

Continuing Education

As in other states, Virginia interventions typically do not address the financial burdens of continuing education, training, and certification. Prior research suggests that certification and recertification exams pose particular difficulties for health care workers. Primary care physicians reported that recertification board examinations cause work-life imbalances, especially in the case of female physicians (Eden, Jabbarpour, et al., 2020; Eden, Chesluk, et al., 2020). Qualitative data collected as part of this study show that license renewal presents a significant financial barrier to nursing and behavioral health providers, especially low-income and/or rural individuals. Research elsewhere suggests this is a national challenge in retaining the health care workforce (Orr, 2020; Fast, 2022).

Given the challenges that licensing and associated fees present, it is noteworthy that most European Union countries regulate health care professions much less than the United States does: Just over 70 percent of all health care professions are regulated in the United States, compared with just under 50 percent in the European Union (Hermansen, 2019). Virginia's recent efforts to reduce licensing barriers focus mainly on recognizing out-of-state licenses but still require those individuals to pay Virginia licensing fees (e.g., out-of-state counselors under VA HB1433) (Virginia's Legislative Information System, 2023).

Professional/Personal Development, Recognition, and Decisionmaking Capacity

One study showed that residents (i.e., physicians in training) value education that includes strategies on managing debt, retirement planning, and information about the business of medicine (Garrett et al., 2022). This is important because residents' framing of educational debt and their level of financial literacy were found to affect their sense of agency and well-being. Resident participants in this study indicated that residency programs can facilitate stress mitigation by providing residents with skills to help manage debt and plan for retirement. This study also noted that, in order to reduce clinician debt, such education needs to occur in tandem with systemic changes to financing medical education.

In our interviews and focus groups, nursing, primary care, and behavioral health stakeholders noted the importance of professional development and staff recognition as a retention strategy. Interviewees noted,

> It's about creating opportunities, scheduling fairly, and considering employee's needs, thinking about reducing burn out . . . for longer term, retention bonuses and valuing staff are critical.
>
> *—Nursing stakeholder*

In reference to health care workplace retention lessons learned from the pandemic, interviewees shared,

> Employers think about employees in a new way, not just some number. It has paid dividends for those employers who are thinking like this.
>
> *—Labor representative*

> Training and mentorship programs have been on the rise. Companies [used to] spend a lot more on recruiting talent than training up and retaining the talent they have. There's been a shift in this since the Great Resignation. Gen-Z and millennials are not afraid to leave their employers and negotiate higher salary.
>
> *—Labor representative*

> Wage salary compression and retention bonuses are great strategies, but this is what people expect and deserve. Pay is the short answer.
>
> *—Community health/behavioral health representative*

Nursing stakeholders particularly stressed the need to give bedside nurses decisionmaking authority and including them in shared governance plans. Interviewees noted,

> Have nurses on the table instead of on the menu . . . make them a part of decisionmaking tree
>
> *—School of nursing representative*

> I am surprised health care hasn't learned from travel agency on shared governance, how they want to work. We are meeting with Virginia Hospital and Healthcare Association and the nursing association on staffing committees to improve them, so they have teeth and are meaningful. Not just inundated with reporting.
>
> *—Nursing stakeholder*

> One measure that I have seen is effective in delaying departure is track scheduling. The nurse can design the schedule or pick your option from a list of options. It renews at the next session. You can plan your life.
>
> *—Nursing stakeholder*

Scope of Practice and Practice Agreements

Restrictive licensure for PAs and NPs can inhibit the benefits of increasing the supply of PAs and NPs and reducing the reliance on primary care physicians (that are in short supply) in meeting patient needs. A study showed that changing NP and PA scope of practice legislation in Alabama to match states in the upper quartile of those that use a collaborative practice model, such as Washington and Arizona, would increase both the employment and distribution of NPs and PAs (Hooker and Muchow, 2015). Other studies have shown that hiring NPs and PAs may

be a strategy to accommodate new Medicaid patients at lower cost (Cawley et al., 2016; Barnes et al., 2022; Burt, Sparbel, and Corbridge, 2021). Over half of U.S. states have adopted a more relaxed NP licensure model than Virginia, including some of its neighboring states, such as Maryland and West Virginia, and NP licensure plays an important role in retention of NPs (Kueter, 2022; Wiesen, undated). The NP scope of practice in Virginia is restricted practice by state law, which means that NPs must enter a collaborative agreement with physicians, autonomous practice is also restricted, and Virginia does not recognize NPs as primary care providers (McGhee, 2022). In contrast, in Maryland, NP scope of practice is full practice—that is, NPs can diagnose and treat the patient independently, practice autonomously, and deliver care in the primary care setting (Wiesen, undated). Although in comparison with Maryland, West Virginia is reduced practice—meaning that NPs have to be in a collaborative agreement with a physician—they are still able to be a primary care provider (Wiesen, undated).

Modernization of licensure laws can remove unnecessary barriers to access to NP health care services (Kapu and Pitts, 2023). Studies show that the NP-physician co-management care delivery model did not adversely affect patient outcomes and, in some cases, was more beneficial in reaching practice and clinical targets (Norful et al., 2019). Efforts should be undertaken to implement the law in each organization by engaging leadership, increasing awareness about the positive impact of the law promoting NP independence, and promoting relationships between NPs and physicians (Poghosyan, Norful, and Laugesen, 2018). In 2015, New York State adopted the Nurse Practitioners Modernization Act to remove required written practice agreements between physicians and NPs with at least 3,600 hours of practice experience. Such modernization of licensure laws also applies to physician's assistants, dentists, pharmacists, dieticians, and community health workers as a strategy to expand the health care workforce (National Academy of Medicine, undated).

New Jersey's COVID-19 Temporary Emergency Reciprocity Licensure Program provided temporary licenses to more than 3,000 out-of-state health care providers. Over a quarter of these providers were mental health providers. As the need for mental health care increased during the pandemic, expanding mental health provider capacity was critical to ensure access to the needed care. As demonstrated by one study, temporary out-of-state mental health providers helped ensure mental health care continuity and access (Nguyen et al., 2023).

Seventeen states currently allow for licensure of psychologists at the master's level, and the American Psychological Association has developed accreditation standards for such graduate programs. To integrate authorized subdoctoral psychology practitioners into the mental health services system, models such as collaborative care or service extender models could be useful to increase mental health services provided by doctoral-level psychologists (Thompson, 2020).

In our interviews and focus groups, interviewees expressed the need to expand representation from NPs and PAs as a way of expanding primary care capacity. One interviewee noted,

> NPs are left out of solutions for primary care shortages. Nursing, especially advanced practice roles, can be part of that solution.
>
> *—Nursing representative*

Behavioral health stakeholders noted the need to expand the scope of work of nonlicensed providers as a strategy to increase behavioral health capacity. One interviewee said,

> Look at licensing and regulation and streamline [the] process, what you want to achieve and decide what nonlicensing people can be doing but need to change the regulation around that as well.
>
> *—Community health/behavioral health representative*

Behavioral health stakeholders also expressed the need to "broaden" the definition of a behavioral health provider. One interviewee noted,

> Exploring broader roles for health care providers, such as community health workers, in addressing behavioral health issues . . . can help alleviate workforce challenges.
>
> *—Behavioral health representative*

Role of Technology

The use of physician order entry clerical personnel is a simple, cost-effective intervention that can improve the work experience among primary care physicians (Contratto et al., 2017). Rural stakeholders indicated that *technology* (i.e., IT solutions) can play in important role in retention in Virginia's rural areas. Some of the issues pertinent to workforce development in rural areas are unique to these settings. A leader from a rural hospital noted,

> EPIC has some solutions but too expensive for a rural hospital like ours—any technology-based solution for documentation would be too expensive.
>
> *—Rural hospital leadership*

Resiliency and Well-Being

In our interviews and focus groups, we heard about the need to address stress and burnout among the behavioral health workforce. Participants noted,

> Address the issue of workforce burnout and stress by providing resources and support for self-care and mental health among mental health professionals.
>
> *—Behavioral health representative*

> Invest in resilience and well-being programs for existing workforce to prevent burnout and attrition.
>
> *—Behavioral health representative*

Stress and burnout are common across health care occupations. Building resiliency can prevent burnout and may improve a resident's quality of life and health behavior. Research to date has often focused on providing health care professionals with additional education and

training on identifying stress and burnout, as well as strategies to address these conditions (e.g., Brennan and McGrady, 2015; Couser, Chesak, and Cutshall, 2020). These courses can be supplemented with online anonymous interactive screening programs targeting well-being and suicide and/or professional coaching (Norcross et al., 2018; Dyrbye et al., 2019).

However, such courses and support services have not been extensively evaluated for improvements in health care provider well-being and resilience. Additionally, courses like these likely provide a partial solution, at best, to health care provider resiliency and well-being, given the complex myriad of individual, institutional, and other factors driving stress and burnout (National Academy of Medicine, 2019). For example, participants in qualitative interviews and focus groups noted that **patient-on-provider violence, inappropriate patient-provider ratios and throughput requirements, burdensome documentation requirements, low and/or differential compensation for care provided, and lack of basic supplies all impact stress and well-being in their day-to-day work**; all of these factors are at least partially, if not mostly, driven by institutional factors beyond individual health care providers.

Interventions for Workforce Recruitment

Scholarships, Loan Forgiveness, and Other Support

Currently, Virginia's support for the health care workforce mainly addresses the financial burdens related to education and training via scholarships and loan forgiveness. There is evidence that scholarships and free tuition programs in particular encourage individuals to obtain additional education and training. Research evaluating programs that offer general scholarships or free tuition in a field experiment found that individuals attending four-year institutions of higher education are more likely to enroll *and* complete a course of study—especially low-income individuals (Burland et al., 2022; Dynarski et al., 2021).

A similar pattern likely holds for individuals attending technical colleges as well (Anderson, Monaghan, and Richardson, 2023). There are likely two main reasons for the apparent effectiveness of scholarships and free-tuition programs. Besides significantly reducing (or eliminating) the costs of attendance, they are simpler than federal financial aid programs that require students to navigate processes and submit paperwork each academic year while taking on sometimes significant amounts of student loan debt. Low-income and otherwise disadvantaged populations are less likely to take out loans more generally (Waddell and Singell, 2011; Black, Denning, and Rothstein, 2023; Burland et al., 2022). While the Commonwealth offers general scholarships that can be applied to health care professions (e.g., G3, FastForward) (Virginia G3, 2023; Virginia Foundation for Community College Education, undated), Virginia legislation and government websites and interview data suggest there are many fewer scholarships targeted towards the health care professions than loan forgiveness programs in Virginia (Virginia

Department of Health, undated; VHWDA, undated-b; Claude Moore Charitable Foundation, 2022).

This is in contrast to other states, such as neighboring West Virginia, that have targeted scholarship programs specifically for individuals entering health care professions. West Virginia and other states specifically target health care shortage areas, such as rural and other underserved areas, by offering financial supports for educating and training health care workers (Vestal et al., 2022). Some states report success with targeted scholarship programs (Hu, Dill, and Conrad, 2022). For example, research suggests that a rural physician scholarship program increased the number of rural physicians (e.g., (Vestal et al., 2022)). However, evaluation research to date is relatively sparse, and other studies suggest rural physician scholarship programs do not lead physicians to change their preferences (Spiers and Harris, 2015). Instead, individuals with preexisting preferences for rural practice and/or who originally hail from a rural area are the main participants in such programs, and they remain in rural areas after any terms of service associated with the scholarship have ended (Rural Health Information Hub, 2022).

Virginia has many more loan forgiveness programs than scholarship programs focusing on health care occupations. Virginia's loan repayment programs (Virginia Department of Health, undated) include a variety of health care professionals (e.g., physicians, nurses, social workers) and use a mix of Commonwealth, employer, and federal funds (e.g., the Virginia State Loan Repayment Program [VA-SLRP]) or strictly Commonwealth funds (e.g., Virginia Physician Loan Repayment Program) (Virginia Department of Health, undated). Unlike its scholarship programs, at least some of Virginia's loan repayment programs target underserved areas facing a shortage of health care providers (e.g., VA-SLRP). Virginia has recently expanded the VA-SLRP program to include certified nursing aids (Virginia's Legislative Information System, undated-a). Prior research suggests that loan forgiveness programs might increase the number of individuals who become physicians, but the evaluation research to date on physician or other health care worker loan forgiveness programs is unclear (Bärnighausen and Bloom, 2009; Guan et al., 2023) regarding the amounts of debt relief for higher-paid health care workers (e.g., physicians) (Catherine and Yannelis, 2023). Additionally, cited research on scholarship and free tuition programs suggests that scholarships are likely more effective for propelling disadvantaged populations into postsecondary education and training.

Scholarships and loans are also used to *reallocate* Virginia's existing health care workforce, not just to *recruit* new workers. For more discussion on improving systemic efficiency by reallocating workers, please see the last section of this chapter.

Stakeholders noted the importance of offering loan repayment and scholarship programs as a recruitment tool in Virginia. In reference to behavioral health, interviewees commented,

> Offer loan repayment, scholarships, and incentives for going into behavioral health, especially to younger, more diverse population. If you come from a rural or socioeconomically challenged area, the idea of a four-year institutional degree and borrowing loans seems insurmountable. Federal money can often help pay

> back much of that debt. Loan repayment is helpful for those in the field, but not for attracting college students.
>
> *—Behavioral health representative*

> In southwest Virginia, people do not like to take on debt, or people of color, or bilingual people, you need to provide money at the front end.
>
> *—Behavioral health representative*

> Loan repayment is essential. In Virginia, in addition to the regular state-funded loan repayment, we just created a behavioral health loan repayment program two years ago. If we pass a budget, the Governor has increased the money in it and increased the amount available.
>
> *—Behavioral health representative*

> Health care organizations offer loan repayment programs but with high stakes (3-year commitment), current generation is not into this and [they] don't take advantage of those.
>
> *—Behavioral health representative*

> There is a scholarship program for psych NPs. It is a post-certificate program which has been attractive to older folks who may have some debt but have made progress in their career. They want to go back to school but they don't want to incur more debt. Scholarship pays for the full freight.
>
> *—Scholarship program representative*

Interviewees also noted a role for private funding for behavioral health education and training. One interviewee expressed,

> Private business funding has not been tapped [into], [we] don't do it enough. Go Virginia is already in place but . . . it has not taken off as it should have. It's in place already so it's a shame.
>
> *—Behavioral health representative*

Attendees of the study's multi-stakeholder conference discussed industry-supported tuition models in Virginia where the employer supports their employees' school tuition. They mentioned that such models can potentially create an opportunity to move the current generation into the health care workforce. For example, Bon Secours Health in Virginia pays for individuals' education upfront (Bon Secours Mercy Health, undated). They need to make a commitment on students' part to stay with industry for a specific amount of time (recently changed it from three years to 18 months). Then it is on the industry to make students realize they want to stay.

Behavioral health representatives cited payment for preceptorship/licensed supervision as a major barrier to behavioral health recruitment and expressed a need for creating mechanisms to help students pay for preceptorship/licensed supervision. Interviewees commented,

> For people who want to become LCSWs [licensed clinical social workers] and licensed professional counselors, they are thwarted by paying for the required

> supervision on their own that they have to go through to get a license. …a lot of people who want to become therapists and are motivated, and have the aptitude, cannot run that financial gauntlet.
>
> *—Behavioral health representative*

> The licensing process for behavioral health is very cumbersome and expensive. By the time I graduated I still needed 3,000 hours that had to be supervised for which I had to pay somebody…This is not a good system. This was 12 years ago but I am still hearing the same concerns.
>
> *—Labor representative*

Stakeholders also expressed the need for more effective advertisement around scholarship and loan repayment opportunities in Virginia. Interviewees shared,

> Talking to the psych group, they didn't know the loan repayment was there to help recruit faculty or [options to] keep people in Virginia.
>
> *—Behavioral health representative*

> It is shocking how few people know about the behavioral health loan repayment program. Some of it has to be because it started during the pandemic, and a lot has to do with...loan repayment in the department [being short-staffed]. We need to figure out more creative ways to make sure the key folks are aware of the program.
>
> *—Behavioral health representative*

Rural stakeholders indicated the need for providing social support to students and trainees as part of recruitment efforts in rural areas:

> Children from rural areas are struggling with complicated issues (food insecurity, insufficient class supplies, incarcerated parents). Need more resources for families with K–12 students.
>
> *—Rural community health/education representative*

> Many students are first generation so don't have the proper support in place. They play a lot of catch-up...Any financial cost that is incurred (for licensing, registration, etc.) is going to be a problem, so vouchers and offers along those lines can go a long way. Cost of education, licensing, and continuing education is typically a huge barrier for first generation [students].
>
> *—Rural community health/education representative*

Rural stakeholders also stressed the importance of securing proper housing for students and trainees in rural areas:

> Housing will resolve many of the issues. . . . Medical students have struggled to find a place to live [in Southwest Virginia] that is of sufficient quality, safe, and comfortable. . . . There is a sense of "otherness"—inability to find a place to live

> makes them feel unwelcome. A feeling of belonging is critical from the institution as well as the community side.
>
> *—Rural community health/education representative*

Wages and Regulations for Educators

The number of available educators has direct implications for whether existing education and training programs in health care can train a sufficient number of health care workers, especially in the case of nurse education and training.

Prior research notes that educator shortages in nursing schools limit the number of students a program can accept and can also degrade the overall experience of students admitted to the program (Margolis et al., 2023; American Association of Colleges of Nursing, 2022). In Virginia, the number of nursing educators limits the number of nursing students that institutions of higher education can accept as well as the ability of these students to find appropriate clinical placements and preceptors during their education (Zhavoronkova et al., 2023).

Nurse preceptors are a particular pain point in Virginia nurse education and training. Nurse preceptors must complete an application and pay a fee, regularly renew their preceptor license, provide on-site and face-to-face instruction, and can supervise no more than two trainees at a time (Virginia's Legislative Information System, 2023). Additionally, interviews and focus groups emphasized revised preceptorship requirements and regulation. Participants shared the following comments,

> Some education . . . is very highly regulated . . . on ratios of faculty/preceptors. For example, for students at BS [bachelor of science] level, faculty have to be masters prepared or ask for temporary exception. In community settings, we should not be limited to ratio, may miss out on opportunity for student learning. A guidance document that allows us to be more flexible, students can be in different settings, this is not in place.
>
> *—Behavioral health representative*

> Faculty have to be on site with students. This limits where students can be. For example, need a faculty to learn about food pantry—does not make sense. Precious Time Program in James Madison University, which helped disabled children at home . . . used to count as clinical hours, but now does not count because faculty is not there.
>
> *—Behavioral health representative*

Focus group data also suggest that traveling nurses cannot serve as preceptors—even if travelers have sufficient experience in Virginia health care facilities, currently work in a Virginia facility, and otherwise meet all preceptor requirements. Notably, preceptors receive little to no compensation (e.g., University of Virginia, 2023). The recently established Virginia Nursing Preceptor Incentive Program provides $1,000 for 250 hours of supervision for a maximum of $2,000 per school year (Virginia Department of Health, 2023).

Nurse preceptor survey data in published research reinforce these challenges to recruiting new nursing professionals to Virginia's workforce. Those data indicate compensation and faculty-preceptor communication are top preceptor concerns. Preceptors also indicated the need for protected teaching time, preceptor training, and meaningful preceptor recognition (Boyce et al., 2022; Burt, Sparbel, and Corbridge, 2021).

The Virginia Nursing Stakeholder Workgroup recently published a plan to support Virginia's nursing workforce (2023), noting the importance of financial incentives for clinical nurse preceptors. The group endorsed tax credits as an important way to incentive nurse preceptors. Many of the same issues for nurse educators' wages and regulation are evident in behavioral health as well. Behavioral health stakeholders also noted the importance of paid preceptorship/licensed supervision and an overall shortage of faculty. Interviewees commented,

> I have been against paying for preceptorship, but given the world we live in, we might have to think that way. Or pay the organization to free up the preceptor.
>
> —*Behavioral health representative*

> Is there enough faculty? No. Why? Because faculty don't get paid enough, so they don't want to be faculty. There are required ratios. The revenue generating requirements of existing faculty in larger institutions create problems because they cannot generate revenue while overseeing people. There are a lot of unreasonable requirements there.
>
> —*Behavioral health representative*

Preceptor Capacity

Nursing stakeholders expressed low capacity for preceptors and faculty as a significant barrier to recruitment. Specifically, nursing stakeholders indicated that some nursing schools have to turn away qualified applicants because of insufficient faculty and preceptor capacity. According to one interviewee,

> The number of students that come out of high school, who want to be a RN, we are turning them away because of faculty and space on campus shortages. It's not a simple fix but still needs to be addressed in some way; it takes a lot of funding. Scholarships will not make a difference in this case because classes are full.
>
> —*Community health representative*

Behavioral health stakeholders also indicated the need for creating a pool of behavioral health preceptors/licensed supervisors by leveraging retirement age providers. They noted that about 60 percent of providers were retirement age or older in 2019, and that pool can be a source to help increase behavioral health preceptor/licensed supervisor capacity.

Outreach and the Public "Image" of Health Care Professions

Nursing stakeholders indicated a need for raising public awareness and improving the "image" of nursing careers through a public campaign. Interviewees identified the negative

image of health care professions—especially since the COVID-19 pandemic—as a key barrier to effective recruitment. Interviewees shared that,

> Other industries are marketing in elementary and high school. Health care has a bad PR situation. The headlines around being in health care in general, being overworked, nursing in particular.
>
> *—Behavioral health representative*

> Johnson & Johnson marketing strategy does a very good job about getting the right stories out. Be better about sharing stories about the joy of the [health care provider] jobs, not just entice with benefits and salary.
>
> *—Nursing stakeholder*

Behavioral health stakeholders shared similar sentiments regarding the need for more effective outreach and raising public awareness of behavioral health professions for successful recruitment. Interviewees said,

> You have to convince the parents it's a viable career option. We do a terrible job at career paths. . . . [High schoolers] can talk to professionals who are in that field. . . . We just can't show them a pathway unless we create one.
>
> *—Community health/behavioral health*

> Engage in creative events such as such as college fairs, city buses wrapped in advertising, career fair targeting just bachelors to get them into the door as case managers. Offer unique internships etc.
>
> *—Behavioral health representative*

> Need to raise public awareness about the importance of mental health and behavioral health services, as well as the value of the professionals who provide these services.
>
> *—Behavioral health representative*

> Implement campaigns and initiatives to combat the stigma around mental health professions, highlighting the meaningful work they do and the positive impact they have on individuals and communities.
>
> *—Behavioral health representative*

> We need to make sure there is clear and effective communication to the right population. What will grab the attention of a 17-year-old?
>
> *—Behavioral health representative*

The multi-stakeholder conference attendees discussed the importance of rebranding and improving the perception of current health care jobs among young people through partnership between the Department of Education; school-based providers. such as high school counselors; and community colleges.

Health Care Workforce Data-Tracking

During our study interviews we heard from a participant regarding the importance of data-tracking by colleges and universities in Virginia in order to better understand where students are going after completion of their programs and to inform efforts to keep students in the Commonwealth. This interviewee shared,

> The colleges and universities do not see it as their role to educate the people in front of them. They don't see it as their role to identify positions to help graduates, encourage graduates to stay in the state. They don't track where they go. You would think the alumni office does it, but not the behavioral health departments. There is a role for the universities where they can be much more engaged.
>
> —*Behavioral health representative*

During the study's multi-stakeholder conference, participants indicated the importance of leveraging data to track Virginia's health care workforce needs on an ongoing basis to inform interventions to address any ongoing staffing shortages.

Virginia has a number of data sources that can help facilitate workforce data-tracking. The Virginia Commonwealth University's Department of Family Medicine and Population Health houses the Virginia Ambulatory Care Outcomes Research Network (ACORN) (Virginia Commonwealth University, undated-a). ACORN partnered with Virginia Department of Medical Assistance Services in 2018 to evaluate primary care capacity in the context of Medicaid expansion in the Commonwealth. Through this work, ACORN identified every primary care physician in the Commonwealth and conducted extensive interviews and surveys focused on understanding primary care capacity in both 2018 and 2022. Using its robust Virginia-based datasets, ACORN has facilitated a deep understanding of primary care clinician panel size, scope of practices, and communities served (Huffstetler et al., 2022).

The George Mason University Center for Health Workforce (Mason Center for Health Workforce, undated) conducts workforce data collection and analysis and leads collective efforts in health workforce planning and development in Virginia. Notably, the center houses health care workforce supply and demand dashboards.

Data sources such as those utilized by ACORN and Center for Health Workforce can be leveraged to conduct surveillance on the health care workforce needs of the Commonwealth to inform needed interventions and policies on an ongoing basis.

Recruiting Youth and Members of Underrepresented Communities

African-American/Black physicians are more likely to practice primary care and care for underserved populations than other physicians and remain underrepresented in medicine. Because Historically Black Colleges and Universities (HBCUs) have a legacy of matriculating students with lower standardized test scores, majority medical schools may be reluctant to form partnerships with HBCUs. **Despite lower average Medical College Admissions Test (MCAT)**

scores, groups did not differ significantly in terms of graduating, matching into residencies, selecting primary care, or achieving board certification (Capers and Way, 2015).

Nursing, primary care, and behavioral health providers in our interviews and focus groups indicated a need for outreach to school-aged children regarding health professions. Interviewees shared,

> Need to go into schools early . . . even 5th grade. Middle school kids are not encouraged to go into health care. . . . A lot of people who are awesome at [providing health care] got Bs in high school. GMEC runs a summer camp and will use Claude Moore money to support health care counselors for overnight to encourage kids re health care careers.
>
> *—Rural provider*

> Get to them in high school and in training, too. You need to expose them to long term settings. Incentive-wise show high school graduates, if you become a LPN, you can go up the ranks (many examples of starting off work at front desk and now own nursing homes). Pathways are there but need to make clear what the opportunities are.
>
> *—Community health representative*

> Dedicated recruiters need to fan out and tap into underserved communities to get the message out . . . need to think holistically and strategically, not just post it. [Adopt] a grassroot messaging approach for local communities in addition to providing support such as child care, transportation etc. This is where gains can be made where historically it has not been.
>
> *—Labor workforce representative*

Primary care stakeholders noted that AHEC can probably play more of a role in outreach to underrepresented communities for health care professions recruitment. One interviewee said,

> Not enough being done with AHEC to introduce health careers to students/people in different communities. Need recruitment strategies for people of color. They need more information, introduction of public health in that community, specifically. We need to garner a lot of ideas from those populations, talk to white kids, Black kids, brown kids. . . . You'll get different solutions.
>
> *—Community health center leader*

Behavioral stakeholders also stressed the need for specific recruitment strategies for communities underrepresented in health care professions. Interviewees said,

> Another way to motivate people of color who are leaning towards the behavioral health profession is to see people who look like them in those roles, like a counselor or similar capacity. Build pipelines way back down into grammar school, middle school, involve the guidance counselors, particularly in underserved populations.
>
> *—Behavioral health representative*

> First generation students need extra support. That is a strategy that brings them along. That leads to them becoming licensed and staying practicing. For our

> programs, we recruit by saying we will pay for things. That removes a financial obligation.
>
> *—Behavioral health representative*

Online Instruction

Health care education experts have highlighted the need to center clinical education around online learning (e.g., Emanuel, 2020). Online instruction can increase access and flexibility to local and nonlocal clinical education, especially at the introductory level (Goldberg and Crocombe, 2017). This was demonstrated during the COVID-19 pandemic when most health care education was forced online. However, a relatively robust body of research on the effectiveness of online postsecondary education generally suggests that online instruction can negatively impact student learning, with some important caveats. Online education does not seem to support student learning any more or less than large, in-person classes. Also, mixed instruction with in-person and online learning does not negatively affect student outcomes. Lastly, online education that uses peer-to-peer learning or other collaborative and social components may improve the effectiveness of online learning (Zhao et al., 2018; Alpert, Couch, and Harmon, 2016; Bowen et al., 2014; and Joyce et al., 2015).

Virtual instruction can support new approaches to enhance conventional learning. During the COVID-19 pandemic, interactive virtual clinical teaching was routine, including virtual rounds on hospital wards, virtual clinical clerkships, virtual emergency department callbacks where emergency department providers contact discharged patients for follow up evaluation, virtual medical response teams for supporting community health teams, and greater access to instruction from renowned clinicians (Wilcha, 2020).

In spite of its promises, online instruction is not without weaknesses. Online instruction can contribute to isolation and disengagement, is associated with lower grades, and might not confer attitudinal growth critical for skillful clinical practice, such as willingness to conduct routine screening for illicit drug use (Lee et al., 2022; Knopf-Amelung et al., 2018). That being said, the COVID-19 pandemic led to natural experiments in online instruction, often for medical students, that can be built upon for all health care professions to address shortages in experienced instruction in the classroom and in clinical settings. Combined with conventional instruction in a blended learning environment (McCutcheon, O'Halloran, and Lohan, 2018; Terry et al., 2018) and perhaps using advanced training technology such as augmented or virtual reality, online instruction is an important tool for innovation in health care education and training (National Academies of Science, Engineering, and Medicine 2021).

Pathways to Health Care Professions

Nursing stakeholders discussed the importance of creating multiple pathways to nursing careers as a recruitment strategy. Interviewees shared,

> One of the things we're doing at my institution, we are on a pilot…to help build this pipeline, where students take particular curricula and they get dual credit and they have a pathway so they get exposed to the health care careers, not just nursing but all the health care careers and have shadowing opportunities.
>
> *—Nursing stakeholder*

> [Offer] tuition assistance and demonstrate it's an ascending staircase and have some sort of mentorship support. I was in your shoes just six years ago… Plug away, and there is a future for you here. Not all organizations can lean towards that but demonstrate that there is a career.
>
> *—Labor workforce representative*

> In Minnesota, the governor said we are going to recruit by paying for tuition, pay for working time, pay for uniform, etc. We need to get 1,000 CNAs [certified nursing assistants] within 90 days, and they were immensely successful. It cost the state $5–6 million. CNAs can be trained very quickly, that's why it was the focus. Retained 20 percent of those that were trained.
>
> *—Community health representative*

Other stakeholders shared similar thoughts about the importance of developing the primary care pipeline. They shared the following comments:

> Offer paid internships at high school level so students can be exposed to the reality of health professions; match undergrads with medical students and promote mentorship alongside internship.
>
> *—Labor representative*

> One of the biggest barriers is lack of equitable pipeline. There is a well-earned mistrust in certain communities towards medicine and health care. Look at pipeline overall and create something that garners trust.
>
> *—Labor representative*

> In-depth understanding of the pipeline is needed as well as an understanding of capacity of the programs. Building comprehensive, in the weed maps of what is happening and what the need is. A three-year goal is a sweet spot for identifying concerns and launching pilot programs to address sub concerns, followed by evaluation of programs and what can be scaled up.
>
> *—Labor representative*

Behavioral health stakeholders raised the need for implementing alternative pathways for behavioral health licensure. They noted that in order to increase the number of individuals entering behavioral health fields, there is a need for more entry ramps and educational pathways into the behavioral health workforce. This includes developing academic programs at different levels, such as associate and bachelor's degrees, to provide more immediate relief to the workforce shortage. Interviewees shared these comments:

> Implement expedited and streamlined licensure processes for in-demand areas of specialties facing workforce shortages so that qualified professionals can enter the field quickly.
>
> —*Behavioral health representative*

> Offer structured and supervised training programs to individuals to gain practical experience while working towards licensure.
>
> —*Behavioral health representative*

> Establish interstate telehealth licensure compacts that allow professionals to practice across state lines without requiring additional licenses.
>
> —*Behavioral health representative*

Participants in the study's multi-stakeholder conference stressed the importance of creating intermediary on-ramps for behavioral health workers given the current path to the field is entry level and it takes six years to reach licensure. They offered focusing on growing the pool of NPs and PAs in primary care and behavioral health as a strategy to increase additional capacity in these fields. Programs such as those offered by George Mason University (Nursing Process, undated) can help accelerate family NPs into psychiatric NPs to help fill the dual void.

Multi-stakeholder conference participants raised the need to expand on innovative programs such as I2CRP and fmSTAT offered at Virginia Commonwealth University (Virginia Commonwealth University, undated-b; Virginia Commonwealth University, undated-c) that attract students into the health care workforce and incentivizes them to stay in Virginia. They also mentioned the MedServe model from North Carolina (MedServe, undated), which takes advantage of gap year and allows for fellowship opportunities whereby students get residency in North Carolina and typically chose to stay there because the tuition is less.

Conference participants also offered engaging existing community health care workers and strategizing to transition them into licensed/specialized roles in primary care and behavioral health as a potentially promising solution for increasing the workforce capacity in these fields. They raised transitioning service members (as well as military spouses)—many of whom are qualified health care experts transitioning from the military—into civilian employment, anchoring them in Virginia as a strategy to retain talent. Participants recommended evaluating recruitment opportunities such as military medical school physician preparatory program (College Recon, 2021), designed to give promising enlisted service members interested in becoming military physicians a pathway to medical school.

Rural stakeholders stressed the importance of creating pathways for rural residents to enter nursing, primary care, and behavioral health careers:

> Recruitment locally is important. Especially in rural areas. Recruit from rural high schools. True for all three fields.
>
> *—Primary care physician/educational leader*

> Students from local community college . . . plug into a nurse externship and they work as CNA until they finish their program and they retain about 50 percent of them. There's a nurse in the hospital that is the key liaison to community college.
>
> *—Rural hospital leadership*

> There are only a few med schools in rural settings in the U.S., and most are D.O. programs.
>
> *—Primary care physician/educational leader*

Competency-Based Education

Behavioral health stakeholder discussed how practice hours for behavioral health training should be set based on the level of competency. They noted that individuals should be assessed based on their skills and competencies rather than solely relying on their level of education and training. One interviewee shared,

> There is a limit, 500 minimal of practice hours. Some people will be competent at 300 but still have to do 500; others will not be competent even at 700.
>
> *—Behavioral health representative*

Work-Based Learning for Pay

Work-based learning, paid and unpaid, is not a new concept—although it is one that has garnered increased attention of late as a tool for addressing a variety of education, training, and workforce issues in health care and non–health care occupations. Health care occupations have historically included more work-based learning in education and training than other occupations (e.g., clinical rotations, clinical intern or clerkships, and residencies). However, stakeholders are increasingly interested in expanding these options across different health care occupations, particularly in nursing (Goolsbee, Hubbard, and Ganz, 2019; Love and McCarthy, 2018; U.S. Department of Labor, undated). Residencies and apprenticeships are two primary forms of work-based learning under consideration by health care workforce stakeholders in Virginia and beyond (Wilkinson, 2023).

Virginia is currently proposing to build upon its existing 12-month apprenticeship or "learn and earn" programs for certified nursing assistants to include nursing staff at all levels based on collaborative partnerships between K–12 and postsecondary educators and health systems and other employers (Commonwealth of Virginia, 2023). Virginia joined a number of other states that offer general nursing apprenticeships (Love and McCarthy, 2018; U.S. Department of Labor, undated). The Council on Adult Education and Learning partnered with nine states under a U.S. Department of Labor grant to offer an apprenticeship that combines online academic instruction and work-based training and mentoring while the student earns a paycheck (U.S. Department of

Labor, undated). Nevada also offers a nurse apprenticeship program (Figure 2.1), including a transportation voucher for students/apprentices who travel at least 50 miles one way in this largely rural state (Nevada Rural Hospital Partners, undated).

In the study interviews, we heard about the importance of paid internships in behavioral health. One interviewee commented,

> Paid internship for behavioral health should be an option instead of frontloading all the debts and then getting the hours. Behavioral health apprenticeship exists in the country . . . and Virginia has just authorized its first one.
>
> —*School of nursing representative*

Licensing Exam and the Licensure Process

Behavioral health stakeholders expressed a lot of frustration with the licensing exam and licensure processes in the Commonwealth, indicating that examinees should have more frequent opportunities to retake the exam and that the licensure timeline needs to be truncated. Interviewees commented that,

> The amount of time that it takes once you submit your application [for licensure] to get that turned around, it's criminal. [The Department of Health Professions] is working to bring that down.
>
> —*Community health/behavioral health representative*

> Social workers have to get a huge portion of clinical hours before they can take the exam. If you fail, you have to wait 90 days [before retaking].
>
> —*Community health/behavioral health representative*

Importantly, many nursing apprenticeship programs center around career pathways with defined training levels that build on each other, such that an apprentice has a clear pathway(s) from nursing aid to nurse leader positions (U.S. Department of Labor, undated). This follows current practice in postsecondary education and training around "guided pathways" that aim to clarify and support student pathways through postsecondary enrollment to credential completion (Bailey, Jaggars, and Jenkins, 2015).

In general, research suggests that apprenticeship and earn-and-learn models might positively impact individual learning and wage outcomes (Reed et al., 2012; Kemple 2008), but the size of these potential positive impacts likely depends on the economic and other contextual factors of apprenticeships (Novella and Pérez-Dávila, 2017; Dougherty and Ecton, 2021). However, evidence on the effectiveness of apprenticeships generally, and particularly in health care, is still developing (Rosen, Visher, and Beal, 2018; Goolsbee, Hubbard, and Ganz, 2019). To date, research on nursing apprenticeships is highly descriptive but suggests financial incentives and mentoring activities are central to training and retaining new nurses (Brook et al., 2019). Apprenticeships are also a potentially important mechanism by which to increase *and* diversify the recruitment pool for new nursing staff (Love and McCarthy, 2018).

While physicians complete an obligatory residency before becoming fully certified to practice, residencies are not common in other health care professions. Moreover, it is noteworthy that policy perspectives on residencies for physicians and other health care professionals are trending in opposite directions. While residencies are often seen as a barrier to practice in primary care for physicians who have completed medical school (Boyle, 2020), residencies are seen as an answer to enhanced recruitment of new nursing and other health care professionals (Brook et al., 2019; Goodwin et al., 2021; Finneran and Kreye, 2019; Goolsbee, Hubbard and Ganz, 2019).

Nursing residencies vary in duration but appear to uniformly include work-based learning upon completion of a regular degree program and under the supervision and support of a clinical preceptor and/or mentor. Evidence is limited on the effectiveness of residency programs for nursing professions. However, it appears that programs 12 months in duration can reduce nursing staff turnover in the first year after initial hire (Perron et al., 2019). Residency programs might also improve confidence, competence, job satisfaction, critical thinking, and mental well-being for a nurse (Edwards et al., 2015).

In contrast to policy momentum supporting the expansion of residencies for nursing professionals (especially new RNs and NPs), policy efforts related to the medical residency have focused on ensuring the residency is not a barrier to general practice. Virginia, for example, introduced legislation in 2023 to allow individuals who successfully completed medical school but did not immediately match to a residency to practice as an associate physician in the interim. Though this legislation ultimately did not pass, other states have established laws to allow physicians to practice without completing a residency, including Missouri, Arizona, Florida, Washington, Arkansas, and Utah (Sawhney, 2022). States have reduced residency requirements in other ways. For example, Tennessee now allows foreign-trained physicians to practice medicine without completing a residency in the United States. (Hollowell, 2023). Others go further, compressing physician education overall to reduce time to full independent practice while still providing standardized training under medical experts in a given field. In 2009, Shanghai, China began piloting a program to train fully practicing physicians in eight years—five years for a medical bachelor's degree and a three-year residency (Zheng et al., 2020). This represents a reform over the traditional Chinese model of a bachelor's in medicine followed by an apprenticeship with a local, practicing physician. Under Shanghai's pilot, a three-year residency aimed to provide more standardized training with national experts in a field to improve the overall quality of the physician workforce while still keeping a new physician's time to independent practice minimal. Others have simply established new medical schools to provide additional residencies or funded new residency positions (e.g., Brazil, Hone, et al., 2020; Centers for Medicare and Medicaid Services, 2021). As is typically the case in health care and other workforce research, little research evaluates the impacts of these interventions on physician training, overall supply, retention, quality care provided, or other outcomes (Hone et al., 2020).

Education/Training Curricula

In response to whether stakeholders believe that medical school education and/or primary care training should be shortened as a recruitment strategy, stakeholder shared,

> Revamp the [primary care] curriculum instead of shortening the training period for providers. Students benefit from exercising knowledge in real world environment and see what they learn in the classroom does not jive with real world, it's a lesson to learn. Get the book knowledge, and then learn the practical experience. Shortening education will make them less prepared; curriculum needs more updating. Programs that offer immersion with the community, such as Community Nourishment Project, relieves the jaded-ness and preserves empathy. But if data is showing no measurable change or improvement in outcome from shortening the education/training period, then it should be explored.
>
> *—Rural community health/education representative*

> There is a generational change, current generation is more aware of the world, in tune with emotional needs of people, so a revamping [of the curriculum] will need to address things like multiple disabilities, insurance barriers. . . . Social determinants of health need to be looked at from modern perspective.
>
> *—Rural Community health/education representative*

> While I do think that there is a lot of value to shortening the curriculum between high school and college, doing that kind of dual program, I just don't think that it will take root in Southwest Virginia until we address the infrastructure issues that we see with K through 12 education in this area.
>
> *—Rural community health/education representative*

Rural stakeholders stressed the importance of providing cultural awareness training to students and trainees in rural areas:

> There is an element of mistrust running through the population. It's an underserved community, coal mining camps, etc., so the providers need to be aware of the [need for] cultural competency.
>
> *—Rural community health/education representative*

> When you have health care professionals making assumptions about patients and lack cultural competency of that local region, there is a problem. Jobs held by local leaders can help alleviate this concern.
>
> *—Rural community health/education representative*

Advanced Education/Training Technologies

An example from midwifery demonstrates innovations in clinical practice and education through the use of web-based technologies, such as three-dimensional (3D) virtual learning environments in interprofessional education. A nurse-midwifery education program at a Southeastern U.S. university provides web-based interprofessional education for nurse-midwifery and third-year medical students using the Virtual Community Clinic Learning

Environment (VCCLE). The VCCLE is a 3D, web-based, asynchronous, immersive clinic environment where students interact with instructor-controlled virtual patients and virtual preceptor avatars. They move through diagnostic sequences and are asked to develop a care plan for women throughout the lifespan. Through this interface, students learn both clinical competencies and competencies for interprofessional collaborative practice (Reis, Faser, and Davis, 2015).

More students, including those who live in rural and underserved regions and who otherwise may not be able to attend a traditional onsite campus, are provided the opportunity to complete quality midwifery education through online programs, which in turn may help expand the women's health care provider workforce (Arbour, Nypaver, and Wika, 2015). Furthermore, simulation-based learning is increasingly seen as an effective strategy to develop student nurse-midwives into effective health care team members (Warren et al., 2016; Ruyak et al., 2018).

Training programs that integrate the use of technology are needed to prepare students for the future of service delivery in psychology. Training opportunities in telepsychology can equip students to develop, implement, and evaluate innovative modalities for mental health care. However, few options are available for trainees seeking to acquire these experiences, and while guidelines for service provision using technology are emerging, guidelines for and documented examples of training programs in telepsychology are virtually nonexistent. The Telehealth Counseling Clinic, located at the Texas A&M Health Science Center, has developed a training model to prepare the next generation of psychologists to work with new technology to provide counseling services to low-income and uninsured individuals living in designated Mental Health Professional Shortage Areas in rural Texas (McCord et al., 2015).

The U.S. Department of Veterans Affairs Connecticut Healthcare System (VACHS) is one of five Centers of Excellence in Primary Care Education pilot sites. The overall goal of the CoEPCE program, which is funded by the Office of Academic Affiliations, is to develop and implement innovative approaches for training future health care providers in postgraduate education programs to function effectively in teams to provide exceptional patient care. This longitudinal study works to understand the effect of a combined nursing and medical training model on professional identity and team development at the VACHS CoEPCE site. The study findings suggest that internal medicine residents initially struggled to understand NPs' roles and responsibilities, whereas NP trainees doubted their ability to work alongside physicians. At the end of one academic year, these uncertainties disappeared, and a strong interprofessional team of health providers developed. This study provides early evidence of successful interprofessional collaboration among NPs and internal medicine residents in a primary care training program (Meyer, Zapatka, and Brienza, 2015).

Number of Residency Slots

Behavioral health stakeholders indicated the need for increasing the number of psychiatry residency slots. One interviewee said,

> The national bodies only give you certain slots, that's where faculty ratios come in. The general assembly got focused on child psych, so ten more seats opened up for residencies. But it is piecemeal. It is not a silver bullet. It is all intertwined. Paying for more slots is helpful, but getting national boards to allow more slots is important.
>
> *—Behavioral health representative*

Notably, there is recent precedence for Congress approving 1,000 new residency slots targeted at training in rural and other underserved areas (Rains et al., 2023).

Behavioral Health and Primary Care

Behavioral health stakeholders in our interviews indicated that behavioral health is often seen as separate from primary care, leading to a fragmented approach to health care. They noted that integrating behavioral health services into primary care settings and training primary care providers to address behavioral health issues can help improve access and quality of care.

Interventions That Augment the Workforce by Increasing Efficiency

Geographic Reallocation of the Health Care Workforce

As mentioned above when discussing financial incentives for recruitment, the Virginia State Loan Repayment program (VA-SLRP), administered by Virginia Department of Health, Office of Health Equity, incentivizes health care workers to serve for two years in underserved locations in return for $7,000 to $20,000 of state-funded student loan repayments (up to $40,000 per recipient when including matching Federal and employer funds).

Although moving a health care worker to an underserved location in Virginia often produces no net gain for Virginia recruitment, it may still enhance the workforce by increasing structural efficiency. Workers functioning in a more efficient system may produce improved health outcomes in Virginia.

For example, one physician interviewee mentioned how addressing workforce shortages in underserved areas of Virginia can increase the overall efficiency of the system by reducing the number of emergency cases in underserved areas. This interviewee noted that,

> We don't have nurses and physicians and primary care people in the right places. . . . We don't have enough people in rural areas, underserved areas and that just puts pressure on everybody that this makes patients sicker. So, when they go to Regional Medical centers, they're sicker.
>
> *–Physician stakeholder*

The Virginia Department of Health has collected some preliminary evidence that recipients of SLRP often stay in underserved areas even beyond their years of required service. Data from 97 SLRP recipients who completed their obligatory service during 2021 or 2022 show that 51 percent remained in their original obligation post as of 2023. Future analysis of how many SLRP

recipients move to locations that are not HPSAs will reveal the return on investment that SLRPs provide. If, for example, the state provides $10,000 to help persuade a health care worker to serve in a HPSA for one year, that may be a steep price to pay for this improvement in Virginia's labor allocation ($10,000 per year). If, on the other hand, the program expects 50 percent of SLRP recipients to serve in a HPSA for decades after their one or two-year obligation, then the investment may be well worth the cost (less than $1,000 per year of HPSA service, assuming the worker wouldn't have moved to the HPSA without the incentive).

Technology Interventions That Improve Health Outcomes Produced by a Given Workforce

Some of the technologies mentioned earlier in this report may increase retention or recruitment of health care workers, and they can also increase the structural efficiency of any given workforce. For example, even if a word recognition or artificial intelligence (AI) technology that facilitates notetaking has little or no effect on retention or recruitment, it may improve the health outcomes produced by any given workforce by freeing up worker hours. Hours spent performing notetaking or physically demanding tasks can then be spent providing other services that improve health outcomes. Clinical decision support and other digital tools such as a patient's risk calculator can reduce physician cognitive burden and allows for more informed decisionmaking, better tracking, and improved communication with patients and across the care team (Mujumdar and Jeffcoat, 2022). Even during the upcoming 15-year window that is the focus of this study, hospitals are likely to deploy machines that lift patients, perform sanitation tasks, and fetch supplies (Wang, 2022), which should free up significant health care worker time to help patients in other ways.

The health care sector is unlikely to see the decline in demand for workers that many other sectors of the economy have experienced, but even marginal use of machine learning has already been demonstrated to augment the amount of diagnostics a single worker can perform (Henriksen, 2022). These applications could eventually empower any given number of primary care physicians to diagnose a greater number of patient conditions, and may also improve the accuracy of diagnoses, both of which will improve health outcomes.

Rural stakeholders noted the importance of technology in creating work efficiency and for improving patient outcomes:

> Data tracking/health information exchange system can help with patient care in rural areas. If we had a good data tracking system, the health information exchange—like ConnectVirginia, which is still not operationalized after 3–5

> years—we could facilitate patient-centered care plans. . . . This exchange can facilitate patients receiving care anywhere in Virginia.
>
> —*Rural representative*

Interventions That Improve Health Outcomes Produced by a Given Workforce

Removal of reporting, licensing, and other administrative burdens placed on health care workers can increase health outcomes produced by any given health care workforce. Interventions that reduce these burdens are discussed above in the context of retention and recruitment, and it is also worth noting that such interventions can bolster any existing workforce by improving the structural efficiency of the system in which they operate.

Chapter 3. Recommendations for Strengthening the Virginia Health Care Workforce

Shortages in nursing, primary care, and behavioral health workforces are an on-going challenge across most of the United States and in Virginia. In the previous chapter, we identified potential interventions to address key drivers of Virginia health care workforce shortages, while in this chapter we recommend prioritizing a subset of those interventions based on their potential impact and their practical accessibility.

Our results show that multiple interventions involving all key stakeholders in the Commonwealth are needed to reduce or eliminate the health care worker shortages. We forecasted these shortages using a model of supply and demand that quantifies the impact one or several interventions may have on the future supply of workers. Stakeholders that may implement these interventions include health care and educational organizations, public and private enterprises, and lawmakers—all of whom may leverage innovative methods and technology to bolster the health care workforce. Our labor supply and demand forecasts indicate that if these stakeholders do not intervene, workforce shortages will only worsen over the next 15 years. Our models also help to quantify the extent to which various interventions may reduce or eliminate workforce shortages in the coming years.

This chapter highlights the most promising interventions for improving retention, recruitment, and the efficient use of Virginia's health care workforce. Some of the interventions we identify help to bolster the workforce in more than one way (i.e., retention-, recruitment-, and/or efficiency). However, each recommended intervention is assigned to the facet of workforce improvement that it affects the most. For example, an intervention classified under "Retention" can also impact recruitment, but it primarily impacts retention of the existing workforce. If retention interventions result in creating better jobs in these health care fields and, consequently, happier workers, this may impact the reputation of the field, which may encourage others to join those workforces.

Within each grouping, we also categorize interventions by whether they are financial, academic, nonacademic, or institutional. These categorizations facilitate mapping interventions to the key actors or stakeholders that are best placed to implement them. For example, a state government representative working on the budget may wish to focus on the interventions that are financial.

Although we identify interventions specific to nursing, primary care, and behavioral health, some of the interventions are cross-cutting and pertinent to all three fields. Increasing pay and other financial incentives, reducing the burden of documentation, investing in professional development, implementing team-based care, increasing workforce diversity, leveraging cross-sector collaboration, reevaluating scope of practice, and leveraging technology are important for

workforce retention in all three fields: nursing, primary care, and behavioral health. Providing scholarships, loan forgiveness, and other support, conducting more effective outreach to communities, correcting the public image of the health professions, data-tracking, and targeted recruitment strategies for underrepresented communities are also important for recruitment in all three fields. Interventions that increase workforce productivity, such as reallocation of workers to where they are most needed, leveraging technology to improve patient outcomes, and removing work barriers that impede worker efficiency and productivity are also pertinent to all three fields.

Our quantitative forecasts support the conclusion that many interventions are applicable to all three workforces, but their effect size can vary depending on the workforce. For example, raising real wages always has at least some positive effect on retention and recruitment, but our model suggests that the same percent increase in pay may have a greater effect on expanding the primary care and nursing workforces than it has on expanding the behavioral health workforce. Although our model assumes real wages increase by 2 percent each year for all baseline scenarios, and real wages increase 3 percent each year for all wage increase scenarios, the effect of wage increases after 15 years on each workforce's number of FTE workers (relative to baseline forecasts) varies: Our 2038 primary care workforce supply forecast in the wage increase scenario is 4.4 percent larger than our baseline forecast of the 2038 primary care workforce, while nursing is 3.2 percent larger, and behavioral health is 2.7 percent larger than the baseline forecasts.

Key Findings

The results from the system dynamics model show that if current trends persist, nursing, primary care, and behavioral health workforce shortages will increase across Virginia.

By reducing the barriers that cause reluctance to work in the field of nursing by half—barriers such as workplace violence, trauma, and stress—we forecast a rapid increase in the number of nurses employed. However, over a period of 15 years, increased recruitment will have a more dramatic effect on workforce numbers, surpassing the effect of decreased barriers. Increasing nurse wage growth from an average 2 percent annual growth to 3 percent annual growth also increases the number of nurses retained and recruited, but not as much as the other interventions do. As expected, a combination of all three interventions has the largest effect on the forecast of nurse employment, boosting the total number of FTE nurses employed in 2038 by a little more than 10,000 above the baseline projection.

Unlike our forecasts for RNs, our forecast for the number of active primary care workers in the Commonwealth shows a decline under baseline conditions, making the future shortfall in primary care workers even more severe than for nursing alone. Similar to our model for nursing, the largest immediate boost to the workforce would come from cutting in half the number of barriers that make workers reluctant to work in the field. Over the course of 15 years, the effect on total employment of increasing wage growth catches up to the effect of decreasing barriers.

The effect of increasing recruitment is more modest because baseline recruitment begins at very modest levels. An ambitious combination of all three interventions (the multi-intervention scenario) would boost total employment by more than 2,000 workers.

If current conditions persist, the number of behavioral health workers employed in Virginia is forecast to slowly decline in the coming years. Implementing any one of the three interventions promises to keep the existing workforce numbers at 2023 levels, but only by combining all three interventions can Virginia produce a sustainable increase in behavioral health workers employed.

The following sections include key takeaways from the study's environmental scan and qualitative and quantitative analyses regarding solutions for nursing, primary care, and behavioral health workforce retention, recruitment, structural efficiency, and related innovations.

Nursing Retention and Recruitment

- To successfully retain the current nursing workforce in Virginia, the Commonwealth needs to ensure safe and supportive workplaces that prioritize nurse autonomy in scheduling and enforce zero tolerance for workplace violence.
- Given the level of risk involved in nursing work (e.g., exposure to infectious diseases, mental trauma, and potential violence), especially in inpatient and emergency department settings, nurses at all levels need to have health insurance that adequately covers such risks.
- Nurses need to spend more time at bedside and less on documentation (i.e., "charting") at the computer. Voice-recognition and artificial intelligence (AI) technologies may help facilitate reducing documentation burden for nurses.
- Patient-to-nurse ratios need to be replaced with patient to "care team" ratios and need to factor in patient acuity and complexity and the team's combined level of experience and expertise to inform patient assignments. Such an approach will allow providers to work at the top of their license by including and shifting tasks that do not require as much expertise to other health care workers on the team.
- Bedside nurses need to have an active voice in governance, and their professional growth needs to be supported by employers.
- Resources are needed to address nursing staff mental health and to mitigate burnout.
- Recruiting a diverse nursing workforce that reflects the communities served by a health system can help retain nurses from historically underrepresented communities.
- Scholarships, loan forgiveness, and other forms of financial support need to be expanded and robust advertisement strategies implemented so that those interested in nursing professions can see a path forward in the field.
- Investments in expanding nursing slots at colleges and universities need to occur concurrently with expanding clinical training facilities and the number of nursing faculty and preceptors.
- Recruiting retired nurses to serve as faculty and preceptors in sufficiently paid positions could help increase nursing faculty and preceptor capacity.
- More pathways need to be created for individuals to enter nursing fields and work-based/learn and earn opportunities should be leveraged—especially through health system nursing college/university partnerships.

- To improve recruitment, the public image of nursing professions needs to be improved, and specific strategies need to be developed for outreach to school-aged children and communities underrepresented in nursing through collaboration between hospitals and health systems, nursing colleges and universities, and K–12 schools.

Primary Care Retention and Recruitment

- Payment increases (especially Medicaid payments), loan forgiveness, and other financial incentives are important for retaining primary care providers. Virginia should join the ranks of 21 other states that currently mandate a minimum state primary care spend to ensure that the Commonwealth has the resources needed to retain and expand this workforce (Johnson et al., 2022; National Conference of State Legislatures, 2023).
- Reducing patient-provider ratios by implementing team-based care in primary care settings should be evaluated as a strategy to reduce the burden of high patient volumes on providers.
- Implementing strategies for provider professional and personal development will be important to ensure continued professional growth and retention of the primary care workforce.
- Increasing representation from PAs and NPs in primary care should be considered as a cost-effective approach to increase primary care capacity.
- Virginia should provide scholarships for underrepresented groups as opposed to loan forgiveness.
- Furthermore, creating opportunities for medical students to do rotations in federally qualified health centers (or requiring such rotation as a core elective) can increase provider capacity in these settings and can serve as a recruitment tool.
- Given that African American/Black physicians and Doctors of Osteopathic Medicine (DOs) are more likely to enter primary care fields and practice in underserved communities, targeted recruitment strategies to attract physicians from these communities to primary care professions may be an effective recruitment strategy for primary care.
- The Virginia legislature should consider adopting legislation, similar to that adopted by Tennessee (National Academies of Sciences, Engineering, and Medicine, undated), allowing physicians trained in residencies outside of the United States to practice in Virginia without having to repeat a residency.
- Virginia should adopt legislation to allow medical school graduates to practice primary care under supervision while waiting for a medical residency match. This policy intervention can help recruit additional primary care capacity in the Commonwealth.

Behavioral Health Retention and Recruitment

- Increasing payment for behavioral health services is a critical step for both retention and recruitment of workers in the behavioral health professions. Increasing Medicaid payment, in particular, can help with retention. Increasing payment can help reduce provider patient volume (or panels) by ensuring that behavioral health services are supported through adequate staffing so the needed care can be delivered to every patient.
- Documentation and regulatory and reporting requirements should be reevaluated in order to reduce redundant and unnecessary tasks for providers that lead to stress, burnout, and inability to focus more on direct patient care.

- Addressing the mental health needs of behavioral health providers who work in a field that is often very stressful can help to mitigate burnout and attrition.
- To recruit new behavioral health providers, several actions will be critical, including creating new (and shorter) pathways to behavioral health professions and expanding the pool of preceptors and licensed supervisors by leveraging retired providers and creating mechanisms to pay these individuals to reduce the financial burden on students and trainees (for example, by allowing providers to bill for supervised visits).
- The Commonwealth should evaluate mechanisms for competency-based certification so that persons can get certified regardless of the number of hours of preceptorship/licensed supervision they receive if they demonstrate proficiency in the required skillsets.
- In addition to shortening the licensing process for behavioral health professions, the Virginia Department of Health Professions should consider allowing examinees that do not initially pass the exam to take the licensure exam more frequently.
- Create mechanisms to help students pay for preceptorship/licensed supervision.
- Loosen strict behavioral health preceptor and licensed supervisor requirement such as educational degree requirements for preceptors /licensed supervision, preceptor/licensed supervisor-to-student ratios, and need for preceptors/licensed supervisors in community settings.
- A public education campaign that both helps counter the stigma associated with working in behavioral health fields and highlights the rewarding aspects of the work—especially in communities underrepresented in behavioral health—should be prioritized as a recruitment strategy.

Increasing Structural Efficiency and other Innovations

In addition to retention and recruitment interventions, the Commonwealth should consider strategies that optimally use the current workforce through increasing structural efficiency. Some of the interventions that we identified have limited evidence behind them to determine if they increase the number of available health care professionals or otherwise address critical health care workforce issues (e.g., burnout). Nonetheless, some are innovative and worth considering:

- Incentivizing existing nursing, primary care, and behavioral health workers to move from areas of more provider capacity to those of less capacity in Virginia can help to achieve an allocation of labor that maximizes overall health outcomes.
  - In the case of primary care and behavioral health, some of this reallocation of labor may be achieved by increasing opportunities for telehealth for providers, effectively (though not physically) moving labor to the locations with the highest need.
- Removing work barriers—such as reducing documentation, reporting, and regulatory requirement and/or leveraging technologies such as voice recognition and AI to help with these tasks—can both create efficiency and potentially increase worker job satisfaction to reduce attrition.
- One strategy that can help increase structural efficiency in both primary care and behavioral health is to increase locations in the Commonwealth that offer both services in the same setting—implementing a team-based approach to more efficiently address related mental health illnesses.

- The Commonwealth should consider offering loan forgiveness for all individuals who go into primary care and not just those that practice in federally qualified health centers and HPSAs.

Furthermore, regular health care workforce data-tracking may be an effective strategy to inform interventions for retention, recruitment, and structural efficiency, and to pivot as needed to ensure that the health care needs of Virginia residents are met. Health care workforce data exist in Virginia Commonwealth University's ACORN, in the Virginia Longitudinal Data System, and at the George Mason University Center for Health Workforce. Similar data-tracking should be implemented by health professions colleges and universities to inform strategies to retain graduates in the Commonwealth (Mason Center for Health Workforce, 2023).

Also, although there are promising programs in Virginia focused on health care workforce retention and recruitment, there is currently no mechanism for tracking and disseminating these programs. A clearinghouse for tracking and sharing current practices and programs can facilitate dissemination of promising interventions. The newly established Virginia Department of Workforce Development and Advancement will play a key role in supporting workforce data infrastructure across different industries. In close collaboration with this department, VHWDA could take on such role for health care workforce data.

Transitioning service members (as well as military spouses)—many of whom are qualified health care experts—into civilian employment and anchoring them in Virginia is a strategy that may help retain talent in the Commonwealth and expand the health care workforce.

Health Care Workforce Retention and Recruitment in Rural Settings

Many of the interventions we identified apply to urban, suburban, and rural settings in Virginia. However, there are some unique considerations for health care workforce development in Virginia's rural communities.

- One of the most important factors for retention and recruitment in Virginia's rural areas is developing infrastructure such as housing, transportation, and child care.
- Another important intervention in these settings is providing cultural awareness training to incoming students, trainees, and providers so that they are able to better understand the local community and integrate.
- Recruitment of local students from these communities is an effective retention strategy to bolster rural workforces—rather than convincing providers from elsewhere to move. This recruitment would be most effective if it is paired with providing upfront financial support for education and life-expenses.

Interventions by Strength of Evidence and Key Stakeholders for Implementation

Table 3.1 is a guide to interventions reflected in Tables 3.2 and 3.3 to help rank each intervention by strength of evidence based on our analyses. Table 3.2 includes interventions that

primarily impact retention, and Table 3.3 includes interventions that primarily impact recruitment. The key actors/stakeholders important for implementing each intervention are noted in each table.

As mentioned above, simulations that forecast increases in workforce supply caused by wage increases indicate that all three health care workforces would increase if real wages increase. Additionally, retention and recruitment interventions were modeled, but because of the lack of evidence in the available data and peer-reviewed literature on the effectiveness of most barrier reduction and recruitment interventions, the simulation model does not support definitive statements regarding specific interventions for barriers and retention. This underscores the critical need for rigorous evaluation research—not only for understanding a single intervention's effects on the workforce in a given context but to understand that intervention's potential effects in other contexts given changing empirical conditions and in tandem with other interventions in simulation/systems models. Given these features of the simulation model, we note evidence for a specific barrier and recruitment intervention (e.g., preceptor capacity) in Tables 3.2 and 3.3 based on the environmental scan and the qualitative data analysis below, with one exception: It is important to note that evidence from simulations for wage-specific data also support wage-related interventions for health care workers in Tables 3.2 and 3.3.

Table 3.1. Guide to Intervention Tiers

	Tier 1 interventions are strongly supported by the analyses. The interventions are supported by the literature review (evaluation studies) *and* were identified multiple times across the multi-stakeholder conference, interviews, and/or focus group data.*
	Tier 2 interventions are moderately supported by the analyses. These interventions are supported by the literature review (non-evaluation studies) and were identified multiple times across the multi-stakeholder conference, interviews, and/or focus group data.
	Tier 3 interventions have some support in the literature review *or* were identified in the multi-stakeholder conference, interviews, and/or focus group data.

* Support for an intervention in the qualitative work indicates that the intervention has valence—or is deemed an attractive option by interviewees—but it does not indicate whether the intervention will have a positive effect on retention, recruitment, or productivity.

Table 3.2. Interventions for Health Care Workforce Retention

Tier	Retention Intervention Category (Key Implementation Stakeholders)	Specific Intervention
Tier 1	Resiliency and well-being (health care organizations)	1. **Implement programs to address mental health and well-being among health care workers**—especially in behavioral health professions 2. **Address underlying causes of health care worker stress and burnout** such as inappropriate patient-provider ratios, throughput requirements, documentation requirements, low and/or differential compensation for care provided, and lack of basic supplies.
Tier 1	Scope of practice and practice agreement (Legislature)	1. **Reevaluate license restrictions for PAs and NPs** to increase the appeal of primary care for these health professionals and to expand primary care capacity.
Tier 2	Team-based care (health care organizations)	1. **Implement team-based care** to mitigate the stresses of high patient to provider ratios and large patient panels and take patient complexity and acuity into account when assigning patients to providers.
Tier 2	Pay increase and other incentives (health care organizations)	1. **Increase pay for nursing, primary care, and behavioral health** providers and provide appropriate benefits—including health insurance coverage commensurate with risks involved in health care delivery (e.g., exposure to disease, despair, and violence). Provide assistance with transportation, child care, and housing.
Tier 2	Documentation burden (health care organizations, systems, legislature)	1. **Evaluate technologies**—such as voice recognition and AI—that may assist with reducing documentation burden.* 2. **Revisit documentation requirements** to identify areas of redundant and/or unnecessary documentation that could be removed from documentation requirements.
Tier 2	Workplace diversity (health care organizations, educational entities)	1. **Develop retention strategies centered around creating more diverse workplaces** for nursing, primary care, and behavioral health.*
Tier 2	Personal/professional development (health care organizations)	1. **Invest in making professional development opportunities** available to staff and increase recognition efforts.
Tier 3	Workplace violence (health care organizations, legislature)	1. **Evaluate legislation to increase legal consequences related to violence toward health care providers**—on par with those currently in place for assaulting prehospital providers and first responders.* 2. **Evaluate health care organization policies** around violence toward health care providers and identify strategies for more strict enforcement of those policies.
Tier 3	Cross-sector collaboration (health care organizations, educational entities)	1. **Identify and leverage opportunities for cross-sector collaboration** between the health care sector, educational organizations, and public and private entities to increase opportunities and funding for nursing, primary care, and behavioral health exposure and training.
Tier 3	Continuing education (health care organizations, educational entities)	1. **Evaluate mechanisms to increase continuing education opportunities and funding**—especially through leveraging collaboration between health care organizations and educational entities.

* Designates an innovative intervention.

Table 3.3 Interventions for Health Care Workforce Recruitment

Tier	Recruitment Intervention Category (Key Implementation Stakeholders)	Specific Intervention
Tier 1	Scholarship, loan forgiveness, and other support (private entities, health care organizations, educational entities)	1. Increase **scholarship opportunities** in Virginia. 2. Raise **public awareness** of loan forgiveness and scholarship opportunities. 3. Develop mechanisms for rural applicants and first-generation students to receive **loan forgiveness** upfront.* 4. **Include support for housing, transportation, and food** for rural and first-generation students.
Tier 1	Wages and regulations for educators (private entities, health care organizations, educational entities, Virginia Department of Health Professions)	1. **Increase wages for nursing faculty and preceptors** to levels similar to engineering, business, and other faculty that receive higher wages. 2. **Loosen strict behavioral health preceptorship requirements,** such as educational degree requirements for preceptors, preceptor to student ratios, and need for preceptors in community settings.* 3. **Create mechanisms to pay for behavioral health preceptorship and licensed supervisors** to remove this financial burden from students/trainees.*
Tier 1	Work-based learn and earn (health care organizations, educational entities)	1. **Offer work-based learning, paid and unpaid.** Health care occupations have historically included more work-based learning in education and training than other occupations (e.g., clinical rotations, clinical intern or clerkships, and residencies). Health care stakeholders are increasingly interested in expanding these options across different health care occupations—particularly in nursing.
Tier 2	Recruiting youth and members of underserved communities (health care organizations, educational entities)	1. **Develop (and/or expand on current programs) to expose K–12 children to health professions**. Such programs should include collaboration between educational and health care entities. 2. **Specific outreach strategies for youth from underrepresented communities are needed**. Such interventions should aim to include both children and their parents in outreach efforts and should, ideally, be delivered by health care professionals from similar backgrounds.*
Tier 3	Preceptor/licensed supervisor capacity (health care organizations, educational entities)	1. **Leverage nursing and behavioral health retirees** to increase pool of preceptors/licensed supervisors.* 2. **Create mechanisms to compensate preceptors/licensed supervisors**—including ability to bill for supervised visits.*
Tier 3	Outreach and public image (health care organizations, educational entities)	1. **Change the image of health professions through public education campaigns.** Such efforts should focus on highlighting the rewarding nature of nursing and behavioral health work, and removing the stigma associated with becoming a behavioral health professional.
Tier 3	Online instruction (health care organizations, educational entities)	1. **Increase opportunities for online learning** to increase access and flexibility to local and nonlocal clinical introductory level education.

Tier	Recruitment Intervention Category (Key Implementation Stakeholders)	Specific Intervention
Tier 3	New pathways (health care organizations, educational entities)	1. **Create multiple entry ramps and educational pathways** to nursing and behavioral health careers as a recruitment strategy. This includes developing academic programs at different levels, such as associate and bachelor's degrees for behavioral health, to provide more immediate relief to the workforce shortage. 2. **Offer paid internships at the high school level** so students can be exposed to health professions; match undergrads with medical students and promote mentorship alongside internship.
Tier 3	Licensing exam and licensure (department of Health professions)	1. **Significantly truncate the duration of application for licensure** in behavioral health fields and allow students that need to retake the licensure exam to **have more frequent opportunities to sit for the examination**.
Tier 3	Advanced education/training technology (health care organizations, educational entities)	1. Increase access to **simulation-based learning** in nursing. 2. Increase access to **training opportunities** in telepsychology.

* Designates an innovative intervention.

Chapter 4. Intervention Implementation

Implementation of the listed interventions in Chapter 3 by VHWDA will require multiple Virginia stakeholders to be involved, including those representing health care, education, labor, both public and private entities, and local and state government and agencies, among others. Importantly, VHWDA will need to function as a coordinating entity bringing together a coalition of key stakeholders and guiding Virginia in taking the steps needed to implement interventions for retention, recruitment, and creating structural efficiency. These steps include the following:

- Identify the list of key stakeholders that need to be part of the health care workforce coalition.
- Under the coalition, form a number of committees tasked with considering the various interventions for implementation (for example, separate committees focused on retention, recruitment, and structural efficiency, respectively).
- Determine the financial cost, feasibility, equity and other important characteristics of each intervention and what funding source can and should be used to pay for them.
- Identify the key partnerships that need to be developed in order to successfully implement the interventions.
- Identify any specific executive, legislative, agency and budgetary action that needs to be considered as part of the implementation process for each intervention.
- Prioritize which interventions to implement (and in what order) based on input from the above-mentioned stakeholders.
- Determine the timeline for implementation of various interventions.
- Determine what data to collect on each program as success metrics to use in intervention/program evaluation.

Implementation Timeline

We recommend that VHWDA develop the health care workforce coalition within three months and form the needed committees under the coalition within six months from the time this report is published. Overall, given the urgency to retain and expand the health care workforce in Virginia, efforts should be made to implement retention recommendations in one to three years and the recruitment interventions in three to five years from the time the work of the coalition begins.

Communication Tools

Part of successful implementation of any of the recommended interventions by VHWDA is engaging the key stakeholders in the Commonwealth. A first step in engagement is effectively communicating the need to develop the health care workforce (and coalition) in the

Commonwealth by sharing findings from this report. This can be accomplished by widely disseminating the report or pertinent sections of it and planning webinars and other interactive sessions open to stakeholders and the public, among other efforts.

Abbreviations

ACORN	Ambulatory Care Outcomes Research Network
AHEC	Area Heath Education Centers
AI	artificial intelligence
COVID-19	coronavirus disease 2019
FTE	full-time equivalent
HPSA	Health Professional Shortage Area
HRSA	Health Resources and Services Administration
LPN	licensed practical nurse
NP	nurse practitioner
PA	physician assistant
RN	registered nurse
SLRP	state loan repayment program
VA-SLRP	Virginia State Loan Repayment Program
VHWDA	Virginia Health Workforce Development Authority

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Identifying Strategies for Strengthening the Health Care Workforce in the Commonwealth of Virginia

Annex

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About This Report

This document contains appendixes to the main report, *Identifying Strategies for Strengthening the Health Care Workforce in the Commonwealth of Virginia*, available www.rand.org/t/RRA2093-1. These appendixes provide details on the methods and analysis used for the research summarized in the main report. The citations in this document point to references listed in the main report.

This research was funded by the Virginia Health Workforce Development Authority (VHWDA) and carried out within the Access and Delivery Program in RAND Health Care. The Virginia General Assembly established VHWDA in 2010 in order to identify and address health workforce issues in the Commonwealth. As a public entity, VHWDA exercises public and essential governmental functions to secure the health, welfare, convenience, knowledge, benefit, and prosperity of Virginians. VHWDA's mission is to "facilitate the development of a statewide health professions pipeline that identifies, educates, recruits, and retains a diverse, appropriately geographically distributed, and culturally competent quality workforce." VHWDA accomplishes this through core functions outlined in the Code of Virginia (Virginia's Legislative Information System, undated-c).

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Appendix A. Resources on Virginia's Health Care Workforce

In addition to other sources of information, this research relied on various data collection and aggregation efforts to glean insight into the national, state, and regional health care workforces. We used some of the data resources listed here to inform our model of nursing and physician workforce supply and demand (see Appendix E for more on that model). We used other data resources listed here to provide context and background for understanding Virginia's health care workforce challenges and interventions designed to overcome those challenges.

Data Related to Health Care Education

We reviewed data from the State Council of Higher Education for Virginia (SCHEV) and the National Student Clearinghouse to better understand the pipeline of graduates in health care fields. The SCHEV data can be accessed in the Virginia Longitudinal Data System, and we thank the Mason Center for Health Workforce for helping us to access and process these files.

Mason also collects education data directly from schools or programs, including data related to the career and technical education pipeline from high schools and college preparatory schools, by defined types of academic programs. We did not review these data, but we mention them to raise awareness that data exist to facilitate a more detailed and robust study of the health care education pipeline.

Data Related to Workforce Personnel

Various publicly available datasets attempt to measure the past and present supply and demand for nursing, primary care, behavioral health, and other health care workforces. We have relied primarily on the U.S. Bureau of Labor Statistics' (BLS's) Current Employment Statistics State and Local Areas to quantify the number of personnel and average wages for each job category in each Virginia locality.

Additionally, a pre-pandemic study conducted by the U.S. Department of Health and Human Services projected demand for registered nurses (RNs) in the United States (U.S. Department of Health and Human Services et al., 2017), which we used as a starting point for projecting demand for nursing labor by observing the ratio of nationwide bed occupancy to national demand, then using the same ratio for Virginia-specific bed occupancy to scale down to the state level. Although this technique only roughly approximates demand for nurses in Virginia, the main purpose of our model was to forecast the *relative change* in demand and supply (from any given starting point), so the starting point need not be precise. Furthermore, quantifying demand is *by nature a highly imprecise endeavor*, given the fact that there exists a numeric difference between minimum number of personnel to operate a hospital, desired number of personnel,

optimal number of personnel from a financial perspective, and optimal number of personnel from the perspective of maximizing health outcomes.

The Virginia Employment Commission (VEC) also has data on health care workforce supply and demand, which the Virginia Hospital and Healthcare Association supplied to us through 2019, and we supplemented these data with additional VEC data through 2021 from https://virginiaworks.com/download-center.

Recruitment and Retention

Preexisting survey data helped us to better understand workers' motivations for joining or leaving the Virginia health care workforce. As mentioned in more detail in Appendix E, we relied on analyses conducted by McKinsey on longitudinal national surveys on nurses carried out since the onset of the pandemic (Berlin, Lapointe, and Murphy, 2022; Berlin et al., 2023) to enumerate and weight factors that affect the retention of workers. Additionally, to provide context on recruitment, retention and the composition of the Virginia health care workforce, we reviewed survey data collected by the Virginia Department of Health Professions' Healthcare Workforce Data Center, which conducts voluntary surveys on the department's licensees through the department's online application and renewal processes. We reviewed the Virginia Hospital and Healthcare Association's Survey on Graduating Nurses for additional insights into the pipeline of nursing recruits. Lastly, we analyzed Virginia State Loan Repayment Program data from the Virginia Department of Health, Office of Health Equity, for insight into the effects, costs, and efficacy of state loan repayment programs.

Appendix B. Environmental Scan Methods

The environmental scan entailed a review of the peer-reviewed and gray literature related to interventions for health care workforce retention and recruitment published from 2013 to 2023. The scan includes interventions both within and beyond Virginia and the United States.

Methods

The research team conducted its environmental scan following methods defined by the Institute of Medicine (2011). Based on those methods, we engaged in six steps to conduct the environmental scan: (1) defining the research team for the environmental scan, (2) collecting user and stakeholder input, (3) identifying the topic and research questions in the scan, (4) developing and implementing a review protocol (including the study screening and selection process), (5) screening and selecting studies, (6) appraising and synthesizing selected studies, including quality of evidence.

Defining the Environmental Scan Research Team

The environmental scan research team is a subset of the overall study team and included a social scientist with expertise in quantitative research in education, labor markets, and workforce development and a policy researcher with expertise in qualitative and mixed methods, health care and health policy, and environmental scans. The team has extensive experience in environmental scans as well as the methodological and substantive expertise to evaluate relevant research and other literature. The larger research team discussed and informed the environmental scan, including the selection process and preliminary findings.

Collecting User and Stakeholder Input

To elicit user and stakeholder input, the environmental scan research team first identified key health care domains based on the original study proposal—primary and behavioral health care. The team then developed preliminary definitions for these domains based on the National Academy of Medicine methods and identified different occupations and sites of care for each health care domain. Based on email feedback from the larger research team and key stakeholders over a two-week period, the environmental scan research team finalized the health care domain definitions, focal occupations, and sites of care in the environmental scan. Key stakeholder feedback was especially critical for flagging occupations and sites of care of particular relevance in the Commonwealth of Virginia.

Identifying Topics and Research Questions

Parameters of the scan, including focal health care domains, occupations in those domains, and sites of care for focal health care domains were iteratively defined by the environmental scan team with review and discussion by the larger research team and Virginia stakeholders, including the Virginia Health Authority, a study advisory board comprised of various Virginia stakeholders, and the larger Virginia health care practitioner and policy community at the study multi-stakeholder conference. From this process, five basic topics emerged, outlined in Table B.1. Stakeholders also helped identify search engines and websites used in this environmental. A professional librarian identified the initial set of articles based on pre-defined search terms and processes.

Table B.1. Environmental Scan Topics and Research Questions

Topic	Research Questions
Virginia health care workforce	• What are basic demographic characteristics of the health care workforce in Virginia? • How does it compare to other Mid-Atlantic states and the United States as a whole?
Education and training	• For a given health care occupation, what are the basic education and training requirements? • What are areas of concern in relevant education and training programs? • How does education and training compare to other Mid-Atlantic states and the United States as a whole?
Legislation and regulation	• For a given health care occupation, what are the main governing and regulatory bodies in Virginia? • What are the main regulations for each health care occupation in Virginia? • What are recent proposed and instated changes in a given occupation's regulation in Virginia? • How does legislation and regulation compare to other Mid-Atlantic states and the United States as a whole?
Recruitment and retention	• What factors facilitate/impede recruitment into health care occupations in Virginia overall? • What factors facilitate/impede recruitment into health care occupations in Virginia for key subpopulations? • What factors facilitate/impede retention in health care occupations in Virginia overall? • What factors facilitate/impede retention in health care occupations in Virginia for key subpopulations? • How does recruitment and retention compare to other Mid-Atlantic states and the United States as a whole?
Promising programs and practices	• What are the best or promising programs and practices for supporting the health care workforce in Virginia? • How do best or promising programs and practices compare to other Mid-Atlantic states, the United States as a whole, and globally? • What is the quality of evidence vis-à-vis the effectiveness of these programs and practices? • How do best or promising programs and practices compare to other Mid-Atlantic states, the United States, and globally?

For each topic, the environmental scan team identified specific research questions, also shown in Table B.1. Overall, the environmental scan was intended to provide a detailed description of the Virginia health care workforce over time, the current education and training landscape, recent and pending legislation and regulations related to the Virginia health care

workforce, and promising workforce development programs, policies, and practices to support the health care workforce in Virginia and elsewhere—particularly those dealing with recruitment and retention.

Developing and Implementing a Review Protocol

The professional librarian formulated detailed search strategies for PubMed (NIH/NLM), CINAHL (EBSCOhost), and American Psychological Association PsycINFO (EBSCOhost). We applied the following limits for each database: articles in peer-reviewed literature, published in English language, published in the last ten years (2013–2023), and U.S. studies only. We conducted searches for state legislation in Nexis Uni and BillTrack50. Additionally, we conducted searches for policy documents and other grey literature (2013–2023) in Google. All search strategies were based on the defined focal health care domains, occupations in those domains, and care settings for focal health care domains. The following health care domains, occupations, and settings further bounded the search:

- health care domains
  - primary care, including
    - internal medicine
    - family medicine
    - pediatrics
    - obstetrics and gynecology
  - behavioral health, including
    - psychotherapy
    - psychiatry
    - social work
    - drug and alcohol rehabilitation
- occupations
  - primary care, including
    - physicians
    - physician assistants
    - licensed midwives
    - nursing
  - behavioral health, including
    - psychiatrists
    - licensed alcohol and drug counselors
    - board-certified behavior analysts
    - licensed mental health counselors
    - licensed professional counselors
    - licensed clinical social workers
    - certified substance abuse counselors
    - psychiatric nurse mental health clinical specialists

    - licensed independent clinical social workers
    - licensed marriage and family therapists

- care settings
    - hospitals
    - health systems
    - nursing homes/long-term residential care
    - clinics and medical offices (outpatient, ambulatory)
    - community health centers (federally qualified health centers)
    - mental health treatment centers, addiction treatment centers.

Table B.2. summarizes key topics and associated search terms.

For each identified topic of interest, the array of search terms was based on (1) basic research questions associated with each identified topic (e.g., "What are basic demographic characteristics of the health care workforce in Virginia?"), (2) a preliminary search of related research articles and grey literature on a given topic by the environmental scan team, and (3) search terms based on environmental scan and larger research team discussions for a given topic.

After each initial search, the librarian and environmental scan team met to briefly review the search process and ensure the executed process and search terms followed the review protocol.

The librarian conducted the initial search over a three-week period, addressing one topic before moving to the next. The librarian limited a given search to a single health care workforce, including primary care and behavioral health care for physicians, nursing, counselors and social workers. The librarian provided a detailed Excel database of search results for each topic, including the article title, authors, journal or other place of publication, abstract, and URL. Searches were conducted in May and June 2023.

Table B.2. Key Concepts and Related Search Terms

Topic	Key Concepts
Virginia health care workforce	• Health care workforce statistics including: – Demographics – Workforce trends + projections – Staffing retention rates – Retirement rates
Legislation and regulation	• State regulations/federal regulations /current legislation/ policy + affecting health care workers including: – Virginia code + regulation + health care workforce – Virginia Department of Health Professions + regulation/licensing – Virginia + regulatory review + health care workforce – Virginia + legislation + health care workforce – Virginia + alternative licensing + health care workforce – Current funding environment + health care workforce development – State/ federal financial aid and loan forgiveness programs

Education and training	• Education/training/licensing/registration/accreditation/curriculum • Continuing education/professional development/license renewal • Education/training/licensing/registration/accreditation/curriculum + postsecondary • Education/training/licensing/registration/accreditation/curriculum + K–12 • Education/training/licensing/registration/accreditation/curriculum + Area Health Education Center
Recruitment and retention	• Continuing education/professional development/license renewal • Continuing education/professional development/license renewal + Area Health Education Centers • Higher education student financial assistance + health care workforce • Education/training + faculty • Education/training + clinical placement • Support/ continuing education/training for providers • Promoting/impeding factors + health care professions for immigrants, veterans, military spouses—disparities/inequities/underrepresented, underserved • Promoting/impeding factors + health care professions + immigrants, veterans, military spouses • Barriers/facilitators + health care professions + immigrants, veterans, military spouses • Incentives/incentivizing + health care education + training + professions
Promising programs and practices	• Best practices/promising programs/successful programs + health care workforce/jobs/occupation/front line health workers

Screening and Selecting Studies

Members of the environmental scan team independently screened and selected articles across two iterations. In the first iteration, a team member reviewed the full array of articles identified in an initial search, using specified databases and search terms (see "Developing and Implementing a Review Protocol" and Table B.2). Across all health care occupations and searches, a total of 1,405 articles were included in the full, initial array. In the second iteration of screening and selection, a team member reviewed articles for topical relevance based on the title and abstract. If the article topically matched specified research questions, it was retained—regardless of research methods used or the geographic focus of the research. Team members reviewed each other's work and discussed and resolved any discrepancies in retained articles. This topically relevant but methodologically and geographically broad array of articles ($N = 357$) served as the core set of articles for the environmental scan.

Appraising and Synthesizing Selected Studies

To analyze and synthesize selected studies in our environmental scan, the environmental scan team engaged in four steps: (1) an initial overview of articles to understand broad patterns, (2) coding and otherwise assessing articles according to research questions and identified patterns or themes in Step 1, and (3) drafting and discussing text regarding main findings, within the environmental scan team and the larger research teams. In Step 4, the team presented preliminary findings to Virginia stakeholders for comment and discussion.

Appendix C. Interview and Focus Group Guide

1. From your perspective, what are the main causes of shortages among Virginia's primary care workforce?
   - Behavioral health?
   - Nursing?
2. What strategies and/or policies have you observed in Virginia to retain its primary care workforce? Which ones are effective (or ineffective) in your view? Please elaborate.
   - Behavioral health?
   - Nursing?
3. What strategies would you like to see your community or state government use to boost retention of its existing primary care workforce?
   - Behavioral health?
   - Nursing?

   [Probe on role of strategies such as: increased compensation/monetary incentives, supporting work-life balance, and transportation, etc.]
4. What strategies might Virginia use to help recruit new practitioners to expand its existing health care workforce in:
   - Primary care?
   - Behavioral health?
   - Nursing?
5. A few states have created alternative pathways to licensure for international doctors, veterans, military spouses, and other populations seeking work in in health care. Should Virginia pursue similar strategies to boost workforce in the following fields? Describe the risks and/or benefits of doing so.
   - Primary care?
   - Behavioral health?
   - Nursing?
6. How much of a barrier do the costs associated with education and/or licensure (and re-licensure) present for people seeking practice in health care, nursing, and behavioral health?
   - How about requirements for long periods of supervised practice?
   - How about stresses related to work in these fields (e.g., workload, paperwork/charting burden, stressful work environment)?
7. Should Virginia aim to incentivize more high school and/or college students to enter the following fields? If yes, how would you do it?
   - Primary care?
   - Behavioral health?

   - Nursing?

8. What steps need to be taken in order for state, federal, and private funding to be allocated to workforce development programs?
9. What strategies do you recommend be used to boost the number of training positions for health professionals in
   - Primary care?
   - Behavioral health?
   - Nursing?
10. We've heard that there are not enough nursing faculty, clinical preceptors, and training sites. What ideas do you have to address this challenge?
11. Should Virginia change its processes for awarding and managing educational scholarships and/or loan forgiveness to incentivize individuals to pursue careers in primary care, behavioral health, and nursing? What ideas do you have to accomplish this?
12. Based on your expertise, name an actionable step or strategy you believe Virginia should and *can* take in the next 6 months to address workforce shortages in primary care, nursing, and behavioral health?
    - In one year?
    - Next two years?
13. What strategies can be used to ensure that efforts around health care workforce development are sustained over time?

Appendix D. Hospital Survey Questions

1. Which of the following strategies has your hospital/health system used to retain nurses? Mark all that apply.

   [ ] Increased salary
   [ ] Bonuses
   [ ] Educational loan repayment
   [ ] More flexibility in work hours
   [ ] Transportation vouchers
   [ ] Convenient and/or free parking
   [ ] On-site childcare
   [ ] Subsidizing cost of housing
   [ ] Meal coverage
   [ ] Mental health services for staff
   [ ] Job training to improve and/or expand skillsets
   [ ] Diversity, equity, and inclusion strategies
   [ ] Strategies that promote teamwork
   [ ] Covering cost of maintaining licensure
   [ ] Changed patient flow or staffing models
   [ ] Offering educational advancement opportunities as part of employment
   [ ] Supervisory training and/or ombudsman program to address employee concerns

14. How have you changed practices and/or technology to support flexible staffing models?

Appendix E. The Mathematical Formulation of our System Dynamics Simulation Model

Introduction

In early 2022, we developed a simulation model focusing on the short and medium-term impact of the COVID-19 pandemic on the nurse labor market. Our model incorporated a wide range of factors, including epidemiological trends, behavioral dynamics, hospitalization patterns, relief programs, and wage considerations., In this appendix, we present a revised model that, building on this precursor model, simulates and tracks the dynamics of key variables related to the health care workforce in Virginia over time. While our revised model does incorporate the effects of the COVID-19 pandemic, our primary objective here is to simulate the medium- to long-term supply and employment trends within Virginia's health care workforce. We explore scenarios under both baseline (status quo) conditions and various policy interventions. The central aim is to offer a comprehensive set of projections for Virginia's health care workforce, moving beyond the sole assessment of the pandemic's impact over time.

Although our model encompasses workforce dynamics among nurses, physicians, and behavioral health specialists within Virginia, our focus in this appendix will predominantly revolve around nurses. The foundational framework remains consistent for physicians and behavioral health specialists, albeit with variations in initial state variables and input parameters. Our model provides insights into the health care workforce in Virginia, encompassing both state-level and regional perspectives, spanning the eight Area Heath Education Centers (AHEC) regions of Virginia. It calculates medium- to long-term dynamics, yielding output projections for the next 15 years.

Our model employs a system dynamics approach. This approach ensures a deterministic representation of aggregate population dynamics. The system dynamics method proves advantageous when studying labor markets during prolonged non-equilibrium periods, such as those induced by pandemics. It offers a macroscopic perspective for analyzing research questions and facilitates scenario exploration and sensitivity testing.

The choice of the system dynamics approach is driven by its ability to specify causal mechanisms driving system dynamics and its suitability for examining labor markets impacted by extraordinary events like pandemics, which often operate outside of equilibrium for extended durations. Furthermore, the system dynamics approach is computationally efficient, quicker to develop, easier to understand, and faster to execute compared with individual-level microsimulation or agent-based models, particularly when dealing with a substantial number of parameters.

The system dynamics approach involves formulating the model using coupled ordinary differential equations (ODEs) and numerically integrating them using specialized solvers. The numerical integration poses a stiff problem, where the step size of the numerical solution is limited more by the stability of the numerical technique than by its accuracy (Hindmarsh and Petzold, 1995). For our implementation, we used the R programming language with the deSolve package (Soetaert, Petzoldt, and Setzer, 2010). DeSolve employs FORTRAN solvers of the Livermore family to solve initial value problems for stiff ODEs, and it offers various types of solvers for this purpose. We used the default integration method, LSODA, that switches automatically between using methods for stiff and nonstiff systems.

Our model operates with a weekly timestep for generating outputs, although the solver typically uses much smaller time steps during numerical integration. Since many input model parameters and rate values are provided on a yearly basis, we convert these values into weekly rates to maintain consistency with the model's weekly timestep.

The System Dynamic Model and its Differential Equations

The state variables include the supply of nurses ($q_s(t)$), the qualified pool of potential nurses ($n_s(t)$), the yearly wage for nurses ($w(t)$), and the perceived barriers affecting their willingness to work as nurses relative to a baseline ($z(t)$). We also consider nurse demand ($q_d(t)$), which represents the need for nurses and is externally specified as an input to the model.

The nurse supply variable ($q_s(t)$) represents the proportion of available nurses actively choosing and desiring to work as nurses, including those currently employed or actively seeking nursing positions. On the other hand, the qualified pool variable ($n_s(t)$) includes individuals who possess the necessary qualifications to work as nurses but may have temporarily chosen not to do so. This category encompasses retired nurses who could potentially return to the workforce, individuals in less demanding professions with lower pay, and nurses experiencing hidden unemployment. However, nurses who have pursued completely different career paths outside of nursing, such as becoming doctors or researchers, are not considered. The actual number of available nurses is determined as the minimum between demand and supply, given by $q(t) = \min[q_d(t), q_s(t)]$.

Our model assumes that the supply of nurses ($q_s(t)$) depends on the qualified pool of potential nurses ($n_s(t)$), the yearly wage for nurses ($w(t)$), and the perceived barriers affecting their willingness to work in the nursing field relative to a baseline, summarized by one variable $z(t)$ whose size is proportional to the strength of said barriers.

In order to derive an explicit expression for $q_s(t)$ as a function of these quantities, we assume that the decision to work made by the nurses in the qualified pool follows a simple utility maximization principle. We assume that nurses receive a utility $\ln(w)$ from working for wage *w*, and a utility $\ln(w_0)$ if they do not work, where w_0 has the interpretation of a reservation wage, since nurses only work if $w > w_0$. We assume that there is variation in the reservation wage in

the nurses' population, and therefore we model w_0 as a random variable with a log normal distribution. Therefore, the total number of nurses working is:

$$q_s = n_s P\big(\ln(w) > \ln(w_0)\big) = \frac{1}{2} n_s [1 + \text{erf}(s_s(\ln(w) - \ln(w_0))]$$

where s_s is a parameter that is inversely proportional to the variance of the reservation wages w_0. Qualitatively, the supply of nurses is an increasing function of wages, which is 0 when wages are 0, is exactly one half when wages are equal to the reservation wage (because nurses are then indifferent to the two options) and becomes equal to the entire pool n_s when wages tend to infinity.

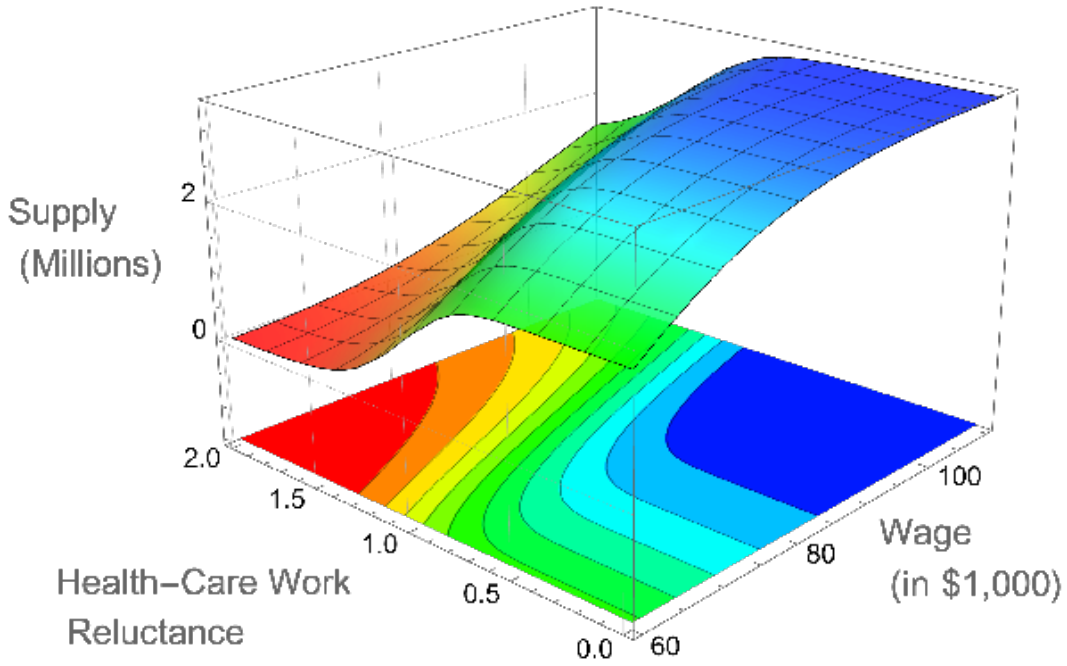
What is missing from this formulation is the reluctance to work z. We assume that the reluctance to work influences the reservation wage w_0 and that higher levels of reluctance to work raise the reservation wage. We model the relationship between reluctance to work and reservation wage with an S-shaped function:

$$w_0(z) = K\left[1 + \frac{1}{2}[1 + \text{erf}(s_z(\ln(z) - \ln(m_z))]\right]$$

When the reluctance to work is 0, the reservation wage is K and the supply of nurses is maximum. As the reluctance to work grows to infinity, the reservation wage reaches its maximum value ($2\,K$), and the supply reaches its minimum value. We assume that $K = \rho_w w_0(1)$. This is because we choose to set to the reluctance value z equal to 1 to represent our baseline setting.

In our model, $q_s(t)$ adheres to a specific functional form represented by a sigmoidal S-surface specified by the equations q_s and $w_0(z)$ given above. It is important to note that this specific function for $q_s(t)$ is just one of many possible choices or models to describe how supply reacts to changes in wages and perceived barriers to work. Essentially, it is just one way we model supply changes. In a more general context, $q_s(t)$ can be characterized using alternative functional forms, potentially dependent on a different set of parameters. For clarity, we denote this specific model as $q_s(t) = S_\theta(n_s, w, z)$, where $S_\theta(n_s, w, z)$ represents the particular functional form we've chosen to represent supply. Here, θ is a parameter set that defines the specific shape of the sigmoidal function we've selected. The parameter set θ includes of $\rho_w, w_0(1), m_z, s_s$, and s_z. In the subsequent text, we will use $q_s(t)$ as a general reference to the nurse supply and use $S_\theta(n_s, w, z)$ to denote the specific functional form we use to model supply. Our sigmoidal S-surface for supply is visually presented in Figure E.1. The contour plot beneath the S-surface demonstrates that as health care work reluctance increases, real wages must increase to sustain the nurse supply. This aligns with the concept of compensating-wage differentials in economic theory.

Figure E.1. Impact of Health Care Work Reluctance on Nurse Supply and Real Wages Illustrated Through Sigmoidal Curves



The time evolution of supply of nurses is determined by the interplay of various variables that change over time. To capture these dynamics, we consider a differential equation describing the rate of change of the supply function $q_s(t)$ with respect to time t. The differential equation is given by:

$$\frac{dq_s}{dt} = \frac{\partial q_s}{\partial t} + \frac{\partial q_s}{\partial n_s}\frac{dn_s}{dt} + \frac{\partial q_s}{\partial w}\frac{dw}{dt} + \frac{\partial q_s}{\partial z}\frac{dz}{dt}.$$

In this equation, the total derivative of supply with respect to time is expressed as a sum of terms containing partial derivatives of the supply with respect to its controlling variables. The first term $\frac{\partial q_s}{\partial t}$ represents the long-term supply trend independent of changes in real wages, pandemic-related outcomes, and the qualified pool of registered nurses. We have assumed that variations in supply are solely attributed to changes in the qualified pool (n_s), wages (w), and reluctance (z), and as a result, we have omitted this term from consideration. The second term captures the long-term supply dynamics of the qualified pool of registered nurses, considering changes due to recruitment and expansion policies, as well as contractions such as permanent retirements. The medium to short-term dynamics are mainly described by the last two terms, quantifying how the supply changes with wages and work reluctance. These terms depend on the

derivatives $\frac{\partial q_s}{\partial w}$ and $\frac{\partial q_s}{\partial z}$, as well as the rates of change of real wages and work reluctance ($\frac{dw}{dt}$ and $\frac{dz}{dt}$). By applying equations ~~d,~~ we derive the expressions for $\frac{\partial q_s}{\partial n_s}$, $\frac{\partial q_s}{\partial w}$, and $\frac{\partial q_s}{\partial z}$.

The differential equation for supply is a general equation that applies to our overall expression of supply, denoted as $q_s(t)$. Now, we move forward by calculating the partial differentials that contribute to the equation for the total derivative of supply. In this context, we will be dealing with our specific representation of supply, $S_\theta(n_s, w, z)$. The derivatives of S_θ correspond to scaled log-normal probability density functions (PDFs) since $S_\theta(n_s, w, z)$ represents a scaled log-normal cumulative distribution function. The expressions are as follows:

$$\frac{\partial S_\theta}{\partial n_s} = \frac{s_s \exp\{-s_s^2[\ln w - \ln m_s(z)]^2\}}{w\sqrt{\pi}} = S_\theta(1, w, z).$$

$$\frac{\partial S_\theta}{\partial w} = \frac{n_s s_s \exp\{-s_s^2[\ln w - \ln m_s(z)]^2\}}{w\sqrt{\pi}}.$$

The expression for $\frac{\partial S_\theta}{\partial z}$ is obtained by taking the product of $\frac{\partial S_\theta}{\partial m_s(z)}$ and $\frac{\partial m_s(z)}{\partial z}$, given by:

$$\begin{aligned} \frac{\partial S_\theta}{\partial m_s} &= -\frac{n_s s_s \exp\{-s_s^2[\ln w - \ln m_s(z)]^2\}}{m_s\sqrt{\pi}}, \\ \frac{\partial m_s}{\partial z} &= \frac{m_s(z) s_z \exp\{-s_z^2[\ln m_z - \ln z]^2\}}{z\sqrt{\pi}}. \end{aligned}$$

With the expressions for $\frac{\partial S_\theta}{\partial n_s}$, $\frac{\partial S_\theta}{\partial w}$, and $\frac{\partial S_\theta}{\partial z}$ derived, we proceed to specify the models describing the rates of change of n_s, w, and z over time in the next sections.

Modeling the rate of change of the qualified pool

Here we present our model for $\frac{dn_s}{dt}$, which describes the changes in the overall qualified pool of workers over time. The model takes into account factors that increase the workforce, such as enrollment and graduation rates from nursing schools, which contribute to the growth of the nurse supply. It also encompasses factors that decrease the workforce, including rates of permanent retirement or nurses transitioning to other career paths. The basic form of the model subtracts the outflows from the inflows to describe how n_s changes over time. We assume that the inflow of qualified nurses is proportional to the current supply, represented by the constant ν scaled by the normalized scaling factor $S_\theta(1, w, z) = \frac{S_\theta(n_s, w, z)}{n_s}$. On the other hand, the outflow is determined by a fixed yearly probability ω of permanently leaving the qualified pool because of retirement or irreversible decisions. Thus, the simplest model for $\frac{dn_s}{dt}$ is:

$$\frac{dn_s}{dt} = \nu S_\theta(1, w, z) - \omega n_s.$$

The stationary solution is obtained by setting $\frac{dn_s}{dt} = 0$, resulting in $\omega = \frac{\nu S_\theta(1,w,z)}{n_s}$. It is worth noting that the depletion of the qualified pool may vary between nurses in the supply and those in the qualified pool but not in the supply. We assume that the per-person depletion rate for nurses in the qualified pool but not in the supply (ω_1) is greater than the rate for nurses in the supply (ω_2) by a constant factor κ_ω. Therefore, $\omega_1 = \kappa_\omega \omega_2$. Combining these considerations, we have:

$$\omega n_s = \omega_1 n_s[1 - S_\theta(1, w, z)] + \omega_2 n_s S_\theta(1, w, z),$$

which leads to:

$$\omega = \omega_1[1 + S_\theta(1, w, z)(\kappa_\omega - 1)].$$

It is important to note that the outflow, representing the permanent retirement of nurses from the qualified pool, implicitly depends on wages and health care work reluctance through the term $S_\theta(n_s, w, z)$ that multiplies ω_1 and ω_2. As wages decrease or work reluctance increases, the supply increases. Since $\omega_1 > \omega_2$, nurses retire at a higher rate or switch to alternative occupations or careers. Similarly, the inflow depends on wages and work reluctance through $S_\theta(1, w, z)$. As real wages increase or work reluctance decreases, the normalized supply increases, signaling to prospective students that nursing is an abundant and desirable occupation to pursue.

Returning to the steady-state solution ($\frac{dn_s}{dt} = 0$), we find:

$$\omega_1 = \frac{\nu S_\theta(1, w, z)}{n_s[1 + S_\theta(1, w, z)(\kappa_\omega - 1)]}.$$

Wage Dynamics

In our model, nurse wages are influenced by the imbalance between demand and supply, and they are assumed to have limited flexibility, resulting in asymmetric adjustments. When wages are below the market-clearing rate, hospitals need to increase real wages to fill vacancies. On the other hand, when wages exceed the market-clearing rate, hospitals may desire to reduce them, but contractual arrangements prevent such adjustments. The real rate of change of nurse wages, denoted as $\frac{dw}{dt}$, is described by the equation:

$$\frac{dw}{dt} = [(\alpha_d - \alpha_s)H(q_d - q_s) + \alpha_s] \cdot (q_d - q_s)\, w\,,$$

Here, $H(x)$ represents the Heaviside step function, which we approximate using an inverse logistic function for integration in our model implementation. The parameters α_d and α_s, determine how the wage gap between demand and supply affects wage changes. We assume that real wages increase more rapidly when there is excess demand for nurses than when there is excess supply. Hence, the rate α_d is numerically greater than α_s to reflect this assumed faster growth rate of wages.

Health Care Work Reluctance

A key component of our model is the health care work reluctance measure $z(t)$ and its evolution over time. Working during a pandemic is undeniably more challenging than under normal circumstances, and z increases based on various pandemic-related factors, including fatigue from COVID-19 hospitalization surges, increased risk of contracting the virus at work, unclear quarantining guidelines, increased proximity to preventable deaths, shortages of personal protective equipment, and higher patient-to-nurse ratios during surges.

Health care work reluctance $z(t)$ is assumed to change according to an exponential weighted moving average (EWMA) process over $\Delta(t)$, which captures nurses' weekly evaluations affecting their reluctance to work. The variable $\Delta(t)$ quantifies nurses' weekly assessments regarding their willingness to work. One way of expressing the dynamics of the EWMA by a differential equation is as follows:

$$\frac{dz}{dt} = (1 - s)[\Delta(t) - z(t)]$$

Here, s is a weekly discount parameter and plays a crucial role in determining the relative significance of past nurses' weekly assessments compared with the current ones in forming a nurse's overall reluctance in health care work. The discount parameter can be calculated by specifying a half-life duration τ using the formula $\ln(2)/(1 - \mathrm{s})$. The half-life represents the duration for past evaluations to contribute half as much to the work reluctance measure.

A broader range of perceived barriers impact $\Delta(t)$. We assume that these barriers can be grouped into three main categories, namely distress, disengagement, and fatigue. From a mathematical perspective, we express these factors as components influencing the assessment of $\Delta(t)$. Our assumption is as follows:

$$\Delta(t) = \beta_D \phi_D(t) + \beta_E \phi_E(t) + \beta_F \phi_F(t),$$

Where $\beta_X \phi_X(t)$, with $X \in D, E, F$, represent the contributions from three different components: distress, disengagement, and fatigue, respectively. The coefficients β represent weights that sum up to one. Each of the components ϕ represents evaluations. Specifically, ϕ_F measures nurses' fatigue, while ϕ_D quantifies their distress.

Fatigue ($\phi_F(t)$) is assumed to be fully determined by the demand level, which can be measured using the patient-to-nurse ratio (η_t) and its changes over time (t). We assume that a fixed proportion ($1-\xi_f$) of distress depends on the demand level. Therefore, $\phi_D = \eta_0\left[(1-\xi_f)\eta_t/\eta_0 + \xi_f\psi_D\right]$, where ψ_D is considered a fixed effect that does not depend on demand and can be influenced by policy interventions unrelated to demand. The default value for ψ_D is one, representing the baseline fixed effects.

Disengagement (ϕ_E) is assumed not to change with demand and is considered as a fixed effect that can be influenced by policy interventions unrelated to demand. Combining all the above points, we have the following expression:

$$\Delta(t) = \beta_F\eta_t/\eta_0 + \beta_D\left[(1-\xi_f)\eta_t/\eta_0 + \xi_f\psi_D\right] + \beta_E\psi_E.$$

For the initial condition at $t = 0$, the patient-to-nurse ratio η_t is set to its baseline value η_0. Therefore, by design the baseline default value for $\Delta(t)$ is set equal to one. As a result, the baseline value for health care work reluctance is represented by $z = 1$. This is because from the differential equation, under the stationary condition (i.e., $\frac{dz}{dt} = 0$), health care work reluctance does not change and remains at its baseline value, $z(t) = \Delta(t)$.

Informing the Model Inputs

Our model draws from a variety of inputs, including parameter values and their ranges, initial conditions for state variables, and historical time-series data for variables such as occupied hospital beds, nurse employment numbers, and real wages. These inputs guide the model's behavior and serve as targets for calibration. In this section, we offer a concise overview of the model inputs and the data sources that informed our parameter estimation.

The State Variables' Initial Conditions

To start, we describe how we computed our state variables' initial conditions. Our model encompasses several key state variables, namely: demand, supply, and the qualified number of nurses within the system. All these variables are quantified in units of nurses. Additionally, our state variables encompass the average annual wage of nurses (measured in dollars), the health care work reluctance metric, and the proportion of hospitalizations attributed to COVID-19 patients.

The model relies on input values to establish the initial conditions for these six state variables. We work with two distinct sets of initial conditions. The first set is employed for calibration purposes, defining the initial states just prior to the onset of the pandemic. This calibration enables our model to operate throughout the pandemic years, facilitating a comparison between projected trajectories of select state variables and the observed data from our time series. Notably, we focus on trajectories related to annual wages and the number of

employed nurses. By contrasting these trajectories with empirical data, we refine the input parameter values via our model calibration process.

The second set of initial conditions delineates the starting states during the current post-acute pandemic phase. These are used for forecasting policy interventions and their relative impacts. It enables us to predict potential outcomes and make comparisons among different policy strategies. When new initial conditions for this phase are absent, we adopt the final conditions derived from our model calibration runs as the basis for the forecast phase.

Here, we delve into the specifics of the first set of initial conditions. Our baseline for analysis is derived from our time series data for Virginia, specifically focusing on the employment figures for nurses in hospitals as of April 5, 2020. On this date, the number of nurses employed in hospitals across the state of Virginia totaled 66,450, with an average annual wage of $74,380. We assume that demand exceeded supply on this date, enabling us to estimate supply as the existing number of nurses employed in Virginia's hospitals. Given the nascent stage of the pandemic in the United States at that time, we consider the proportion of COVID-19 hospitalizations to be negligibly small, approximating it to zero. Additionally, we initialize the health care work reluctance metric at its baseline value of one. Using these foundational estimates, we proceed to determine the range of values for nurse demand in Virginia on this pivotal date.

Nationally, the demand for nurses has been assessed at 3,154,000 (Haines, 2022). To localize this demand to the Commonwealth of Virginia, we employ a scaling methodology. This approach capitalizes on data pertaining to the count of staffed beds and the average bed occupancy rate in Virginia, facilitating the alignment of national demand with the state's contextual factors.

Specifically, within Virginia, the inventory of inpatient beds aggregates to 15,177, with an average occupancy rate of 70 percent. To contextualize the national demand within Virginia's framework, we necessitate insights into the total count of staffed beds at the national level and the corresponding average bed occupancy rate. As per recent data, the cumulative tally of staffed beds across U.S. hospitals reaches 919,649, accompanied by a bed occupancy rate of 64 percent (American Hospital Association, undated; Michas, 2022).

Calculating the ratio between the product of bed occupancy and staffed beds in Virginia and their national equivalents enables us to ascertain the scaling factor. The multiplication of this scaling factor by the national demand yields an approximation of the initial demand tailored to Virginia's circumstances. This methodology customizes the demand projection by integrating the state's health care infrastructure and bed utilization dynamics.

An alternative estimation for demand in Virginia involves assuming that its demand-to-supply ratio mirrors the national level. Consequently, we simply need to multiply this ratio by our supply estimation for Virginia. Nationally, demand surpasses supply, with supply closely aligned to the estimated number of employed nurses at 3,072,000 (Haines, 2022), marginally lower than the 3,154,000 demand estimate. This results in a demand-to-supply ratio of

approximately 1.027. Assuming that initial demand surpasses supply in Virginia, we employ this ratio to upscale the estimated count of employed nurses in the state. This furnishes an estimation for Virginia's demand.

By employing both of these methodologies, we arrive at distinct estimations for the pre-pandemic initial demand scenario in Virginia. The estimated demand ranges from 59,800 to 76,600, with a central value of 68,224 that we consider the most plausible. The lower bound approximates the estimate from our first methodology, and the central value is derived from the second methodology. To establish the upper bound, we apply the same difference between the central and lower values to the difference between the upper bound and the central value. Within this range of uncertainty lies a diversity of values, collectively assuming a critical role within our model calibration procedure.

Informing the Behavioral Model for Health Care Work Reluctance

Here, we outline the parameters that shape our behavioral model for health care work reluctance. We begin by estimating the β weights, which quantify the significance of each behavioral component in influencing evaluations. The most reliable source for estimating these β weights is through surveys that assess work-related attitudes and the desire to continue working, specifically targeting nurses. For this purpose, we utilized the analyses conducted by McKinsey on longitudinal national surveys on nurses carried out since the onset of the pandemic (Berlin, Lapointe, and Murphy, 2022; Berlin et al., 2023).

In exploring the drivers of nurses' intentions to leave their positions, we focused on respondents who expressed a likelihood of leaving within a year. These respondents were required to provide scores for 15 specific factors and 24 barriers, such as *insufficient staffing levels*, *emotional toll*, *approaching retirement age*, *fear of COVID-19*, *lack of career prospects*, *uncertainty*, *unmanageable workload*, and *no work-life balance*. We categorized each factor and barrier under fatigue, distress, or disengagement, depending on their nature. While some factors, such as *no development opportunities*, clearly fell under disengagement, others, such as *move to desirable location*, did not fit neatly into these categories and were excluded from analysis.

Our examination of the McKinsey survey data revealed that fatigue was the most influential factor, accounting for approximately 50 percent of the importance. Distress followed closely, constituting around 30 percent of the total importance. Based on the data and respondent numbers, we estimated an accuracy range of approximately ±15 percent of their values (i.e., ±7.5 percentage points for the case of fatigue) for these importance weights.

Given the constraint that the weights must sum to 100 percent, we derived the importance weight for disengagement by considering the sampled values of importance weights associated with fatigue and distress. This allowed us to establish a comprehensive understanding of the impact of these behavioral components on health care work reluctance.

Alongside the β weights, our behavioral model introduces two additional parameters: ξ_f, which represents the portion of distress that does not depend on the demand level, and the

discount parameter s. Regrettably, despite extensive searches through the McKinsey surveys and existing literature, we were unable to discover any data or sources to aid in estimating ξ_f—the parameter describing the fixed proportion of distress independent of perceived fatigue. In response, we made an assumption that ξ_f falls within the range of 50 percent ±7.5 percent.

However, in stark contrast, the outcomes derived from the McKinsey surveys provide invaluable insights into the temporal evolution of nurses' intentions to leave their positions. These insights can be effectively leveraged to estimate the discount parameter s.The percentage of nurses contemplating leaving their jobs surged from 22 percent in February 2021 to 32 percent by November 2021. This heightened level endured until September 2022, signifying a substantial increase by a multiplicative factor of 1.45, likely attributed to the pandemic-induced circumstances.

Given our analysis that points to fatigue as the predominant influencer of health care work willingness and considering our access to national weekly data on both COVID-19 and non-COVID-19 hospitalizations, we opted to merge the McKinsey survey findings with hospitalization data. This fusion allowed us to estimate the value of the discount parameter s, or equivalently, the half-life duration of work reluctance evaluations. The underlying concept is that heightened hospitalizations and an increased proportion of COVID-19 patients among hospitalizations impact fatigue, which manifests with a lag in time following peaks in hospitalizations and COVID-19 proportion. This enables us to evaluate the perceived increased fatigue after a certain lag period. By interlinking these datasets, we aimed to unravel the dynamic interplay between work reluctance and hospitalization trends.

However, it is important to consider the limitations of our assumption. Initially, the pandemic saw a decrease in overall hospitalizations even as the proportion of COVID-19 hospitalizations increased. During this period, nurses experienced significant fatigue because of increased workloads. The decline in non-COVID-19 hospitalizations contributed to COVID-19 hospitalizations forming a larger proportion of total hospitalizations.

To ensure our analysis yields meaningful results and our simulation model is realistic, we must quantify the additional effort COVID-19 patients demand from nurses in comparison to non-COVID-19 patients. Our approach involves considering factors such as evolving nurse demand, increased ICU patient ratios during the pandemic, and varying levels of effort needed for COVID-19 patients versus non-COVID-19 patients. Our goal is to calculate and utilize an effective patient-to-nurse ratio η_t that captures the added efforts due to COVID-19 patients, serving as a proxy for effort that scales linearly with fatigue.

We start by assessing the pre-pandemic and baseline efforts. Nationally, the nurse-to-patient ratio during this period ranged from 1:4 to 1:5 for medical-surgical units, and 1:2 for ICUs ("The Importance of the Optimal Nurse-to-Patient Ratio," n.d.). For our calculations, we consider a baseline nurse-to-patient ratio of 1:4. The national proportion of patients admitted to the ICU pre-pandemic had a median of 12 percent with an interquartile range of 9 percent to 17 percent

(Seymour et al., 2012). This information aligns with our data from Virginia on hospitalizations. With these values, our baseline patient-to-nurse ratio η_0 is 3.76.

To estimate the added effort for COVID-19 patients, we consider multiple factors. These include comparing the average length of stay between COVID-19 and non-COVID-19 patients, the proportion of COVID-19 patients requiring ICU care, and the increased daily effort required for COVID-19 patients both inside and outside ICU settings.

In 2018, the average length of stay for a hospitalization in the United States was 5.5 days based on 36.4 million inpatient stays (Tipton et al., 2021). In contrast, the estimated length of stay for COVID-19 hospitalizations was 15.35 days, with a 95 percent confidence interval of 13.47 to 17.23 days (Alimohamadi et al., 2022). This suggests that the effort required for a COVID-19 patient is roughly three times that of a non-COVID-19 patient based on length of stay.

During the pandemic, the national rate of ICU admission for COVID-19 patients was initially reported as 32 percent (Abate et al., 2020). However, our analysis of COVID-19 data for Virginia suggests this proportion to be closer to 20 percent.

By integrating these factors, we reevaluated the time-series data on total and COVID-19 hospitalizations, correlating them with the McKinsey survey results when the percentage of nurses considering leaving their jobs peaked. This analysis allowed us to estimate the half-life duration of work reluctance evaluations, indicating a range of three to 12 months. The substantial uncertainty stems from relying on only two time points from the McKinsey surveys. While the accuracy is limited, we chose to work with the available data and exercise our judgment in interpreting plausible outcomes from the analysis.

Informing How Supply Responds to Changes in Health Care Work Reluctance

Having elucidated our behavioral model for work reluctance and its parameter estimation process, our focus now shifts to estimating how changes in health care work reluctance impact nurse supply. This entails the estimation of the supply parameters θ, which govern the relationship $\frac{\partial s_\theta}{\partial z}$. Specifically, we delve into m_z and s_z, which define the supply's response to increasing work reluctance. These parameters, being intrinsic to our model's intricacies, require an indirect estimation method based on the model calibration process, which is detailed in a subsequent section of this appendix.

However, in a bid to enhance the model's input intuitiveness, we've opted to derive and compute the values of m_z and s_z from more readily understandable input parameters. While these parameters still pose challenges for estimation, they boast more intuitive definitions, which could aid experts in behavioral health economics to provide better assessments of their values and the associated ranges of uncertainty.

These intuitive input parameters include the initial proportion of nurses within the supply relative to the total pool of qualified nurses. This proportion acts as our supply's baseline when

health care work reluctance assumes its baseline value of one. Nationally, approximately 84.1 percent of licensed RNs are employed in the nursing sector (American Association of Colleges of Nursing, 2023a). We consider an uncertainty range for this proportion around our central estimate of 84.1 percent spanning 80 percent to 88 percent. This estimate serves as our baseline proportion of nurses in the supply.

Furthermore, we need a second estimation of the proportion of nurses within the supply concerning the total qualified nurse pool. This estimation comes into play when health care work reluctance surpasses its baseline value, while keeping other factors, including the annual wage, constant. Our methodology involves setting this second supply proportion to 50 percent of the baseline supply value. Subsequently, we attempt estimating the range of health care work reluctance values denoted as z_2, which would trigger this particular level of supply reduction.

Our estimation for z_2 spans a wide range from 1.1 to 3, with the most plausible and central value hovering around 1.5. This extensive range reflects the significant uncertainty associated with this parameter. Nevertheless, this range does encompass a specific estimate derived from the analysis of the McKinsey surveys.

The surveys highlighted a range of factors influencing nurses' decisions to leave during the pandemic, varying from 22 percent to 32 percent. This variability suggests that the supply of nurses during the same period might have varied between 68 percent and 78 percent of the qualified nurse pool n_s. A simple analysis or estimation reveals that when the leave factor increases by 45 percent (i.e., a factor of 32/22), the supply diminishes by approximately 13 percent (i.e., 1 – 68/78). It is important to note that this provides a lower bound of the response, as the quoted 22 percent factor was not a baseline estimate but was also estimated within the pandemic period.

The final input parameter essential for estimating how changes in health care work reluctance affect nurse supply pertains to the percentage of the current wage required to sustain the existing workforce if all factors causing work reluctance were eradicated (i.e., $z = 0$). This concept proves challenging to source directly, given its hypothetical nature. The scenario delves into the hypothetical realm of nurses potentially trading a portion of their wages in return for the complete removal of perceived barriers in their work environment. The crux of the matter lies in identifying the minimum portion of their current wage that nurses would be amenable to accept before it significantly influences their likelihood of opting to leave their nursing profession.

Our estimation for the wage that nurses might accept in exchange for the complete elimination of perceived barriers in their workplace spans a broad spectrum from 70 percent to 99 percent of their current wage, with the most plausible and central value gravitating around 80 percent because of the highly skewed distribution of results. This parameter encompasses a diverse range, reflecting the substantial uncertainty inherent in this scenario. Nonetheless, the central estimate aligns with a plausible value that nurses might be willing to consider in a scenario devoid of the barriers influencing their work reluctance.

Sampling the values of these more intuitive parameters within their respective uncertainty ranges leads to the specification of the values for m_z and s_z used in the simulation model.

Informing the Model Describing the Wage Dynamics

Our model component that describes how real wages change over time is guided by two key parameters, α_d and α_s. They control how much real wages increase each week. The larger rate, α_d, applies when there is more demand for nurses than there is supply. The smaller rate, α_s, applies when there is more supply than demand. We derive these weekly changes from the yearly rates. When there is a higher demand for nurses than there is supply, the real wages increase more rapidly each year. We expect this increase to be somewhere between 0 percent and 10 percent every year, but our best estimate is centered at 2% percent. When there is more supply than demand, the real wages still go up, but at a slower rate, and our estimate can be anywhere from 0 percent to 2.5 percent every year, and our best estimate is centered at 0.5 percent.

Informing How Supply Responds to Changes in Wage

After discussing our wage increase model and how we estimate its parameters, our attention now shifts towards determining the impact of wage changes on nurse supply. This involves the estimation of the supply parameters, denoted as θ, that govern the relationship $\frac{\partial s_\theta}{\partial w}$. Specifically, we delve into two key parameters, $m_s(0)$, representing the wage when health care work reluctance is zero, and s_s, which defines the supply's responsiveness to wage changes. Drawing a parallel with our previous parameter estimation for supply response to health care work reluctance, these parameters are intrinsic to our model's complexities and are challenging to estimate directly. However, there is a greater potential for accurate estimation in this case compared with the parameters linked to health care work reluctance. This is because the relationship between wage changes and nurse supply has been extensively studied in economics over the years. Researchers have attempted to estimate the elasticity of nurse supply in response to wage rates, which measures the sensitivity of the quantity of nurses supplied to wage variations. In simpler terms, this elasticity quantifies how much an increase or decrease in real wages influences the influx or exodus of nurses from the workforce that are employed or are actively looking for employment as a nurse. A high elasticity implies that even minor wage adjustments can lead to substantial shifts in nurse availability, whereas a low elasticity suggests that wage changes have limited impact on nurse supply.

Nevertheless, it is important to note that, in line with our sigmoid supply surface, the elasticity of nurse supply in response to wage rates is itself contingent on the prevailing wages and supply levels. Therefore, the elasticity estimation is a localized measure provided under baseline conditions.

Let's begin by introducing the local elasticity of supply equation:

$$\epsilon_s = \frac{(q_s^{-1}\,\partial q_s)}{(w^{-1}\,\partial w)},$$

where q_s represents the local supply of nurses. This equation can be rearranged as follows:

$$w\frac{\partial q_s}{\partial w} = \epsilon_s q_s.$$

Moving forward, let's delve into the differentiation of the function $S_\theta(n_s, w, 1)$ concerning w and evaluating it using wage and employed staff nurses' values before the pandemic. This yields:

$$w\frac{\partial S_\theta(n_s, w, 1)}{\partial w} = \frac{n_s s_s e^{-\tilde{w}^2}}{\sqrt{\pi}}.$$

In this context, $\tilde{w}$ is defined as $\tilde{w} = s_s\left[\ln(w) - \ln\left(m_s(1)\right)\right]$. Moreover, based on the equation defining our sigmoid supply surface, $\tilde{w}$ can also be expressed as $\mathrm{erf}^{-1}[2S_\theta(1, w, 1) - 1]$, where erf^{-1} is the inverse error function, and $S_\theta(1, w, 1)$ denotes the baseline proportion of the supply of nurses from the qualified pool of nurses. We determined this baseline proportion to be 84.1% based on a previous study (American Association of Colleges of Nursing, 2023b) This allows us to compute the value of $\tilde{w}$ and subsequently utilize it to determine the values of s_s and $m_s(0)$. The expressions for these parameters are provided by:

$$\begin{aligned} \tilde{w} &= \mathrm{erf}^{-1}\left(\frac{2q_s}{n_s} - 1\right), \\ s_s &= \frac{\epsilon_s q_s \sqrt{\pi} e^{\tilde{w}^2}}{n_s}, \\ m_s &= w e^{-\tilde{w}/s_s}. \end{aligned}$$

Thus, we successfully derive the values of $m_s(0)$ and s_s, which are presumed to characterize the pre-pandemic supply curve.

Informing the Model Describing the Dynamics of the Qualified Pool of Nurses

The component of the model that describes how the number of nurses in our qualified pool changes due to recruitment and permanent retirement is influenced by three key factors: ν, ω_1, and κ_ω. These parameters determine the amount of new nurses entering and nurses leaving the qualified pool.

Looking at the national context, we observe that there are approximately 155,000 new registered nurse (RN) graduates each year (Salsberg, 2018). This number accounts for around 5 percent of the total employed nurse population of 3.07 million. To estimate the suitable value of ν for Virginia, we apply a similar growth rate that considers the portion of the supply within the qualified pool. This suggests that ν for Virginia should fall between 3,500 and 7,000 new graduates annually.

To gauge the rate at which nurses leave the qualified pool, we assume that this pool changes slowly and remains relatively steady ($\frac{dn_s}{dt} \approx 0$). We also assume that the rate of nurses leaving the workforce supply, but not belonging to the qualified pool, ranges from being equal to the

leave rate of employed nurses, up to twice that rate. Consequently, we estimate that κ_ω varies within the range of [1, 2].

By using our determined values for ν and κ_ω, along with the assumption of steady changes, we can derive an estimated value for ω_1. Within our analysis, we vary ω_1 between 0.75 percent and 1.25 percent. This range encompasses the value that we found during our estimation process.

The Experimental Design for Model Calibration

Having established the model inputs, estimated their values, and detailed the data sources we relied on for both estimation and uncertainty assessment, we move on to describing the process of model calibration. This step involves leveraging the collected information to refine our model's performance. Calibration is a crucial step in optimizing our model's performance. It entails a systematic exploration of various combinations of parameter values within the predefined uncertainty range. To achieve this, we conducted a total of 40,000 distinct parameter value combinations, with each serving as an independent simulation, referred to as a "case run." This selection of parameter values and the quantity of case runs collectively define our experimental approach. Our calibration strategy involves aligning the trajectories of output state variables, particularly those related to nurse supply and wages, with our predefined calibration time-series targets. These calibration targets are summarized in Table E.1 for reference.

Table E.1. Trajectories of Output Variable

Date	Average Wage ($)	Number Employed
Registered nurses		
2020-04-05	74,380	66,450
2021-04-04	76,680	66,980
2022-04-03	81,860	69,510
Primary care providers		
2020-04-05	159,021	15,080
2021-04-04	163,543	16,890
2022-04-03	155,095	16,880
Behavioral health specialists		
2020-04-05	58,618	18,350
2021-04-04	63,301	18,560
2022-04-03	64,099	20,450

This comparison enables the identification of a subset of case runs whose trajectories most closely align with our calibrated targets. Notably, many input parameter values were intentionally selected with substantial uncertainty ranges around their estimated central values.

This deliberate choice provides the model with flexibility during the calibration process. While numerous input parameters possess significant uncertainty ranges, they may have distinct sampling schemes. These schemes can encompass either a uniform distribution spanning the uncertainty range or a PERT distribution. The latter, known as the beta PERT distribution, introduces a bias toward the provided central value or mode, reflecting desired probabilities. Consequently, even when parameters have broad uncertainty ranges, if they are sampled with a beta PERT distribution, most of the sampled values cluster around the central value.

Table E.2. Input Model Parameters, their Values, Ranges, and Sampling Methods

Variable	Description	Mode	Lower	Upper	PDF
initial.demand (RN)	Initial demand of nurses	68,200.000	59800.000	76,600.000	PERT
initial.supply (RN)	Initial supply of nurses	66,400.000	NA	NA	Fixed
initial.demand (PCP)	Initial demand of primary care providers	15,793.735	13572.000	18,015.471	PERT
initial.supply (PCP)	Initial supply of primary care providers	1,5080.000	NA	NA	Fixed
initial.demand (BH)	Initial demand of behavioral specialists	21,671.000	16515.000	26,826.161	PERT
initial.supply (BH)	Initial supply of behavioral specialists	18,350.000	NA	NA	Fixed
supply.prop	Initial proportion of providers belonging to the supply out of the whole qualified pool of providers	0.840	0.798	0.882	Uni
initial.work.reluctance	Initial work reluctance measure (defined in report); the initial pre-pandemic work reluctance is equal to 1 by definition	1.000	NA	NA	Fixed
initial.yearly.wage (RN)	Initial yearly wage of nurses as defined by the BLS	74,400.000	NA	NA	Fixed
initial.yearly.wage (PCP)	Initial yearly wage of primary care providers as defined by the BLS	159,021.000	NA	NA	Fixed
initial.yearly.wage (BH)	Initial yearly wage of behavioral specialists as defined by the BLS	58,618.000	NA	NA	Fixed
num.staffed.bed	Total staffed beds in all U.S. hospitals	15,200.000	NA	NA	Fixed
bed.occup.rate	Bed occupancy rate as defined by the curative care hospital bed occupancy rate in the U.S. from 1960 to 2019	0.699	NA	NA	Fixed
covid.prop	Proportion of all hospitalizations that are due to COVID-19	NA	NA	NA	Derived

Variable	Description	Mode	Lower	Upper	PDF
yearly.growth.demand	Yearly growth in demand as a proportion of the current demand	0.060	0.045	0.075	Uni
patient.to.nurse.nonICU	Initial patient-nurse ratio for non-ICU setting	4.000	NA	NA	Fixed
patient.to.nurse.ICU	Initial patient-nurse ratio for ICU setting	2.000	NA	NA	Fixed
ICU.rate	Proportion of all hospitalizations that require the ICU	0.121	NA	NA	Fixed
yearly.covid.prop.growth	Yearly growth of COVID-19 cases as a proportion of total hospitalizations	0.350	0.250	0.400	Uni
ICU.covid.rate	Proportion of all COVID-19 hospitalizations that require the ICU	0.198	NA	NA	Fixed
extra.effort.covid.nonICU	Multiplicative scaling factor of the effort required by a COVID-19 patient	1.500	NA	NA	Fixed
extra.effort.covid.ICU	Multiplicative scaling factor of the effort required by a COVID-19 patient in the ICU	2.000	NA	NA	Fixed
LOS	Average length of stay of patients in a hospital	5.500	3.800	7.000	PERT
LOS.covid	Average length of stay of COVID-19 patients in a hospital	15.400	13.500	17.200	Uni
n_s (RN)	Yearly number of new graduating nurses that join the supply of nurses under baseline conditions	7,910.000	5930.000	9,890.000	Uni
n_s (PCP)	Yearly number of new graduating primary care providers that join the supply of primary care providers under baseline conditions	165.000	110.000	247.500	Uni
n_s (BH)	Yearly number of new graduating behavioral specialists that join the supply of behavioral specialists under baseline conditions	218.452	145.635	327.679	Uni
κ_ω	Multiplicative scaling factor describing the increase rate in workforce depletion among nurses not belonging to the supply	1.500	1.000	2.000	Uni

Variable	Description	Mode	Lower	Upper	PDF
ω_1	Yearly probability of exiting and no longer participating in the workforce among those belonging to the supply	0.010	0.007	0.013	Uni
yearly.growth.wage	Net yearly percentage increase in wages when the demand for providers is greater than the supply after discounting for inflation	0.020	0.000	0.100	PERT
reduced.yearly.growth.wage	Yearly percentage increase in wages when the supply for providers is greater than the demand	0.005	0.000	0.025	PERT
β_F	Proportion of the change in work reluctance that is attributable to increased fatigue	0.500	0.425	0.575	Uni
β_D	Proportion of the change in work reluctance that is attributable to increased distress	0.300	0.255	0.345	Uni
β_E	Proportion of the change in work reluctance that is attributable to decreased engagement	NA	NA	NA	Derived
X_F	Proportion of the distress that responds linearly to increased demand	0.500	0.375	0.625	Uni
ψ_D	Initial distress component attributable to the portion that does not depend on demand	1.000	NA	NA	Fixed
ψ_E	Initial engagement component attributable to the portion that does not depend on demand	1.000	NA	NA	Fixed
τ_S	The half-life parameter represents the time-scale in years in an exponential weighted moving average model, used to discount past experiences in work reluctance, indicating the time it takes for the weighting of past observations to reduce to half of its original value	0.250	0.020	1.000	PERT
ϵ	Elasticity of supply with wages	0.644	0.250	1.000	PERT

Variable	Description	Mode	Lower	Upper	PDF
wage.prop	The percentage of the current wage needed to maintain the existing workforce if all factors causing work reluctance were eliminated	0.950	0.700	0.990	PERT
z_2	The level of the work reluctance metric required to reduce the nurse supply to the value specified by parameter "supply.prop2" while keeping wages unchanged	1.500	1.100	3.000	PERT
supply.prop_2	The value of the supply that will be achieved when the work reluctance metric reaches the level specified by the parameter $z_{2,}$ assuming there are no changes in wages	0.500	NA	NA	Fixed

NOTE: PCP = primary care physician.

Our input model parameters, their values, ranges, and sampling methods are summarized in Table E.2. It is important to note that while some parameters in the table are fixed and not altered, others undergo variation and are thus sampled. To efficiently create our experimental designs encompassing a wide array of parameter values, we employ Latin Hypercube Sampling (LHS) (Iman, Helton, and Campbell, 1981). LHS empowers the exploration of unique parameter input combinations, effectively capturing the inherent variability and uncertainty within the model. The LHS process involves dividing each parameter's range into intervals and randomly selecting a value from each interval. This strategy results in the creation of unique combinations of parameter values. This approach ensures that each parameter is sampled across its entire range, preserving the overall distribution and inter-parameter correlation. By carefully constructing this sampling design, LHS facilitates a streamlined exploration of the parameter space, providing valuable insights into how the simulation model behaves and performs. This strategic approach enhances our ability to consider various parameter combinations that might influence the model's outcomes and behavior.

Pairing the LHS scheme with Bayesian inference methods offers an efficient iterative calibration approach. In this context, Iterative Monte Carlo Approximate Bayesian Computation (IMABC) methods can be employed, progressively refining parameter estimates through a comparison of simulated and observed data, thereby enhancing model accuracy (Rutter et al., 2019; Lima et al., 2021). In contrast, a single LHS calibration lacks this iterative refinement, potentially leading to less precise parameter estimates and a limited ability to capture intricate parameter-data relationships. However, constrained by time and resources, we chose a single LHS method involving a large number of sampled case runs. Our approach calculates the error for each model run trajectory based on target output alignment and then selects the top one

percentile of trajectories closest to the target values. This method efficiently identifies promising model runs, streamlining calibration within our time constraints—although, in the future, the consideration of IMABC methods remains a possibility.

Sensitivity Analysis

We systematically adjusted input values to discern the inputs wielding the most substantial influence on the outcomes of interest (labor force supply and demand). This exploration of various parameter values yielded insights into how different factors affect model outputs. The process also illuminated interactions among parameters, enhancing our comprehension of the model's behavior.

Additionally, we produced an Excel-based tool that allows policymakers to more easily view how adjusting scenario inputs affects outcomes. For example, the tool allows the user to toggle between wage increase scenarios including baseline (2 percent real annual wage growth), 3 percent, and 4 percent real annual wage growth. By toggling between various scenarios and immediately viewing the effects on outcomes of interest, the user gains better insight into how sensitive the model is to each input.

Limitations and Extensions

In the realm of simulation modeling, simplifying assumptions and reliance on challenging-to-estimate parameter values often become essential because of data limitations. Consequently, model inputs frequently harbor significant uncertainty, emphasizing the need for sensitivity and robustness analyses to gauge policy effectiveness across a variety of scenarios.

Despite its apparent mathematical intricacy, our model actually incorporates several simplifications and disregards various complexities intrinsic to the nurse supply, retention, and recruitment challenge. Acknowledging these limitations, many of which arise from deliberate strategic simplifications to balance model accuracy and simplicity, we have engaged in sensitivity analyses and devised experiments to span a range of potential outcomes. However, it is crucial to acknowledge key constraints intrinsic to our model. Here we list a few examples of the limitations of our model:

1. Our current simulation model focuses on retention and recruitment at a broad level, without accounting for distinct health care worker population groups categorized by demographic indicators or pertinent characteristics, such as age strata. This omission overlooks the impact of aging nurses on wage trends and nurse supply dynamics, underscoring the need to stratify the nurse population by age to better capture these effects.
2. The model primarily addresses the influx of new health care workers into the state, but it doesn't consider the inflows and outflows from neighboring states. To enhance the model, it is essential to include factors such as perceived benefits and wages in Virginia compared with nearby states, offering insights into where graduating health care workers opt to begin their careers.

3. Because of temporal and data constraints, we calibrated the model at the state level and then extending predictions to regional levels using the calibrated parameters. For more accuracy, calibration should also be done at the regional level.
4. Our existing model simulates regions in isolation, disregarding interconnections between them. For a more accurate representation, regions should be simulated together, enabling the exploration of worker redistribution policies across different regions.
5. An expansion of the model could spotlight the potential gains from reallocating time spent on paperwork to patient care, leading to improved patient and worker satisfaction. Further exploration could delve into how efficiency changes and alterations in work types directly and indirectly impact health care worker supply. Additionally, the concept of "output" in health care should encompass improved health outcomes and care quality, transcending mere patient numbers. Structural changes should prioritize increased output without overwhelming health care providers, achieved by optimizing efficiency and work distribution.

Appendix F. System Dynamics Model Results for Registered Nurses

Model Experimental Design

This appendix focuses on the analysis of outputs from our dynamic model concerning nurses in Virginia. We'll complement our findings with informative plots derived from these outputs.

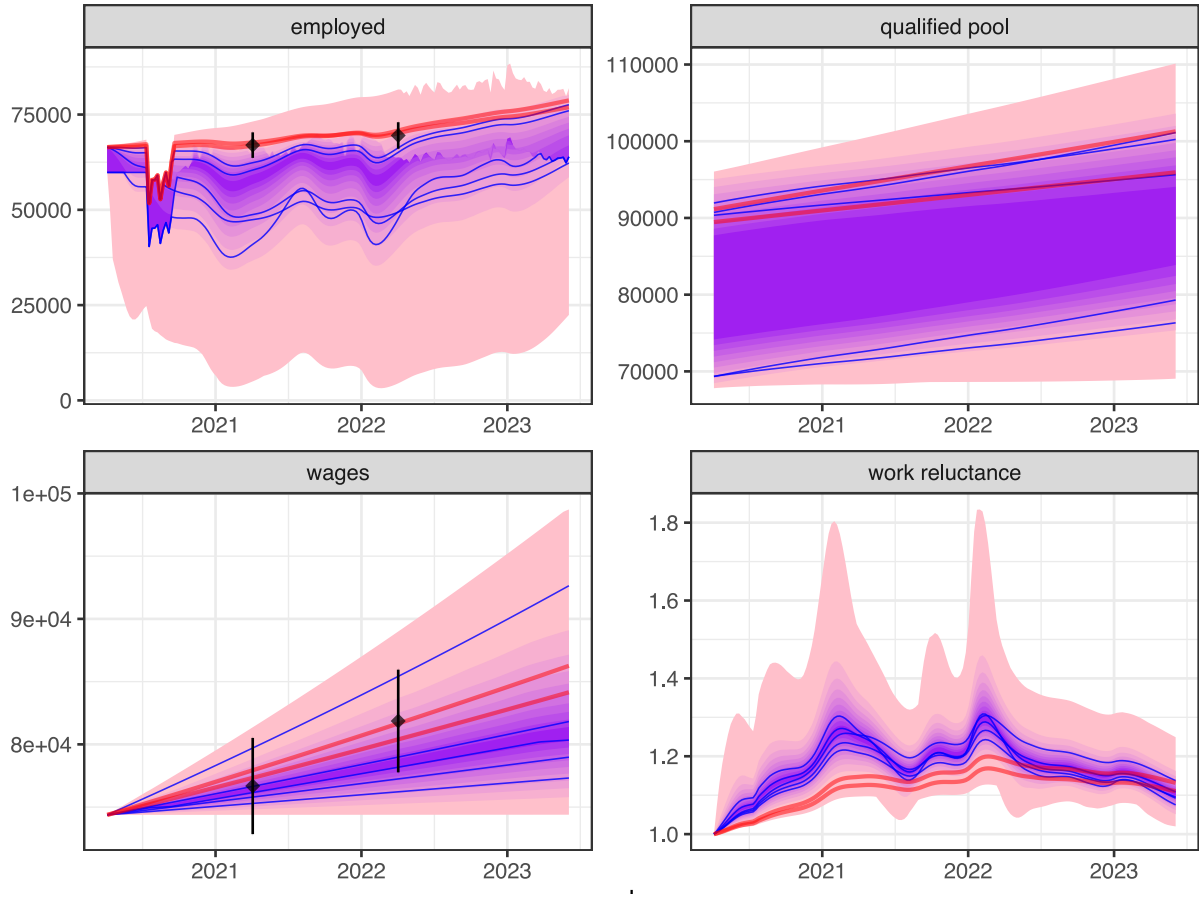
Our approach begins with conducting a sensitivity analysis and model calibration. For these tasks we devise an experimental design by utilizing our parameter value uncertainty range and generating 40,000 distinct case runs. Each case run encompasses a unique parameter combination derived from our sampling approach. For every case, we simulate trajectories for real wages, nurse supply, the qualified nurse pool, and health care work reluctance, serving as our calibration phase and spanning from the pre-pandemic initial conditions on April 5, 2020, to June 4, 2023. These wage and number of nurses employed outputs are then compared against our calibration targets. The trajectories of output state variables, encompassing supply and wages, are aligned with our calibration time-series targets.

Calibration Phase Trajectories

In a single iteration, we calculate the trajectory error for each model run, aligning with the target outputs. We then narrow down our calibrated subset of case runs by selecting the top one percentile of trajectories that closely match the target values. This efficient method enables us to identify the most promising model runs, optimizing the calibration process within our time limitations.

Figure F.1. displays the outcomes of our calibration phase trajectories. There are four outputs showing the number employed, the qualified pool, the wage and the health care work reluctance. We use a pink-to-purple scale to represent the distribution of model runs over time. The purple bands indicate distributions closer to the median, while the pink bands represent distributions further away from the median.

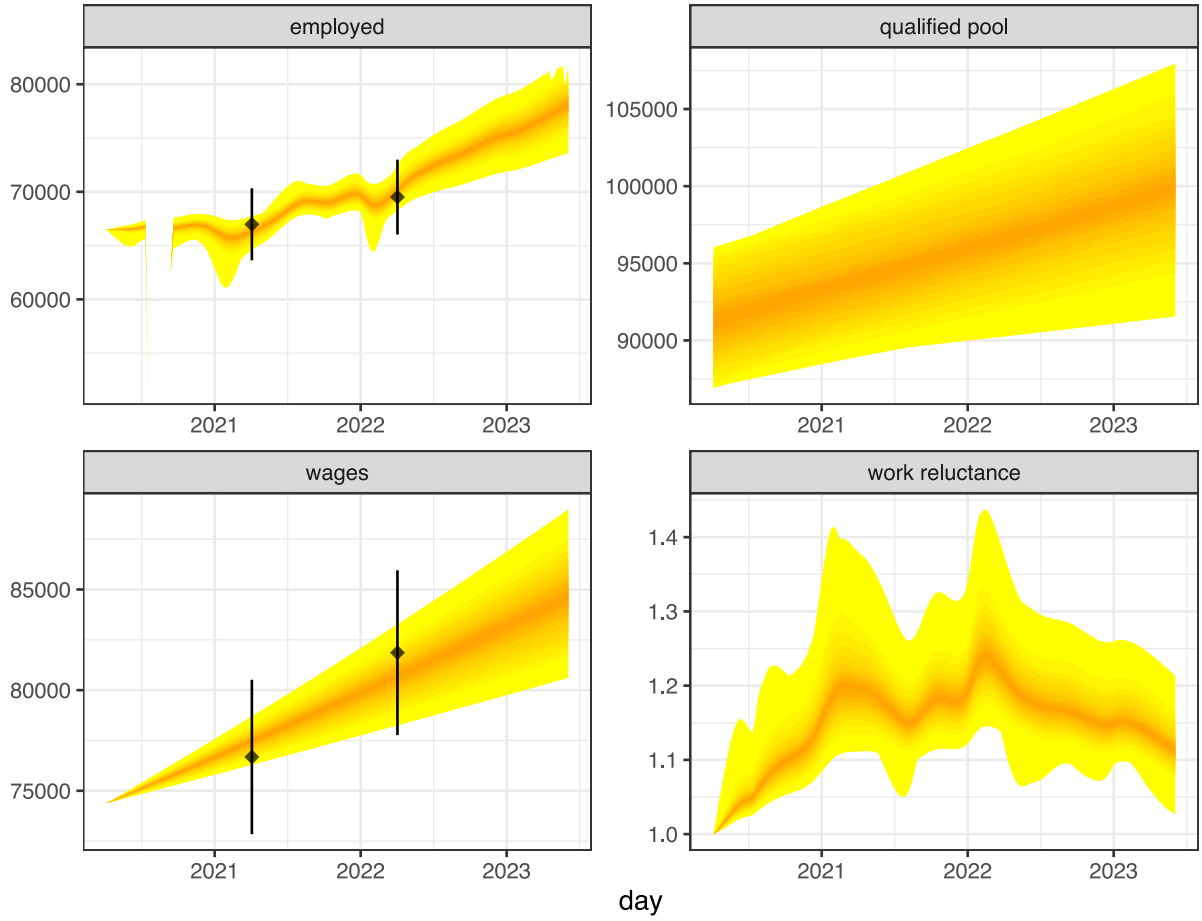
Figure F.1 Full Calibration Phase Trajectories for Registered Nurses



Within the plot, we can observe blue curves representing selected sample trajectories and red curves showcasing randomly chosen trajectories that align with our calibration targets. These trajectories are considered "calibrated" because they closely align with the wage and employed nurse calibration targets. These calibration targets are represented as black points on the plot, and the black lines above and below the points indicate the calibration window. The calibration window represents the tolerance we typically allow for a trajectory to pass through in terms of its distance to the calibration target point.

In Figure F.2, we present the same results, but this time we only consider the set of calibrated trajectories. The four outputs are again displayed, and the color scale now ranges from yellow to orange, showcasing the distribution of calibrated model runs over time. The orange bands represent distributions closer to the median, while the yellow bands represent distributions further away from the median.

Figure F.2. Final Calibrated Model Trajectories for Registered Nurses



Sensitivity Analysis

Before finalizing the subset of calibrated runs and proceeding to policy experiments, we conduct a sensitivity analysis. This analysis explores how different parameter values influence model outputs using our full set of 40,000 case runs. Here we summarize the main findings of our analysis.

During the calibration phase, demand remains an exogenous input, leading to no significant correlations with inputs aside from the initial demand value. The wage trajectory is mainly tied to yearly wage growth and initial demand. An intriguing finding is the weak yet meaningful negative correlation between wages and parameter z_2, indicating that as nurses become less responsive to increased work reluctance, the necessity for wage hikes diminishes. The qualified nurse pool is primarily influenced by initial demand and the influx of new nurses, holding more sensitivity to new nurse inflow relative to workforce depletion, as suggested by its correlations with ω_1 and ω_κ. Health care work reluctance aligns with our behavioral model parameters, including fatigue importance (β_F), fixed effect proportion (ξ_f), and the discount parameter (or

half-life τ_s). A notable observation is its strong negative correlation with LOS, as shorter LOS diminishes fatigue impact.

Supply dynamics involve multiple factors like wages, new nurse inflow, and parameters influencing work reluctance. Notably, supply acts as a pivotal mediating output influenced by a diverse range of inputs, shaping the dynamics of other outputs in our model.

Policy Experiments

Starting from our selected calibrated set of case runs, we conduct several policy experiments. In the formulation of our policy intervention runs, the primary step entails procuring final state variables from our calibrated cases, which then serve as initial conditions for our model projections. Notably, we are not constrained to employ the initial conditions derived from the calibration process's final states. Alternatively, we can opt for distinct calibrated case run parameters while initiating projections from the same initial condition. This approach circumvents the use of diverse initial conditions generated from final states of selected calibrated runs, which were determined based on historical data.

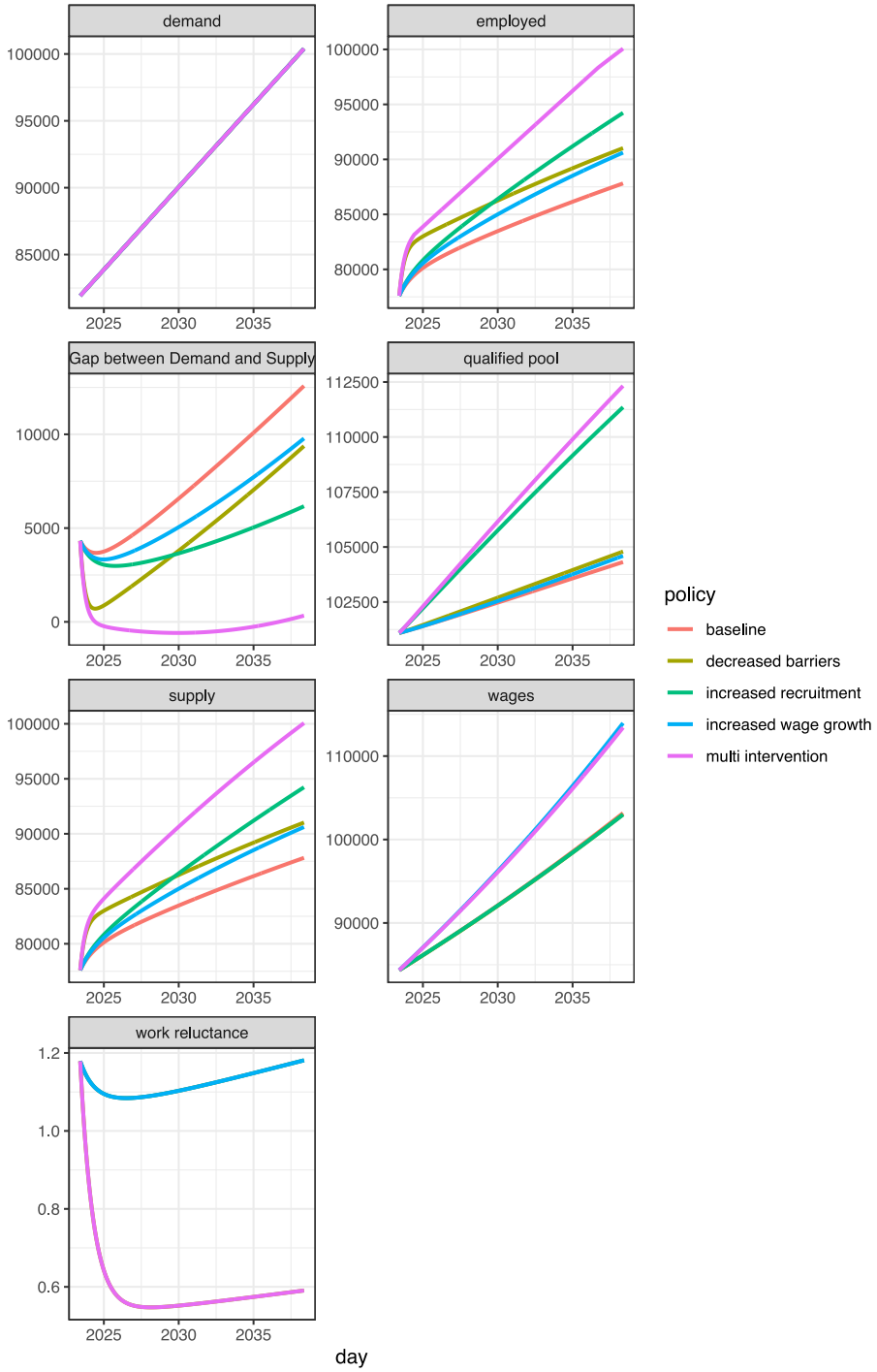
The policy experiments we conducted involve modifying specific input values that can be controlled through policy interventions. We examine the following policy scenarios separately:

1. **Reduced barriers:** This scenario involved a 50 percent reduction in the impact of certain barriers.
2. **Increased recruitment rate:** In this scenario, we amplified the value of the recruitment rate ν by 25 percent, leading to a 1.25-fold annual increase in newly graduated nurses.
3. **Elevated wage growth rate:** Here, we boosted the wage growth rate α_d by 50 percent. While the initial calibration assumed a 2 percent average annual real wage growth, this scenario accelerates the growth to an average of 3 percent per year.
4. **Multi-intervention:** We concurrently implemented all three of the above interventions.

In conjunction with the three aforementioned policies, we execute the baseline scenario, entailing no policy interventions and adhering to status quo conditions. To assess the potential impacts of the specified policy adjustments on the qualified nurse pool and supply within the context of Virginia over the forthcoming 15 years, we utilize projected trajectories as depicted below. Projected trajectories serve as the basis to evaluate the ramifications of these policy adjustments on Virginia's nurse's supply over the next 15 years.

Consolidating our outcome distribution analysis across all policies, we showcase a unified visualization in Figure F.3. by selecting the most representative case run. This encompassing figure comprises four plots, each representing an outcome metric, displaying trajectories under different policies. This arrangement streamlines the assessment of policy impacts across output metrics, fostering an intuitive grasp of their combined effects.

Figure F.3. Comparative Trajectories of Policy Effects for Registered Nurses



Regional Analysis

Drawing from our calibrated case runs tailored to the state of Virginia, we adjusted the initial conditions of state variables in alignment with the wage and population characteristics of each of the state's eight unique AHEC regions. Figure F.4. is a map of Virginia that delineates these

eight AHEC regions. This was achieved through proportional adjustments to parameters associated with nurse counts, leveraging demographic data to create a model that effectively encapsulates the distinct attributes of these AHEC regions.

We employed distinct initial conditions for each of the eight regions and conducted independent policy model runs for each region. Focusing solely on the most representative case runs, we constructed analogous plots for each of the eight regions. These plots, akin to the one showcased in Figure F.5. for the entire state of Virginia, illustrate the ramifications of policy interventions across various outputs. These region-specific plots are showcased in Figures F.6.-F.7, each centered on one of the four outputs. Importantly, each of these figures encompasses eight individual plots, each corresponding to a unique region under analysis. It is worth noting that these simulations for the eight regions were executed independently, with outcomes in one region holding no influence over the outcomes in the others. Because of this independence and because the primary differences between the regions are related to demographics and wages, the output plots for each region are essentially scaled versions of one another.

Figure F.4. Map of Virginia and How it is Divided into Eight Regions of Analysis

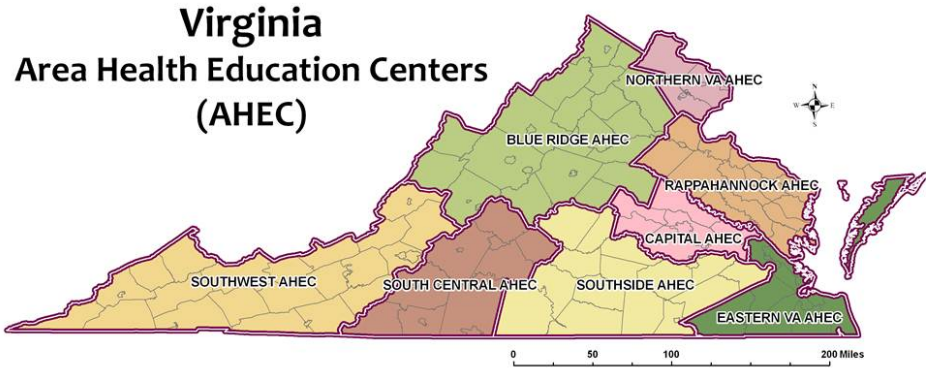


Figure F.5. Results of Policy Interventions on Employment by AHEC Region for Registered Nurses

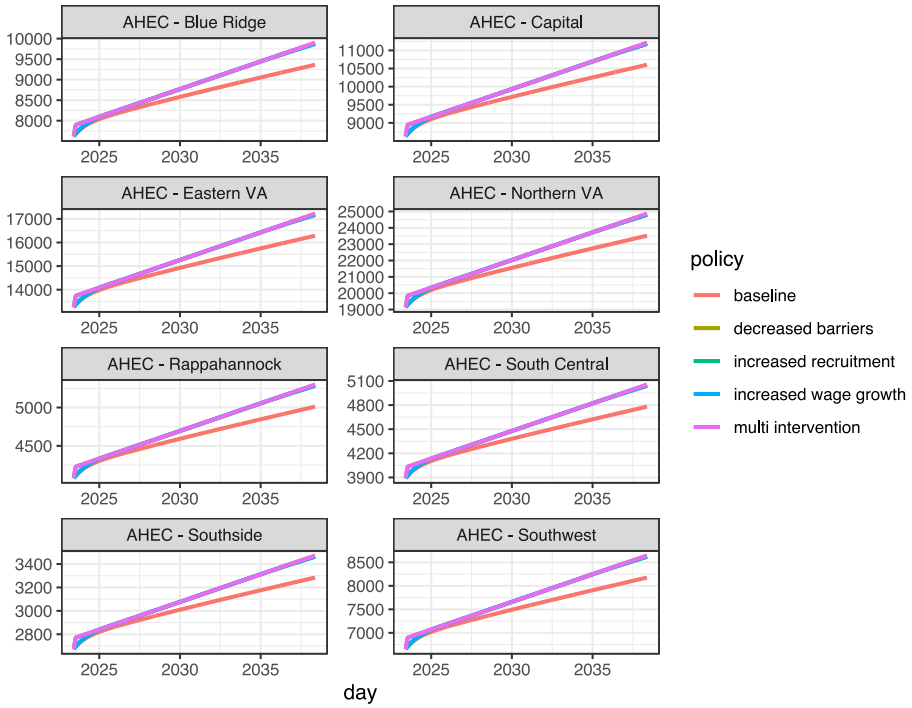
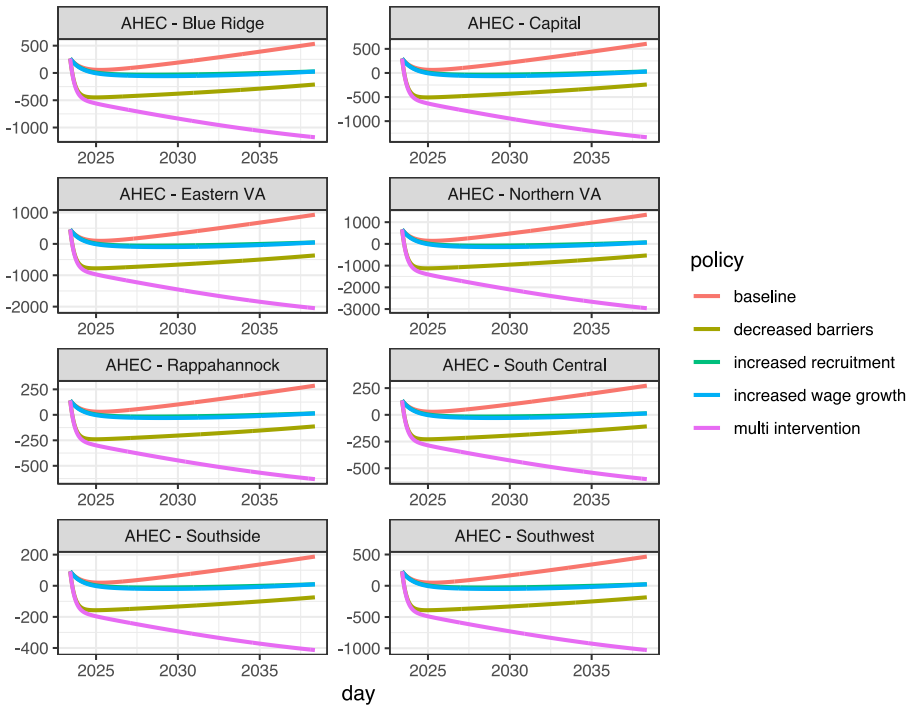


Figure F.6. Results of Policy Interventions on the Gap Between Supply and Demand by AHEC Region for Registered Nurses



Appendix G. System Dynamics Model Results on Primary Care Providers

Model Experimental Design

This appendix contains our dynamic model's results for Virginia's primary care providers. It is structured similarly to Appendix F, which covered nurse-related outputs, but in a more streamlined manner. Like before, we complement our findings with enlightening plots derived from these outcomes. However, we've chosen to exclude certain plot types that appeared in Appendix F, prioritizing those that provide the most insightful information. Sensitivity analysis plots are omitted as well. Our primary focus is on policy analysis plots for the representative case runs, excluding plots displaying outcome bands and distributions across all case runs.

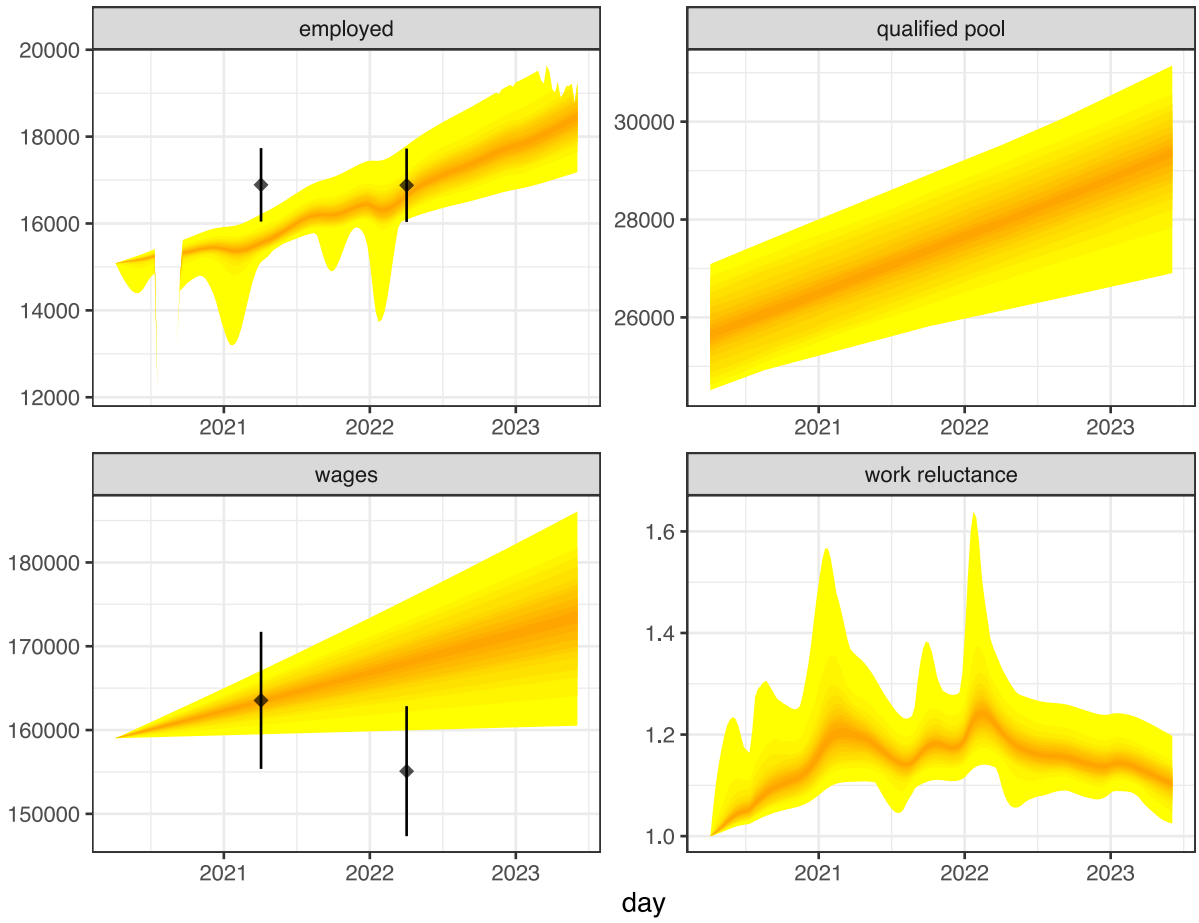
Following a similar methodology, our process starts with model calibration and experimental design. We utilize parameter uncertainty ranges to generate 40,000 distinct case runs, each representing a unique parameter combination. These cases simulate trajectories for real wages, physician supply, qualified physician pool, and work reluctance. Calibration spans from pre-pandemic conditions on April 5, 2020, to June 4, 2023. Output trajectories are compared with calibration targets, aligning wage and employed primary care provider numbers with predefined benchmarks. This ensures thorough alignment with calibration time-series targets.

Calibration Phase Trajectories

Figure G.1. illustrates the calibrated trajectories for the four outputs: number employed, qualified pool, wage, and health care work reluctance. These trajectories are labeled "calibrated" as they closely match the wage and employed primary care providers calibration targets. The calibration targets are depicted as black points on the plot, with black lines above and below indicating the calibration window. This window signifies the allowed tolerance for trajectories in relation to the calibration target point's distance.

A color scale ranging from yellow to orange is utilized, showcasing the distribution of calibrated model runs over time. Orange bands represent distributions closer to the median, while yellow bands signify distributions further away from the median.

Figure G.1. Final Calibrated Model Trajectories for Primary Care Providers



Upon examining Figure G.1, a notable observation arises—our model struggles to effectively track the four designated calibration points, two pertaining to primary care providers employed and two relating to their wages. This disparity stems from the fact that our calibration targets vividly illustrate a decline in physicians' real wages during the pandemic, occurring between 2021 and 2022, while the count of employed primary care providers remained relatively constant during the same period. However, our model doesn't account for the scenario where real wages experience a gradual decrease over time.

Furthermore, based on our initial conditions and calibration targets, it becomes evident that the count of employed primary care providers exhibited a swift surge between 2020 and 2021, followed by a consistent level between 2021 and 2022. Regrettably, our model fails to replicate this rapid upswing in employed primary care providers between 2020 and 2021, instead fitting a more gradual growth curve. Despite these challenges, we are not overly concerned about the perceived noncalibration of our model because of this issue.

This perspective is founded on the understanding that the pandemic-induced conditions of negative wage growth and the dynamics of primary care provider employment are unlikely to be

sustained or replicated in the medium to long term. Consequently, we proceed with confidence by selecting the showcased set of case runs in Figure G.1. for our policy projections.

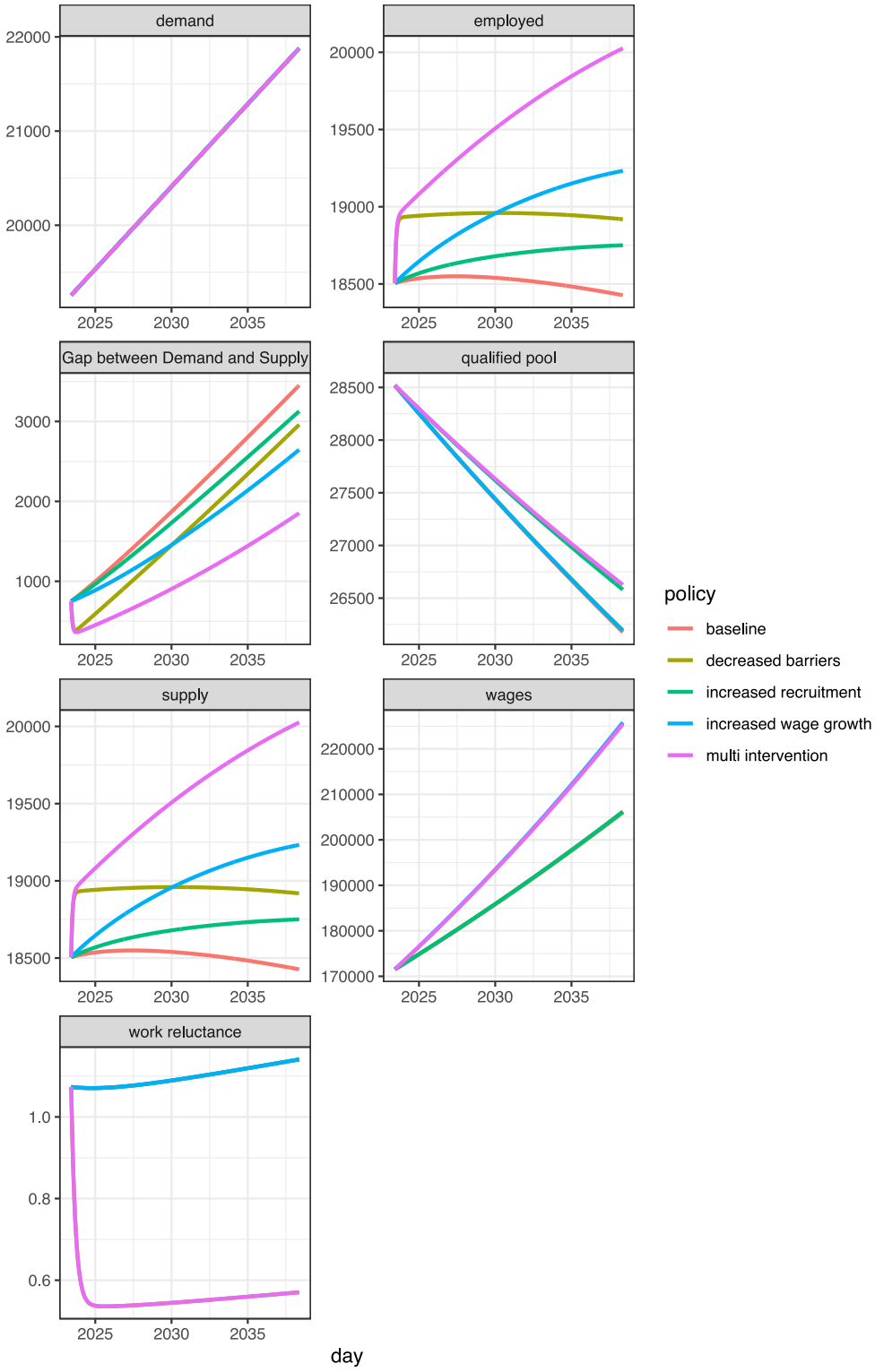
Policy Experiments

Repeating our approach for nurses described in Appendix F, we build upon our calibrated case runs selection and perform policy experiments for primary care providers.

Projected trajectories serve as the basis to evaluate the ramifications of these policy adjustments on Virginia's primary care provider pool and supply over the next 15 years. Consolidating our outcome distribution analysis across all policies, we showcase a unified visualization in Figure G.2. by selecting the most representative case run. This encompassing figure comprises four plots, each representing an outcome metric, displaying trajectories under different policies. This arrangement streamlines the assessment of policy impacts across output metrics, fostering an intuitive grasp of their combined effects.

Commonwealth Analysis

Figure G.2. Comparative Trajectories of Policy Effects for Primary Care Providers



Regional Analysis

Applying the method outlined in Appendix F, Figures G.3.–G.4. display region-specific plots for primary care providers, each dedicated to one of the four outputs. Within each figure, you'll find eight distinct plots, each representing a specific region under analysis.

Figure G.3. Results of Policy Interventions on Employment by AHEC Region for Primary Care Providers

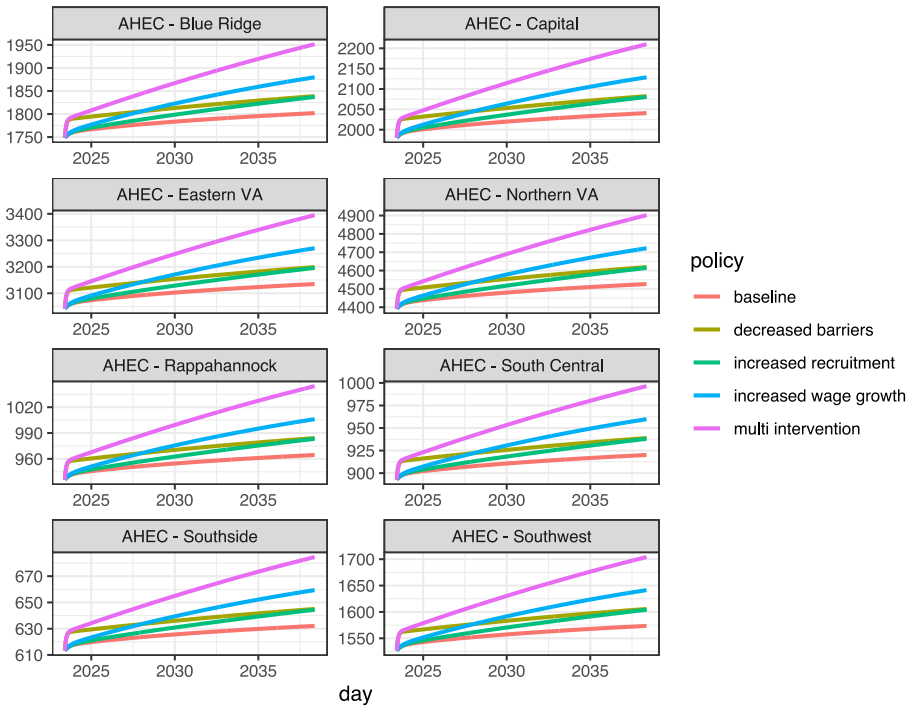
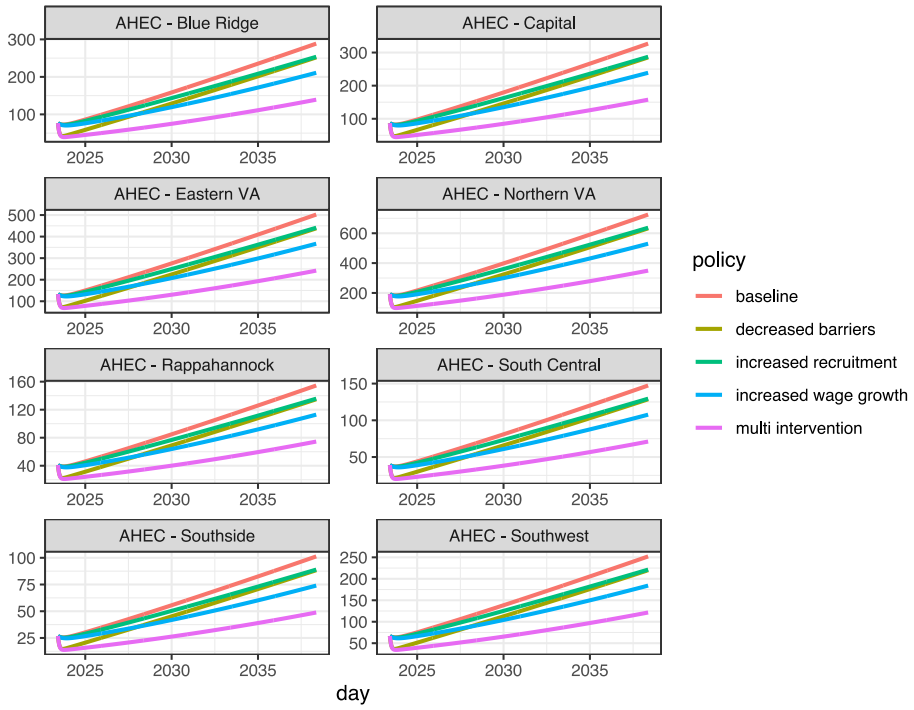


Figure G.4. Results of Policy Interventions on the Gap Between Supply and Demand by AHEC Region for Primary Care Providers



Appendix H. System Dynamics Model Results on Behavioral Health Specialists

Model Experimental Design

This appendix examines outcomes generated by our dynamic model for behavioral specialists in Virginia. It follows a streamlined structure similar to Appendix F, which detailed nurse-related outputs. As in Appendix F, we utilize insightful plots derived from these outcomes, focusing on informative plot types and excluding sensitivity analysis plots. Our focus is on presenting policy analysis plots for representative case runs, excluding plots showing bands and distributions across all case runs for each output.

We begin with model calibration and experimental design, using a parameter uncertainty range to create 40,000 distinct case runs. Each run captures a unique parameter combination. Within each case, we simulate trajectories for real wages, behavioral specialist supply, qualified pool, and health care work reluctance. The calibration phase spans from pre-pandemic conditions on April 5, 2020, to June 4, 2023.

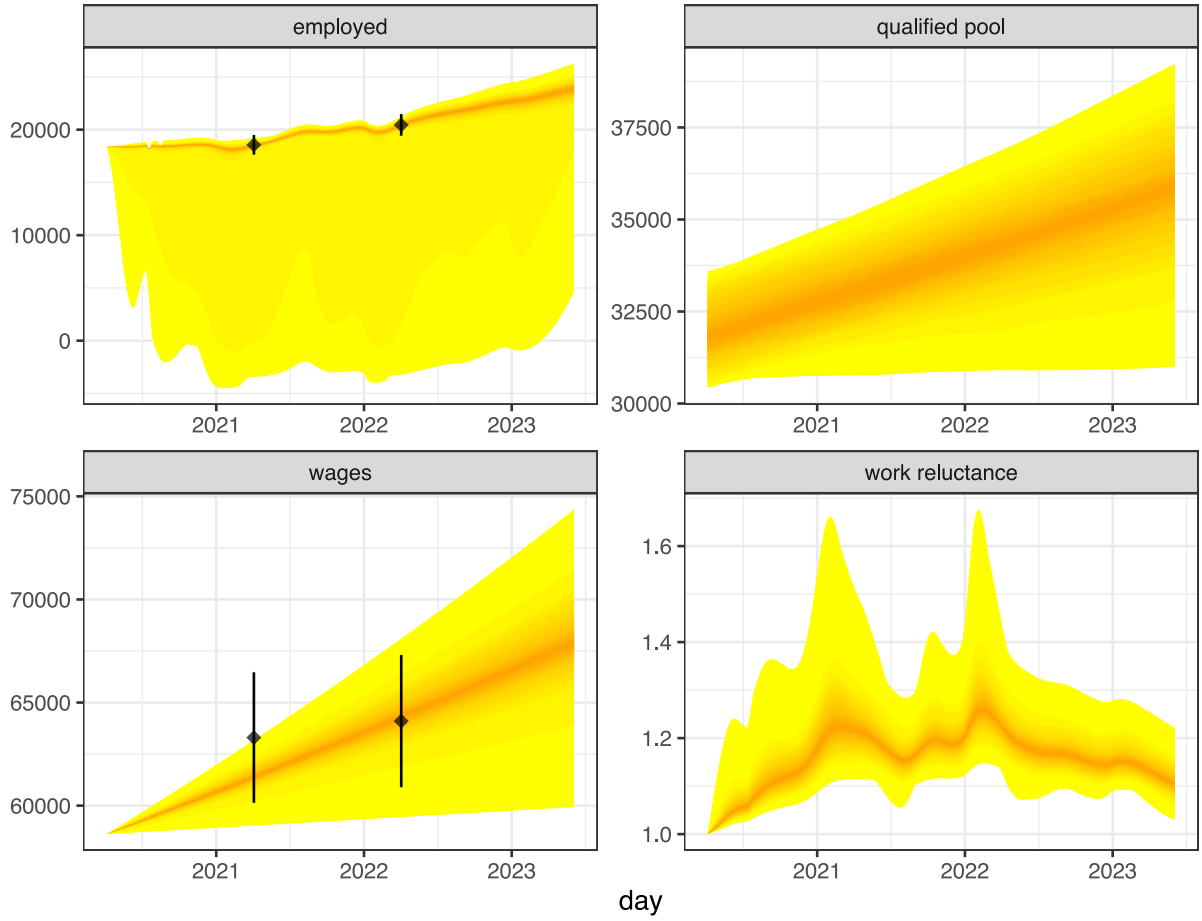
During calibration, we compare output trajectories (e.g., supply and wages) against designated targets. We specifically assess wage outcomes and the number of employed behavioral specialists against predefined calibration benchmarks. This ensures alignment with our calibration time-series targets comprehensively.

Calibration Phase Trajectories

Figure H.1. illustrates the calibrated trajectories for the four outputs: number employed, qualified pool, wage, and health care work reluctance. These trajectories are labeled “calibrated” as they closely match the wage and employed behavioral health specialists calibration targets. The calibration targets are depicted as black points on the plot, with black lines above and below indicating the calibration window. This window signifies the allowed tolerance for trajectories in relation to the calibration target point’s distance.

A color scale ranging from yellow to orange is utilized, showcasing the distribution of calibrated model runs over time. Orange bands represent distributions closer to the median, while yellow bands signify distributions further away from the median.

Figure H.1. Final Calibrated Model Trajectories for Health Behavioral Specialists



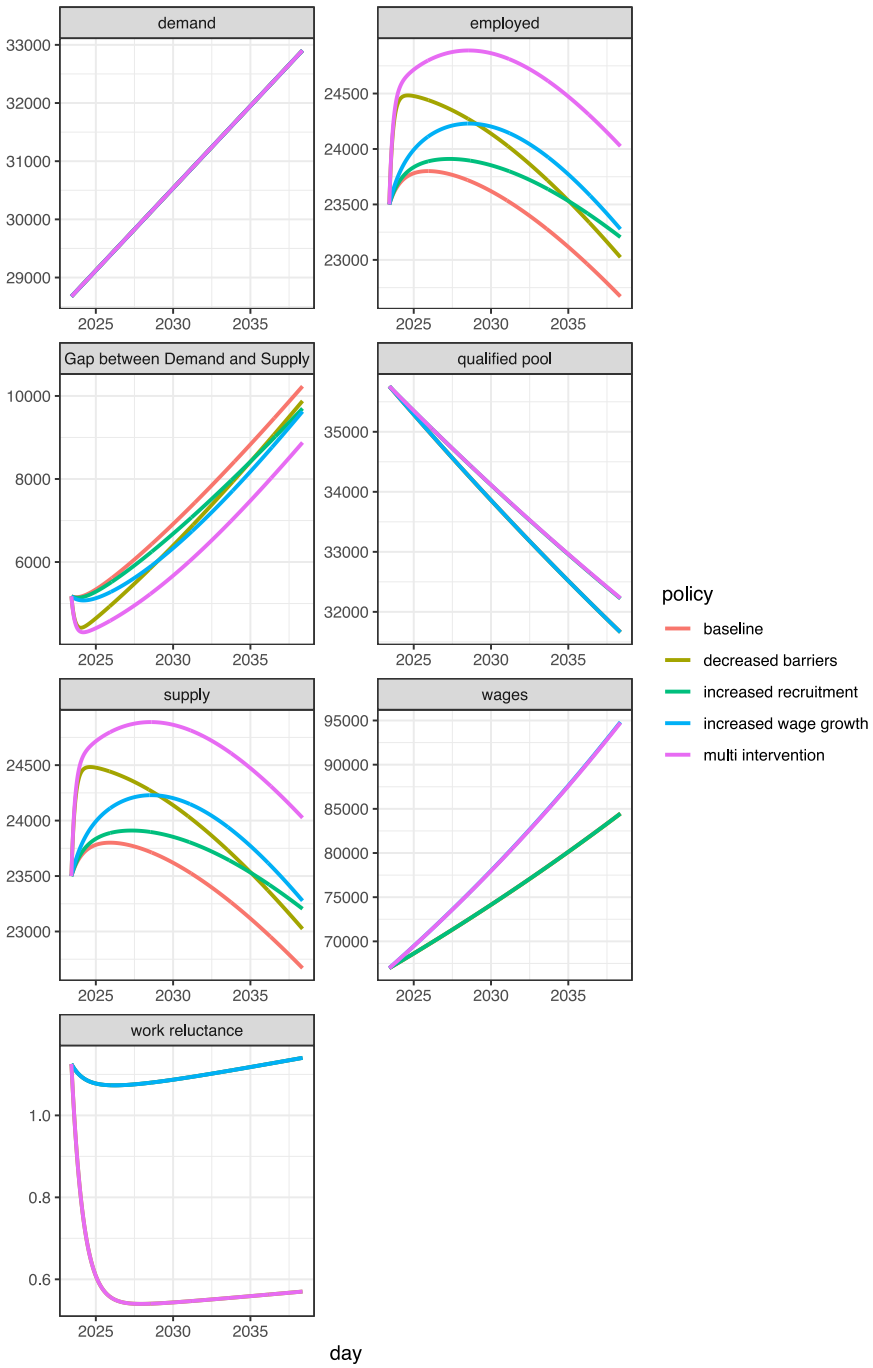
Policy Experiments

Repeating our approach for nurses described in Appendix F, we build upon our calibrated case runs selection and perform policy experiments for behavioral specialists.

Projected trajectories serve as the basis to evaluate the ramifications of these policy adjustments on Virginia's behavioral specialist pool and supply over the next 15 years. Consolidating our outcome distribution analysis across all policies, we showcase a unified visualization in Figure H.2. by selecting the most representative case run. This encompassing figure comprises four plots, each representing an outcome metric, displaying trajectories under different policies. This arrangement streamlines the assessment of policy impacts across output metrics, fostering an intuitive grasp of their combined effects.

Commonwealth Analysis

Figure H.2. Comparative Trajectories of Policy Effects for Behavioral Health Specialists



Regional Analysis

Applying the method outlined in Appendix F, Figures H.3.–H.4. display region-specific plots for behavioral specialists, each dedicated to one of the four outputs. Within each figure, you'll find eight distinct plots, each representing a specific region under analysis.

Figure H.3. Results of Policy Interventions on Employment by AHEC Region for Behavioral Health Specialists

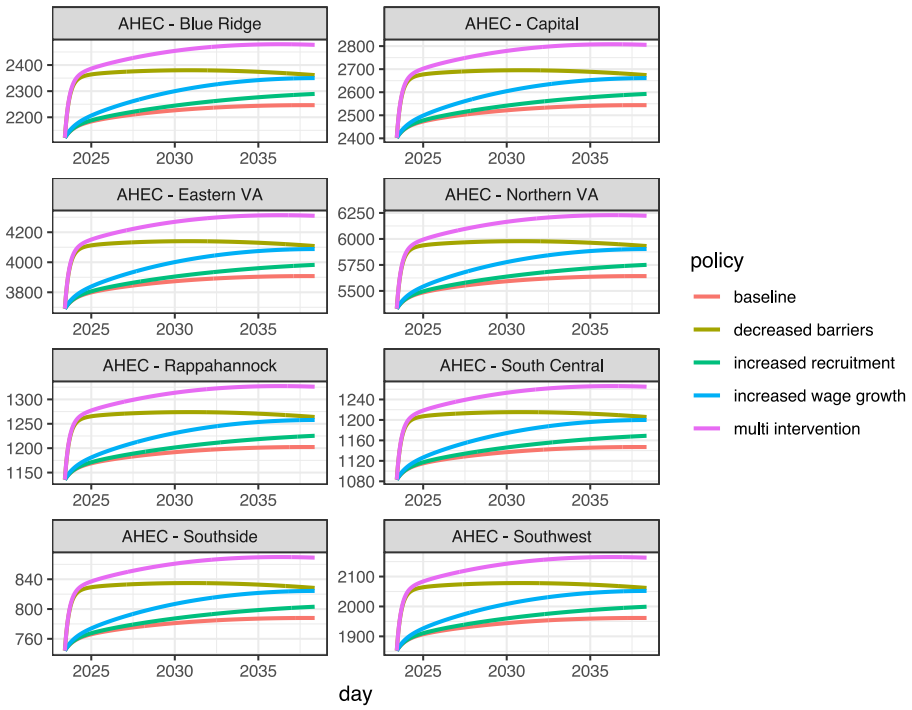
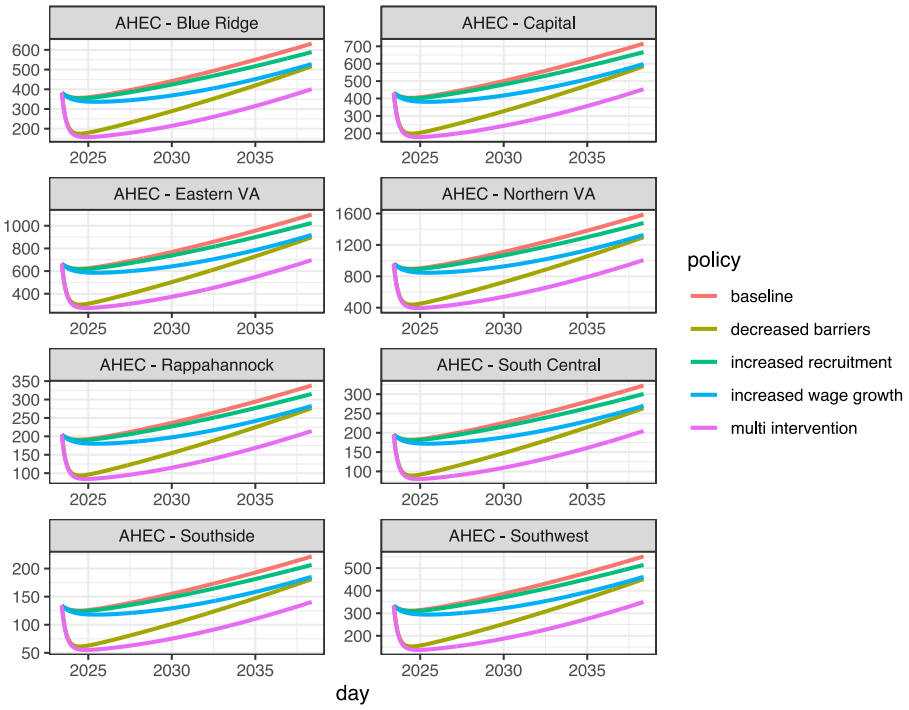


Figure H.4. Results of Policy Interventions on the Gap Between Supply and Demand by AHEC Region for Behavioral Specialists



Abbreviations

AHEC	Area Heath Education Centers
AI	artificial intelligence
BLS	U.S. Bureau of Labor Statistics
COVID-19	coronavirus disease 2019
EWMA	exponential weighted moving average
LHS	Latin Hypercube Sampling
PDF	probability density function
RN	registered nurse

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