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THE EVOLVING U.S. HEALTH WORKFORCE

A Methodology for Using Workforce Data to Decide Which Specialties and States to Target for Graduate Medical Education Expansion

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Objective. To outline a methodology for allocating graduate medical education (GME) training positions based on data from a workforce projection model.

Data Sources. Demand for visits is derived from the Medical Expenditure Panel Survey and Census data. Physician supply, retirements, and geographic mobility are estimated using concatenated AMA Masterfiles and ABMS certification data. The number and specialization behaviors of residents are derived from the AAMC's GMETrack survey.

Design. We show how the methodology could be used to allocate 3,000 new GME slots over 5 years—15,000 total positions—by state and specialty to address workforce shortages in 2026.

Extraction Methods. We use the model to identify shortages for 19 types of health care services provided by 35 specialties in 50 states.

Principal Findings. The new GME slots are allocated to nearly all specialties, but nine states and the District of Columbia do not receive any new positions.

Conclusions. This analysis illustrates an objective, evidence-based methodology for allocating GME positions that could be used as the starting point for discussions about GME expansion or redistribution.

Key Words. Health policy/politics/law/regulation, health workforce distribution/incomes/training, medicare

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Congressional proposals to expand graduate medical education (GME) have set a goal of funding 3,000 new GME slots for 5 years for a total of 15,000 new residency positions. The Resident Physician Shortage Reduction Act of 2015 (S.1148) and its companion bill in the House (H.R. 2124) require the National Health Care Workforce Commission to submit a report to Congress by 2018 identifying physician shortage specialties using a 2008 report from the Health Resources and Services Administration (HRSA). Implementing these bills, if passed, would prove difficult. Although the National Health Care Workforce

Commission was authorized by the Affordable Care Act, it has not been funded and HRSA's 2008 workforce projections are now outdated. Another bill, Training Tomorrow's Doctors Today Act (H.R. 1201), requires the General Accounting Office (GAO) to identify physician shortage specialties and in August of 2015, 27 members of the House Ways and Means and Energy and Commerce Committees asked GAO to evaluate the current structure of the nation's federally funded GME programs and provide recommendations for improvements (Brady and McMorris Rodgers 2015).

Even if the Workforce Commission, HRSA, or GAO had accurate data on physician workforce shortages, they would have to develop a methodology to translate the data into information that policy makers could use to determine how new positions should be allocated by state and by specialty. The purpose of this article was to outline such a methodology and use a case example to illustrate how the methodology could be applied. The methodology draws on data from the FutureDocs Forecasting Tool,[1] which was developed by the University of North Carolina at Chapel Hill—but any robust forecasting model could be used. We base the case example on an expansion of 3,000 GME slots each year for 5 years as this is the target included in multiple bills submitted to Congress. The goal of this analysis is not to evaluate whether the proposed expansion is appropriate but to outline a methodology for how workforce data could be used to allocate the new GME positions by state and specialty to address population health needs.

METHODS

Model Overview

The FutureDocs Forecasting Tool is a model that estimates the (1) demand for health care services (e.g., visits) for 19 types of health care services in inpatient, outpatient (office-based and outpatient), and emergency room settings; (2) supply of physicians in 35 specialties; and (3) capacity of physician supply to meet health care services use from 2013 to 2030. We define capacity as the

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estimated number of visits physicians in a given state can supply divided by the number of visits patients will use for 19 types of health care services. The capacity measure (henceforth called a "shortage surplus ratio") is a ratio that describes whether a state faces a shortage or surplus of physicians to meet demand for 19 types of health care services. A shortage/surplus ratio of 1 indicates that the workforce is in balance, ratios less than 1 indicate demand is greater than supply ("shortage"), and ratios greater than 1 indicate a surplus capacity. The further from 1 the ratio, the more pronounced the imbalance.

Data

Demand. Health care use was categorized into 19 "clinical service areas" defined by the Agency for Healthcare Research and Quality (AHRQ) Clinical Classification System, plus a preventive care category. We estimated the demand for each of these 19 types of health care service settings using indirect estimate methods (Rao 2003). To do this, we calculated the visits to outpatient (office-based and outpatient), emergency room, and inpatient settings for each respondent in the 2008 and 2009 Medical Expenditure Panel Survey (MEPS) data. For each county in the United States, we reweighted the MEPS population to represent the county based on factors known to influence health care use: sociodemographics (age, gender, race/ethnicity); socioeconomics (family income below federal poverty guidelines); markers of health risk and status (current smoker, obesity, and having been diagnosed with diabetes); and an indicator for whether the respondent is uninsured. Respondents sharing the county's region and rurality were given a higher weight in the initial iteration. County data came from multiple sources; age/sex/race/ethnicity profiles came from the U.S. Census Bureau (2013). Current poverty estimates come from the Small Area Income and Poverty Estimates program (U.S. Census Bureau 2014). Area estimates of rates of smoking, obesity, and diabetes diagnosis are obtained from the County Health Rankings data produced by the University of Wisconsin (which are largely derived from Behavioral Risk Factor Surveillance System [BRFSS] estimates; University of Wisconsin Population Health Institute 2015). Insurance coverage rates are obtained from the Small Area Health Insurance Estimates program at the U.S. Census Bureau (2014). Annual forecast estimates of county-level age, sex, and race/ethnicity estimates for 2010–2030 are obtained from ProximityOne, a commercial firm compiling statistical data (ProximityOne 2015).

A limitation of using visit-based data from MEPS is that patient visits are assigned to the primary specialty of the physician who saw the patient during the visit. This means that no visits are assigned to the specialties of anesthesiology, radiology, and pathology. Therefore, the methodology described in this paper does not identify changes in GME for these specialties.

Supply. Gresenz, Auerbach, and Duarte (2013) note that physician microsimulation models require combining information from multiple sources on the current supply of providers and their specialty type; flows into and out of the physician workforce; and information about the type of services provided by physicians.

Baseline Supply. To establish the baseline number of physicians in 2013, we used data from the American Medical Association's (AMA) Physician Masterfile (MF) together with certification data from the American Board of Medical Specialties (ABMS). The model includes all physicians listed as actively working according to the AMA MF, including those in direct patient care, administration, medical research, or teaching. Physicians classified as retired, semiretired, or not active were excluded. Physicians whose major professional activity was unclassified in the Masterfile were included. Physicians in training —residents and fellows—were excluded from the baseline supply but are included in the Graduate Medical Education (GME) pipeline described below. Federal physicians were included as they often provide health care services to civilians during and after retiring from federal service. To simplify the model, we collapsed the 315 specialties in the AMA MF into 35 categories. The decision rules governing how we used AMA and ABMS specialty categories to assign physicians to specialties are described in detail on the model website.[2] In brief, we grouped specialties according to their training pathways. For example, pediatric surgery, which branches from surgery, is grouped with surgery; pediatric subspecialties such as pediatric nephrology and pediatric endocrinology, which branch from pediatrics, are grouped with pediatrics. The exceptions to this rule are adult internal medicine subspecialties, which are each placed within their own categories for modeling purposes (e.g., endocrinology, cardiology, nephrology).

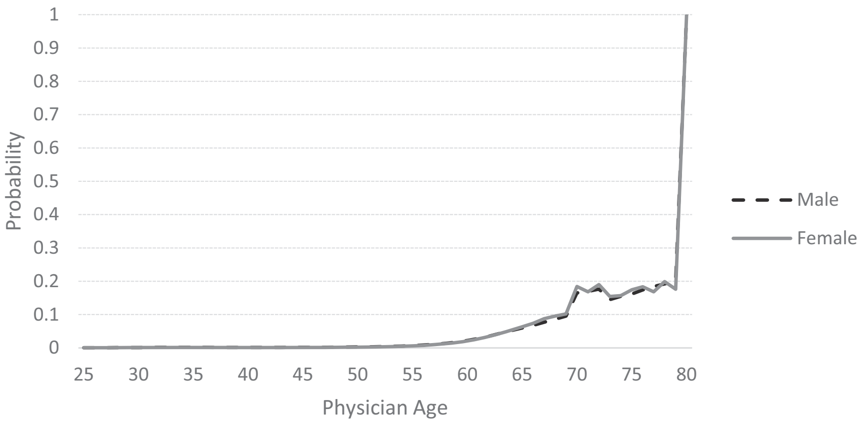
Full-Time Equivalents. Measuring full-time equivalent (FTE) hours in direct patient care is a more accurate reflection of physician supply than a simple head count. Models must also account for the fact that hours worked vary by age and by gender. Male physicians tend to work more hours than female physicians at all ages, especially during the childbearing years, and both male and female physicians begin to reduce their hours in their mid-50s. Hours in patient care also vary by specialty.

Because the AMA Masterfile does not include data on clinical hours, we estimated FTE by age, sex, and specialty using data on patient care hours from the North Carolina Health Professions Data System (HPDS). The HPDS is a long-standing and well-respected source of workforce data collected from initial and renewal licensure information from the North Carolina medical board (Gresenz, Auerbach, and Duarte 2013). According to the AMA MF, the NC physician workforce is similar to the national physician workforce along the dimensions likely to affect FTE. The average age of NC physicians is 49.4 years compared with 50.4 years for the US physician workforce and 31.6 percent of the NC workforce is female, compared with 32.2 percent nationally. The specialty composition of the NC workforce also closely mirrors the specialty breakdown of the rest of the United States.

Exit from Practice. Because the AMA MF underestimates retirements (Staiger, Auerbach, and Buerhaus 2009), we combined data on practice exits from the AMA MF over successive years with mortality data from the National Center for Health Statistics (CDC). Physician exit is the hazard ("risk") of retiring, leaving the workforce, or expiring at each year of life, conditional on making it to that year, as shown in Figure 1. Physicians have a very small but nonzero risk of exiting practice in early years. That risk increases with age and the model assumes that all physicians will effectively retire or die by age 80. We chose a higher retirement age of 80 to capture physicians in teaching and administrative roles who play an important role in the education of future physicians.

Geographic Mobility. The FutureDocs Forecasting Tool is the first projection model that we know of to account for the geographic mobility of physicians and resident physicians between states. Estimating interstate mobility is important as any attempt to address physician shortages by expanding GME in one state will have an effect on other states because physicians are a mobile workforce. We created a 50 by 50 state matrix estimating the probability of moving between states for physicians in all 35 specialty categories using

Figure 1: Probability of Retirement by Age and Sex



concatenated AMA MFs from 2009 to 2013. Separate probability tables were calculated for residents and active physicians.

The Graduate Medical Education Pipeline. Data on the GME pipeline were obtained from the National Graduate Medical Education Census (GME Track) housed at the Association of American Medical Colleges. GME Track includes a census of residents on duty in December of each year in programs accredited by the Accreditation Council for Graduate Medical Education (Jolly, Erikson, and Garrison 2013). We used GME Track data from 2006 to 2013, to estimate (1) the average number of residents who branched in each year of training from core specialties into subspecialties; (2) attrition rates from training; and (3) average training lengths for each specialty. Average training lengths are longer than minimum lengths required for Board Certification because a noninsignificant proportion of residents take time off for either personal or professional reasons (Holmes, Cull, and Socolar 2005; Saalwachter, Freischlag, and Sawyer 2006). Using data on actual, rather than minimum, training lengths allowed us to more accurately model the amount of time it would take for GME expansions to have on physician workforce supply.

We also used GME Track data to estimate the number of residents switching training specialties. This adjustment is critical because the entry specialty of a resident can differ from the specialty in which the resident exits training and becomes board certified.

Because GME Track only contains information about residents in ACGME and joint ACGME/AOA accredited programs, we added an additional 5,900 DO residents and fellows in AOA-only training to the model and distributed them across specialties according to documented DO specialty choices (Jolly, Lischka, and Sondheimer 2015). In total, the model included 123,096 GME positions at the baseline in 2013. We projected a 1 percent annual increase in GME positions per year based on historical levels of growth in GME Track from 2006 to 2013. This annual growth rate is consistent with other estimates derived from GME Track (Grover, Orlowski, and Erikson 2016), but conservative compared with other analyses (Dall et al. 2015; Mullan, Salsberg, and Weider 2015).

Modeling Assumptions

Timing. We assume that the expansion of GME slots begins in 2016 to meet forecast shortages in 2026. We selected 2026 to allow sufficient time for changes in GME to have an effect, while remaining as close to the baseline year as possible to increase the reliability of the shortage estimates. We assume that GME slots are always filled, that states have the capacity to train in the specialties allocated to them, and that residency expansion does not affect health care service use. For modeling simplicity, we assume an average training length across all specialties of 5 years.

In 2016, we create 3,000 PGY1 positions. When these PGY1 residents move to PGY2, we create 3,000 new PGY2 slots and the 3,000 PGY1 slots are reused for 3,000 new residents. This process continues out to PGY5, for a total of 15,000 new residency slots created. The 15,000 new GME positions remain in the system, spread out over 5 years of postgraduate training. The result is 3,000 new entrants to the workforce each year after year 2021, representing an approximate 10 percent increase over the 31,000 new entrants currently added to the workforce each year.

Identifying Shortage Visits. The first step in the methodology is determining which types of health care services will be in shortage in 2026. For each of the 19 types of health services in each state, we use the model to calculate the difference between the number of visits physicians in that state can supply compared with the number of visits that will be utilized by the population.

Translating Visits into Specialties. The second step is to use the model's plasticity matrix (Holmes et al. 2013) to determine which specialties could meet the demand for shortage visits. A visit for a given condition can be provided by multiple specialties; for example, an internist, family physician, or endocrinologist can care for diabetes. To account for this flexibility, we use a "plasticity" matrix that maps specialties to specific health care services. Table 1 is an illustration of how the plasticity matrix is used to determine the number of PGY1 positions needed, in this example case, to meet a shortage of 1,000,000 circulatory visits per year.

Column 1 of Table 1 shows that 24.8 percent of circulatory visits are provided by cardiologists, 44.7 percent by family physicians, 15.4 percent by internists, 4.9 percent by emergency medicine physicians, and the rest by other physician specialties. Using this distribution, we calculate in column 2 how the 1 million shortage visits could be allocated across specialties. We then calculate the average number of physician FTEs it would take to provide these visits (column 3) by dividing column 2 by 2,750, which is the average number of visits per year an FTE physician provides (Medical Group Management, 2012).[3] We then convert FTEs to headcounts (column 4) by dividing FTEs (col 3) by 0.6, as the North Carolina licensure data show that the average physician works 60 percent of an FTE in patient care. As we want to produce the headcount to meet shortage visits in 2026 and, on average across all specialties, residents train for about 5 years, we have 5 years to produce the needed headcount. Therefore, we divide column 4 by 5 and that gives us the number of PGY1 slots needed in 2016. This methodology identifies the total number of PGY1 slots—121—needed to address an example shortage of 1 million circulatory visits. Note that the allocation by specialty is on the basis of the core specialty in which residents complete their training. This means the expansion in cardiology would occur initially in PGY1 in the core specialty of internal medicine and then the model would allocate the needed number of residents into cardiology training in PGY4. This method is then applied for each of the 50 states and 19 clinical services areas to calculate the total number of new PGY1 GME slots in each specialty in each state required to address the shortage visits in 2026 (see Appendix SA2).

RESULTS

Allocating the 3,000 New PGY1 Slots

Once we determined the headcount needed in each specialty in each state to meet demand for visits in 2026, we can then calculate how much of this excess demand for visits could be met by expanding GME by 3,000 slots per year for

Table 1: Example Methodology for Translating Circulatory Visits into Specialties by Headcount

Specialty	*1. Circulatory Visit Activity by Specialty*	*2. Distribution of Shortage Visits by Specialty*	*3. Patient Care FTE Needed by Specialty*	*4. Headcount Needed in 2026*	*5. PGY1 Needed in 2016*
Allergy/immunology	0.0%	137	0	0	0
Cardiology	24.8%	248,023	90.2	150	30
Dermatology	0.1%	1,406	0.5	1	0
Emergency medicine	4.9%	49,062	17.8	30	6
Endocrinology	0.5%	4,560	1.7	3	1
Family medicine	44.7%	446,984	162.5	271	54
Gastroenterology	0.4%	3,862	1.4	2	0
General pediatrics	0.4%	4,071	1.5	3	1
Geriatrics	0.3%	3,331	1.2	2	0
Gynecology/obstetrics	0.4%	4,243	1.5	3	1
Internal medicine	15.4%	154,373	56.1	94	19
Nephrology	0.7%	7,185	2.6	4	1
Neurology	1.1%	11,348	4.1	7	1
Oncology	0.5%	5,297	1.9	3	1
Ophthalmology	0.4%	4,168	1.5	3	1
Orthopedic surgery	0.1%	969	0.4	1	0
Other Physician specialty	2.6%	25,947	9.4	16	3
Otorhinolaryngology	0.1%	907	0.3	1	0
Pediatric nonsurgical specs	0.0%	309	0.1	0	0
Physical medicine and rehab	0.2%	1,849	0.7	1	0
Plastic surgery	0.0%	277	0.1	0	0
Psychiatry	0.1%	577	0.2	0	0
Pulmonology	0.7%	6,828	2.5	4	1
Rheumatology	0.2%	1,606	0.6	1	0
Surgery	1.1%	10,864	4	7	1
Thoracic surgery	0.1%	843	0.3	1	0
Urology	0.1%	976	0.4	1	0
Total	100.0%	1,000,000	364	606	121

Note: Infectious disease, neurological surgery, nonpatient care, pediatric surgical specialties, and preventive medicine specialties have been excluded from the table as MEPS data do not record any circulatory visits for these specialties. Radiology, anesthesiology, and pathology are excluded from the methodology.
Source: Circulatory visit activity by specialty was derived from MEPS.

5 years. To do this, we filled from the "bottom up," meaning that we targeted new GME positions to the states and clinical service areas facing the most significant shortages of physicians to meet the demand for visits in 2026 until all 15,000 new positions had been allocated. This process allocated GME positions to the states with the most significant shortages in 2026 and did not take

into account where a state was at baseline or after 2026. At the end of allocating the new GME positions, the overall shortage/surplus ratio across all states was .774, meaning that 77.4 percent of demand for visits in 2026 across all types of health care services in all states was met. In other words, in the states facing the most significant shortages of physicians, expanding GME by 3,000 slots for 5 years brought physician supply up to a level that met 77.4 percent of demand while states that were already meeting demand above 77.4 percent did not receive any new positions.

Table 2 shows how the model allocates 3,000 new PGY1 positions by specialty. The first column is the number of new PGY1 positions allocated by specialty in 2016, the second column is the number of total GME slots in that specialty in 2015, the third column is the relative growth of the expansion, and the last column ranks growth by specialty.

In terms of absolute numbers, the largest numbers of positions are allocated to generalist specialties—internal medicine, family medicine, general pediatrics, and general surgery—specialties in the model's plasticity matrix that see a large number of visits and address a broad range of health care needs. The large number of cardiology positions reflects the model's attempt to address the rising demand for circulatory services due to the aging of the population. The model does not consider what specialties have historically had difficulty filling GME positions. The 314 new PGY1 psychiatry positions reflect the model's effort to address the large demand for psychiatric services and the historic lack of interest in the specialty that has led to a smaller pipeline than is needed to address demand (Council on Graduate Medical Education 2013). The 20 percent growth in thoracic surgery and 16 percent growth in infectious disease reflect a similar problem of existing residency slots not filling enough to meet demand (Williams et al. 2009; Branswell 2015).

The large percentage growth in pediatric surgical and nonsurgical specialties reflects the model's attempt to address what it perceives as a maldistribution of providers relative to demand as these specialties tend to be regionalized around large academic health centers. The large absolute growth in emergency medicine positions also reflects the model's attempt to fix a maldistribution of providers—eight states get 126 of the 211 slots and 33 states get no new positions (see Appendix SA2 for a matrix of the PGY1 allocations by state and specialty).

The model's plasticity matrix is another source of explanation for how PGY1 positions are allocated between specialties. The plasticity matrix is based on the current, national distribution of visits across specialties, not how

Table 2: Allocation of 3,000 GME PGY1 Slots by Specialty

Specialty	*New PGY1 Positions Needed in 2016*	*Current Slots in 2015*	*% New Slots/ Total*
Internal medicine	440	25,328	2%
Psychiatry	314	6,269	5%
Family medicine	313	11,336	3%
Cardiology	246	3,130	8%
Emergency medicine	211	7,211	3%
General pediatrics	196	8,699	2%
Surgery	148	9,188	2%
Infectious disease	127	800	16%
Pediatric nonsurgical specs	121	1,725	7%
Oncology	121	3,247	4%
Gastroenterology	104	1,521	7%
Neurology	79	3,005	3%
Gynecology/obstetrics	67	5,325	1%
Other physician specialty	65	2,716	2%
Thoracic surgery	62	314	20%
Ophthalmology	61	1,348	5%
Pulmonology	56	1,588	4%
Dermatology	42	1,325	3%
Nephrology	37	953	4%
Urology	33	1,191	3%
Orthopedic surgery	30	4,317	1%
Plastic surgery	25	918	3%
Preventive medicine	25	319	8%
Otorhinolaryngology	24	1,477	2%
Physical medicine and rehab	20	1,252	2%
Pediatric surgical specialties	18	185	10%
Geriatrics	6	332	2%
Neurological surgery	4	1,274	0%
Endocrinology	3	637	0%
Rheumatology	2	432	0%
Allergy/immunology	0	306	0%
Total	3,000	107,668	2%

Note: Radiology, anesthesiology, pathology, and other physician specialties are not included in the model so total does not reflect total GME positions.
Source: http://jama.jamanetwork.com/article.aspx?articleid=2020352 - Table 3 page 2431.

visits could alternatively be provided by other specialties. For example, the growth in pediatric subspecialties reflects the fact that these specialties currently undertake work that could also be done by general surgeons (i.e., appendectomies) and pediatricians (headaches, constipation, and chest pain). Another example is geriatrics. The modest expansion in geriatrics positions reflects the reality that there are far fewer geriatricians relative to internists.

The vast majority of geriatric visits in the model's plasticity matrix (and in the health care system) are seen by internal medicine physicians, but this is likely to change as the number of geriatricians is growing rapidly.

Table 3 shows how the model allocates new PGY1 slots by state. The first column shows the total number of PGY1 slots allocated in 2016, the second column is the total number of GME positions in the state as of 2013 (the baseline year for the model), and the third column is the growth in GME over the 5 years of expansion relative to the starting number of positions. The last four columns show the total number of GME slots per 100,000 population and state ranking before and after the expansion.

A large absolute number of positions are allocated to states that have the worst health outcomes and high demand for health care—Mississippi, Alabama, and Arkansas (United Health Foundation 2016). Western states with relatively few GME positions relative to population size—Idaho, Wyoming, Montana, Alaska, and Nevada—experience a large percentage increase in positions and states with aging populations (Florida) and large, growing populations (California and Texas) receive a large number of new positions. The model's methodology of filling from the "bottom up" means that five northeastern states (Connecticut, Delaware, New Hampshire, Rhode Island, and Vermont) and the District of Colombia receive no GME slots because they are already well supplied. In 17 states, the pre/postexpansion ranking of the total number of GME positions per 100K population did not change and those states that were initially ranked between 18 and 29 remained relatively unaffected by the expansion. In general, states in the lower range are better off after the expansion, including Georgia, Indiana, and Oklahoma, whose rankings rose considerably after the expansion.

Figure 2 shows the effect of the expansion by illustrating the shortage/surplus ratio (visits that providers in a state can supply/visits demanded) before and after the expansion. The biggest changes are in states on the left-hand side of the graph that faced the greatest shortfalls of providers in 2026. The middle group of states remains largely unaffected by the expansion while some states on the right-hand side of the graph that did not receive any new positions are better off after the expansion. This is because the model's diffusion algorithm allocates new residents according to historic migration patterns. When implemented, this means that even though new residency positions are expanded in states where they are most needed, some residents trained in high-need states will migrate to states with greater supply and fewer shortfalls.

Table 3: Allocation of 3,000 GME PGY1 Slots by State

State	*New PGY1 Positions 2016*	*Total GME Positions 2013*	*% Increase*	*GME Slots per 100K before Expansion (2013)*	*Rank before Expansion*	*GME Slots per 100K after Expansion (2016)*	*Rank after Expansion*
Mississippi	293	595	49.2%	19.9	43	68.9	6
Florida	243	3,972	6.1%	20.3	42	26.5	42
Alabama	230	1,386	16.6%	28.7	25	52.5	10
Georgia	208	2,234	9.3%	22.4	40	32.8	32
Indiana	206	1,513	13.6%	23.0	39	38.7	24
Oklahoma	171	830	20.6%	21.6	41	43.8	20
California	157	10,555	1.5%	27.5	31	29.6	36
Texas	133	8,048	1.7%	30.4	23	32.9	31
Arkansas	129	793	16.3%	26.8	32	48.6	14
Iowa	102	861	11.8%	27.9	27	44.4	18
Nevada	101	315	32.1%	11.3	46	29.4	37
Kentucky	100	1,143	8.7%	26.0	36	37.4	25
Tennessee	83	2,464	3.4%	37.9	18	44.3	19
Idaho	70	105	66.7%	6.5	49	28.2	39
North Carolina	67	3,332	2.0%	33.8	21	37.2	26
South Carolina	64	1,332	4.8%	27.9	26	34.6	30
Utah	64	758	8.4%	26.1	34	37.2	28
Virginia	53	2,276	2.3%	27.6	30	30.8	34
Illinois	49	6,406	0.8%	49.7	9	51.6	11
Ohio	48	813	5.9%	7.0	48	9.1	51
Kansas	48	6,323	0.8%	218.5	2	226.8	2
Michigan	46	5,366	0.9%	54.2	8	56.6	9
New York	40	16,990	0.2%	86.5	4	87.5	4
Missouri	31	2,853	1.1%	47.2	12	49.8	12
Pennsylvania	30	8,386	0.4%	65.6	6	66.8	7
Washington	30	1,938	1.5%	27.8	29	30.0	35
Wisconsin	29	1,992	1.5%	34.7	19	37.2	27
Arizona	25	1,725	1.4%	26.0	35	27.9	40
Minnesota	21	2,399	0.9%	44.3	14	46.2	17
Louisiana	18	2,139	0.8%	46.2	13	48.2	15
Colorado	15	1,311	1.1%	24.9	37	26.3	44
Wyoming	15	47	31.9%	8.1	47	20.9	47
Alaska	13	45	28.9%	6.1	50	15.0	49
New Jersey	13	3,014	0.4%	33.9	20	34.6	29
South Dakota	13	146	8.9%	17.3	45	25.0	45
Montana	11	39	28.2%	3.8	51	9.3	50
Nebraska	9	752	1.2%	40.2	16	42.7	21
Maryland	8	2,855	0.3%	48.2	10	48.8	13
Oregon	6	943	0.6%	24.0	38	24.8	46
West Virginia	6	724	0.8%	39.0	17	40.7	22

continued

Table 3: *Continued*

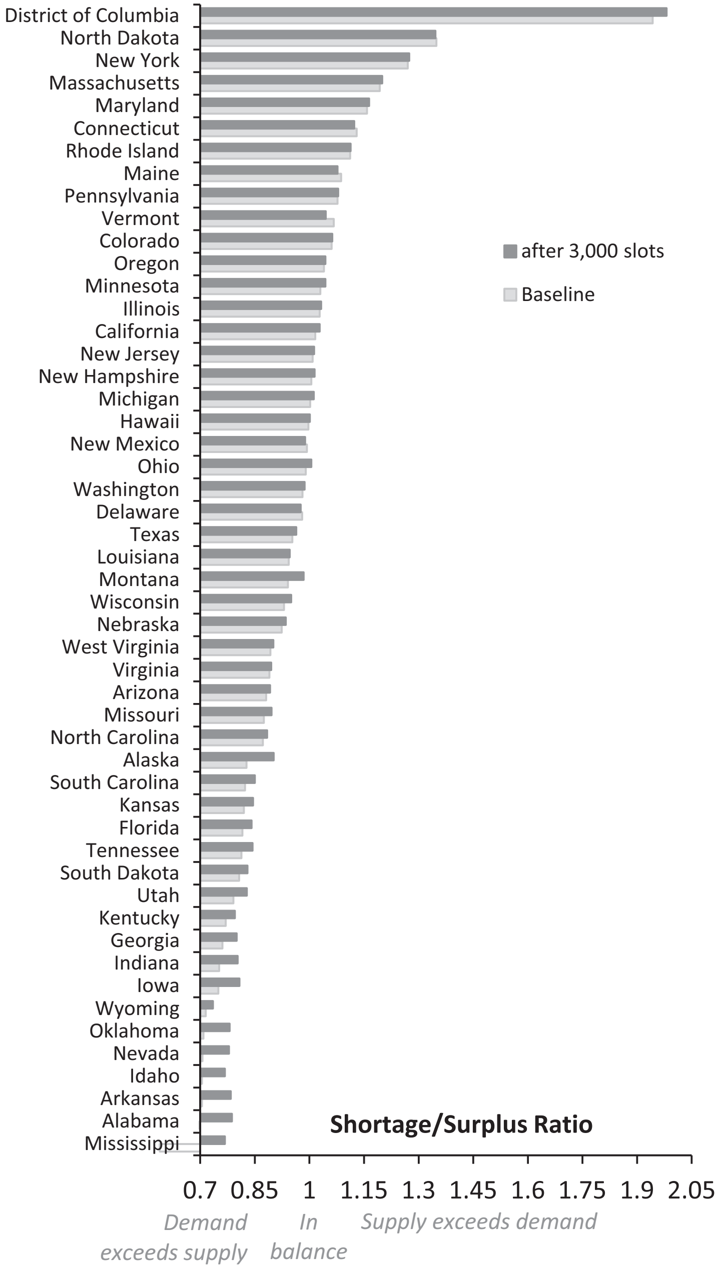
State	*New PGY1 Positions 2016*	*Total GME Positions 2013*	*% Increase*	*GME Slots per 100K before Expansion (2013)*	*Rank before Expansion*	*GME Slots per 100K after Expansion (2016)*	*Rank after Expansion*
Massachusetts	2	5,885	0.0%	87.9	3	88.1	3
Connecticut	0	2,332	0.0%	64.8	7	64.8	8
Delaware	0	374	0.0%	40.4	15	40.4	23
Hawaii	0	391	0.0%	27.8	28	27.8	41
Maine	0	350	0.0%	26.3	33	26.3	43
New Hampshire	0	418	0.0%	31.6	22	31.6	33
New Mexico	0	600	0.0%	28.8	24	28.8	38
North Dakota	0	139	0.0%	19.2	44	19.2	48
Rhode Island	0	810	0.0%	77.0	5	77.0	5
Vermont	0	299	0.0%	47.7	11	47.7	16
Washington, DC	0	1,780	0.0%	275.4	1	275.4	1
Total	3,000	123,096	2.4%	38.9		43.7	

DISCUSSION

The goal of this analysis was to outline a methodology using a case example of how a workforce projection model could be used to allocate the proposed 3,000 new positions over 5 years by state and specialty to address population health needs. This is an important contribution to the field because numerous stakeholders, including the Institute of Medicine (2014), the Macy Foundation (Weinstein 2011), the Medicare Payment Advisory Commission, and the Council on Graduate Medical Education (2013), have called for a better link between GME investments and population health needs.

The methodology generally produced results consistent with current proposals and research. The findings suggest targeting training toward first certificate specialties of family medicine, internal medicine, general pediatrics, emergency medicine, general surgery, and psychiatry (American Academy of Family Physicians 2014). The data also point toward expanding training in cardiology, which other researchers have attributed to the growing demand for health care services by an aging population with increased chronic disease (Dall et al. 2013). States with poor health outcomes (Arkansas, Mississippi, and Alabama); large, growing populations (Texas and California); and older populations (Florida) were allocated a significant share of the 3,000 PGY1 slots. The results also suggest the need to expand GME in Western states with

Figure 2: Shortage/Surplus Ratio before and after Allocating 15,000 New PGY1 Slots, All Visits, United States, 2026



relatively low physician and resident supply such as Idaho, Wyoming, Montana, Alaska, and Nevada. These findings are consistent with Mullan, Chen, and Steinmetz's analysis (2013) that used Medicare Cost reports to highlight geographic imbalances in the distribution of GME positions and funding relative to population.

The methodology produced some unexpected findings. No new positions were allocated to allergy/immunology or to Maine, Hawaii, New Mexico, or North Dakota. A relatively large number of positions were allocated to Iowa. When workforce models produce unexpected results, it may be due to a lack of good data on factors such as how FTE varies by age, gender, and specialty or a lack of information about how different specialty configurations handle different types of patient visits in different states. Nonintuitive findings can also help uncover unexpected information about the types of health care services and physician specialties that will be in shortage in the future. For this reason, expert panels of stakeholders need to be assembled to interpret the validity of the data, the modeling assumptions, and the outcomes of the model. For example, the model suggested that a large percentage growth in pediatric surgical and nonsurgical specialties was needed to address a maldistribution of providers, a finding that expert advisors could challenge if they viewed that patients should be willing to travel for specialized pediatric care. They might also have concerns that expansions in pediatric subspecialties would not address maldistribution if residents trained in shortage locations and then moved to places with an adequate supply. Advisory panel members would also need to have a deep understanding of residency training in the states under discussion to deliberate about whether a state has the capacity to expand training in the specialties suggested by the data. If a state has few or no residency programs in a needed specialty, they may not be able to develop a quality training program. Another consideration is whether positions if opened in a particular specialty or state would fill.

Important differences exist between states in the specialty mix of physicians. Expert panels could adapt the plasticity matrix to fit local labor markets so that a state could address, for example, demand for endocrinology visits by deploying more family physicians or internists instead of endocrinologists. Such an approach would have to balance differing opinions from different specialties about which specialties should be used to address which shortages.

The model's plasticity matrix is based on data about how visits are currently distributed across specialties, which is likely to change with new care delivery and payment models. Experts might want to adjust the matrix to incorporate different assumptions about the balance of care provided by generalists and specialists and to account for care provided by nurse practitioners (NPs), physician assistants (PAs), and other health care providers. Although the model's plasticity matrix accounts for care currently provided by NPs and PAs, the number of NPs and PAs in the workforce is increasingly rapidly. If NPs and PAs take on an increasing amount of care previously provided by physicians, the number of GME positions needed to address shortages will be lower.

Important technical challenges exist in using a methodology such as the one suggested in this analysis. Medicare caps would have to be adjusted to permit the expansions. New training programs would need time to recruit new faculty and residents and secure accreditation by the Accreditation Council for Graduate Medical Education (ACGME). The model's plasticity matrix, utilization, and supply data would need to be updated regularly to capture changes in factors affecting the supply and demand for health care services.

The methodology described in this paper has some important extensions. The model could be used to estimate the effect that changes in the number and type of residents by specialty and state would have on the future physician workforce. The model could be used to simulate how expanding residency positions in one state would affect the numbers of physicians in other states; as Figure 2 shows, expanding residency positions in high-need states will also result in increases in already well-supplied states. This analysis assumed that any expansion of GME slots would occur by adding new positions rather than distributing existing positions. The methodology could be easily extended to identify which GME slots could be withdrawn from oversupplied states and specialties to create training slots in other states and specialties. To do this, states and specialties with shortage/surplus ratios well above 1.5 could have positions withdrawn and redistributed to states facing shortages. Such an approach would have to be guided by an expert advisory panel that could make decisions about how the redistributions would affect the donating and receiving states and specialties.

CONCLUSION

This analysis has proposed an objective, evidence-based methodology for allocating GME positions that could be used as the starting point for discussions about GME expansion or redistribution. With the increased focus nationally and across states on better aligning GME training with population health needs, there is a need to convene workforce stakeholders —physicians, training programs, policy makers, hospitals, and others–to use data, in concert with expert judgment, to target publicly funded GME to where it is most needed. In the absence of workforce data, we risk continued imbalance in the distribution of GME toward states that have a comparative advantage in Medicare funding and substantial residency training capacity (Mullan, Chen, and Steinmetz 2013). Incremental efforts to redistribute GME toward needed geographies and specialties have proven ineffectual (Chen et al. 2013), and the current "hands-off" approach has not produced the workforce needed to meet the nation's health care needs. The methodology proposed in this paper provides a way forward in making better use of workforce data to guide regional, state, and national investments in our future physician workforce.

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NOTES

1. The model was developed under a grant from The Physicians Foundation, Inc., and is available at https://www2.shepscenter.unc.edu/workforce/model.php
2. https://www2.shepscenter.unc.edu/workforce/about.php
3. The methodology contains two basic components: the first component assesses shortages by matching supply to demand; the second component uses these calculations to determine the number of GME positions needed by specialty and state to address shortages. The methodology's first component allows the number of visits to vary by specialty based on data from MGMA and MEPS. However, once shortages are estimated, we then use a simplistic calculation of 2,750 visits per FTE in the second component of the methodology to determine how many physicians will be needed by specialty and state to address these shortages. This is an attempt to simplify the calculations to make the methodology easier to describe and understand but could be modified. Similarly, FTE varies by age, gender, and specialty in the first component of the methodology but is simplified to .6 in the second component.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Appendix SA2: Allocation of 3,000 PGY1 Positions by State and Specialty.