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RESEARCH REPORT

The Anesthesiologist Workforce in 2013

A Final Briefing to the American Society of Anesthesiologists

*Matthew Baird, Lindsay Daugherty, Krishna B. Kumar,
Aziza Arifkhanova*

Sponsored by the American Society of Anesthesiologists



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Preface

The American Society of Anesthesiologists (ASA) funded the study briefed here as a follow-on to a 2009 study published by the RAND Corporation, reported in *An Analysis of the Labor Markets for Anesthesiology* (Daugherty et al., 2010). For the study, we used analysis of survey data and econometric approaches to assess the anesthesiology workforce.

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This publication summarizes the contents of a presentation that was given to an ASA advisory committee on December 18, 2013. Krishna B. Kumar, a senior economist at RAND and the director of RAND Labor and Population, is the principal investigator of this study. He may be reached via email at Krishna_Kumar@rand.org or by phone at 310-393-0411 x7589. Lindsay Daugherty, an associate policy researcher at RAND, is the co-principal investigator. She may be reached at Lindsay_Daugherty@rand.org or by phone at 310-393-0411 x6484.

More information about RAND Health is available on our website:
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Summary

In the past 20 years, there have been concerns about potential shortages in the anesthesiologist workforce. In 2007, RAND researchers conducted a survey and found that there was indeed evidence of a shortage of anesthesiologists in the workforce (Daugherty et al., 2010). In addition, there are important changes taking place in the population and health care that have implications for future supply and demand of anesthesiologists, including expansion of coverage, an aging population, greater movement of women into the physician workforce, increasing cost pressures, and shifting modes of delivery. To determine what the implications of these changes might be for the anesthesiologist workforce, we conducted a national survey of American Society of Anesthesiologists (ASA) members in 2013. ASA counts more than 90 percent of all practicing anesthesiologists in the United States as its members.

We document large and persistent regional differences in the practice of anesthesiologists. Anesthesiologists in western states are less likely to work in a single facility and work fewer hours on fewer cases than those in other regions. Anesthesiologists in the west are also more likely than those in other regions to work independently and less likely to work with non-anesthesia providers. Anesthesiologists in the west are less likely to be involved in procedures that require either monitored anesthesia care or sedation as well. We also document a substantial increase in the entry of women into the anesthesiologist workforce over the past five years and explore some key differences in workforce characteristics by gender. We show that women work for different types of employers, work fewer hours, and focus on different patients than men do. These differences may lead to shifts in the supply of anesthesiologists and changes in the employment arrangements of anesthesiologists to accommodate preferences and constraints of the growing population of female anesthesiologists.

In our analysis of shortage, we employ a maximum-likelihood strategy that relies on a set of indicators of potential shortage collected from our surveys. We have two robust findings across various model specifications: that there was a decrease in the shortage of anesthesiologists from 2007 to 2013 and that the midwestern and western states had higher levels of shortage in 2013. Our best estimate is that, in 2013, the national labor market for anesthesiologists was in near equilibrium with no shortage. However, our confidence intervals are quite large, suggesting that the study of the anesthesiologist workforce may require use of data disaggregated below the state level and a longer panel.

Acknowledgments

We would like to thank members of the advisory committee for their helpful feedback on the methods and research findings, including Richard Dutton, Gifford Eckhout, Fredrick Orkin, Mary Peterson, Armin Schubert, and Kevin Tremper. In addition, we are grateful to Soeren Mattke for his guidance throughout the study. We greatly appreciate David I. Auerbach's thoughtful review on the findings in this report. Finally, we thank the staff of Multimode Interviewing Capability project, RAND's survey capability, for their support in data collection for the study.

Abbreviations

AANA	American Association of Nurse Anesthetists
AHRF	Area Health Resource File
ASA	American Society of Anesthesiologists
CRNA	certified registered nurse anesthetist
FTE	full-time equivalent
HMO	health maintenance organization



The Anesthesiologist Workforce in 2013

**RAND Corporation
December 18, 2013**

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Outline for the Briefing

Outline for the Briefing

- **Background and significance**
- **Data and methods**
- **Survey results**
 - **Employment arrangements**
 - **Team care**
 - **Time use**
 - **Indicators of shortage**
- **Econometric analysis**
- **Projections**

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RAND-Workforce Study Final Briefing-2 Dec-18

This report is divided into five sections.

To start, we discuss the background and motivation for the study.

We then discuss the methods for the survey of anesthesiologists we conducted, and the data we used for the study. The econometric methods are discussed in the econometric section.

Next, we describe the results from the survey. We focus on four areas: the employment arrangements of anesthesiologists, including employer type and compensation; the use of and participation in team care, in which anesthesiologists work with other anesthesia providers to provide care; the allocation of time across different types of cases and patients; and indicators of shortage.

Then, we discuss the econometric analysis and our findings on whether the anesthesiologist workforce appears to be in surplus or shortage. We also look at regional patterns in the econometric findings to determine whether certain parts of the country are likely to have a shortage of anesthesiologists. Finally, we end with a discussion of projections for the future.

In a 2007 Study of the Labor Market for Anesthesiology, RAND Had Several Findings

The study included surveys of anesthesiologists, nurse anesthetists, and anesthesiology directors.

- **Finding 1: There was a shortage of approximately 3,800 anesthesiologists and 1,200 nurse anesthetists**
- **Finding 2: There was substantial regional variation in practice by both anesthesiologists and nurse anesthetists.**

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In 2007, as part of a larger study of the labor markets for anesthesiology, RAND conducted surveys of anesthesiologists, nurse anesthetists, and anesthesiology directors (Daugherty et al., 2010). The two major findings of the study are estimated shortages among anesthesiologists and nurse anesthetists and substantial regional variation in practice by both anesthesiologists and nurse anesthetists.

Many Current and Future Changes Affect the Anesthesiologist Workforce

- **Changing workforce demographics (e.g., aging anesthesiologists, more women)**
- **An aging population**
- **Cost pressures in health care**
- **New provider models**
- **Affordable Care Act**
- **The recent recession**

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There are some current or impending changes in the United States that could have important effects on the anesthesiologist workforce.

First, several demographic trends affect multiple occupations inside and outside the health care sector. Many professional occupations are becoming more diverse with the entry of women and minorities in greater numbers. Although the racial and ethnic makeup of the anesthesiologist population remained constant between 2007 and 2013, there has been a substantial movement of women into the workforce (see “Details on the 2013 Survey” for more information). In addition, the population is aging. An aging workforce could decrease the supply of anesthesiologists as baby boomers age and retire from the workforce. On the other hand, as the population ages, demand for anesthesiology care is also likely to increase because older individuals have a higher demand for health care services than younger individuals.

There are also several trends that are specific to the health care sector. Until recent years, the cost of health care was growing rapidly in the United States, and it became clear that the high level of growth was not sustainable. Recent fiscal crises have only increased concerns about the cost of health care. The pressure on the health care sector to control costs has led to a range of

efforts to improve efficiency and reduce waste. Health care providers and government officials have been exploring new payment models, and facilities have been working to identify options to reduce costs.

Many Current and Future Changes Affect the Anesthesiologist Workforce

- **Changing workforce demographics (e.g., aging anesthesiologists, more women)**
- **An aging population**
- **Cost pressures in health care**
- **New provider models**
- **Affordable Care Act**
- **The recent recession**

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One of the most prominent ideas being discussed as a way to reduce costs is a shift of care provision to lower-cost providers: nurses providing care under the guidance of physicians. This discussion typically focuses on primary care physicians. However, anesthesiologists have also begun to share care provision with the nursing workforce. In recent decades, nurse anesthetists have grown to play an important role in the provision of anesthesia. There are some questions about the movement toward team care in anesthesiology and the impact this may have on the anesthesiologist workforce.

Finally, there are several recent one-time events that may have affected the anesthesiologist workforce. The Patient Protection and Affordable Care Act (Pub. L. No. 111-148, 2010) makes changes to health care in the United States, including the expansion of insurance to a larger portion of Americans, a shift in focus toward preventive care, and encouragement to explore new models of health care payment and health care delivery. All of these moves may have different effects on the demand for anesthesiologists. In addition, the recent economic crisis may have affected both the supply and demand of anesthesiologists. Decreases in wealth and earnings are likely to lead to reduced health care spending and demand for anesthesiologists and may also

lead to delayed retirement for anesthesia care. In addition, it may lead to delayed retirement for anesthesiologists, resulting in an increase in supply.

In Addition, Concerns About Anesthesiologist Shortages Persist

- **Studies over the past 20 years have found wide variation in estimates of shortage**
- **More recent evidence suggests that reductions in training in the early to mid-1990s led to shortages**
- **An aging population and increases in coverage may lead to substantial shifts in demand**
- **On the other hand, shifts in health care delivery may also affect demand**

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There have been concerns about a shortage of anesthesiologists in recent years. In the early 1990s, a report predicted a surplus of anesthesiologists (American Society of Anesthesiologists [ASA], 1994), but more-recent studies have shown a shortage (Schubert, Eckhout, Ngo, et al., 2001; Schubert, Eckhout, and Tremper, 2003; Daugherty et al., 2010). One of the potential drivers of this shortage may have been a reduction in residency openings in the early to mid-1990s.

There are now additional reasons to be concerned about a shortage of anesthesiologists with the aging of the population and increases in the size of the insured population under the recent health care reforms. If demand increases and the growth in the number of anesthesiologists does not keep up, there could be a shortage. On the other hand, shifts in health care delivery and, in particular, a movement toward team care may decrease the demand for physicians. If demand decreases and the growth in the number of anesthesiologists stays steady, there may be a surplus of anesthesiologists.

Current Health Care Context and Concerns About Shortage Raise Questions

- 1) Are patterns of practice changing for anesthesiologists?**
- 2) Have regional differences in practice observed in the 2007 study persisted?**
- 3) What impact is the growing proportion of anesthesiologists who are women going to have on the workforce?**
- 4) Is there still a shortage of anesthesiologists in the United States?**

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RAND-Workforce Study Final Briefing-6 Dec-18

The trends and events just described, including a changing population, new provider models, and the recent health care reforms, may have impacts on the anesthesiologist workforce that lead to differences in findings from those in the 2007 survey. In addition, it is important to determine whether the workforce still appears to be in shortage according to econometric analysis. In order to explore the impact of recent trends and assess the likelihood that the workforce is in shortage, this presentation focuses on four research questions.

We Conducted a Second Survey of Anesthesiologists to Analyze These Questions

RAND Conducted a Second Survey of Anesthesiologists to Analyze these Questions

- **National survey of members of the American Society of Anesthesiologists (ASA)**
 - **Excluded those opting out of third-party emails**
- **Took place April–May 2013**
- **Funded by ASA**

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RAND-Workforce Study Final Briefing-7 Dec-18

We conducted a six-week survey in the spring of 2013 to collect current data for the study. The survey was sent to all ASA members, with the exception of a small number of anesthesiologists who did not have email addresses or who opted out of receiving emails for these purposes. ASA funded the study.

Outline

- **Background and significance**
- **Data and methods**
- **Survey results**
 - Employment arrangements
 - Team care
 - Time use
 - Indicators of shortage
- **Econometric analysis**
- **Projections**

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RAND-Workforce Study Final Briefing-8 Dec-18

We next describe the survey methods and the data used for the study.

Details on the 2013 Survey

- **Surveyed online**
- **Response rate of 25.5%, approximately 6,800 responses**
- **49 items on a range of topics, including:**
 - **Employer and facility arrangements**
 - **Compensation**
 - **Time use**
 - **Future plans**
 - **Indicators of shortage**

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RAND-Workforce Study Final Briefing-9 Dec-18

Approximately one-quarter of the individuals who received the survey actually responded, for a total of 6,800 responses. This response rate was significantly higher than the response rate to the 2007 survey, which was below 22 percent.

To allow for comparison of results across surveys, this survey was very similar to the one from 2007. However, a few questions were changed, deleted, or added. The 2013 survey had 49 items that covered a range of topics. These topics included employer and facility arrangements, compensation, time use, future plans, and indicators of shortage.

There Were Minimal Differences Between Respondents and Nonrespondents

Minimal Differences Between Respondents and Nonrespondents

	Nonrespondent	Respondent
Age (years)	49.2	50.0**
Female	0.242	0.283**
Urban	0.950	0.946
Northeast	0.227	0.212**
Midwest	0.217	0.226
South	0.331	0.341
West	0.225	0.222
N	22,269	6,783

** Indicates statistical significance at the p<0.01 level

We weight for nonresponse and scale to population numbers.

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RAND-Workforce Study Final Briefing-10 Dec-18

There are few differences between the respondents and nonrespondents to the 2013 survey. Respondents were slightly older than nonrespondents. In addition, male anesthesiologists and anesthesiologists from the Northeast are somewhat less likely than female anesthesiologists or anesthesiologists from other regions to have responded to the survey.

To account for these differences and minimize survey response bias, we weight our data to ensure that, to the extent possible, they mirror the anesthesiologist population. We create weights through a regression that predicts the probability of responding based on an anesthesiologist’s location, age, and gender. A respondent’s responses were weighted by the inverse of the probability that he or she would respond. In addition, we scaled the responses to the total number of anesthesiologists in the nation—obtained from the Area Health Resource File (AHRF)—to account for the fact that not all anesthesiologists are ASA members.

For Most Demographic Characteristics, 2013 Anesthesiologists Look Similar to 2007 Anesthesiologists

2013 Anesthesiologists Look Similar to 2007 Anesthesiologists Across Most Demographics

	2007	2013
Age (years)	48.7	50.0**
Experience (years)	15.9	20.2** ^a
Female	0.216	0.249**
Urban	0.945	0.952
Northeast	0.226	0.227
Midwest	0.207	0.204
South	0.334	0.332
West	0.233	0.238
Married	0.902	0.892
Has children	0.724	0.665**
Born in United States	0.773	0.794*
Educated in U.S.	0.807	0.832**
White	0.782	0.788
Hispanic	0.025	0.034
Black	0.019	0.024
Asian	0.102	0.113
Other race/ethnicity	0.072	0.039**
N	22,269	6,783

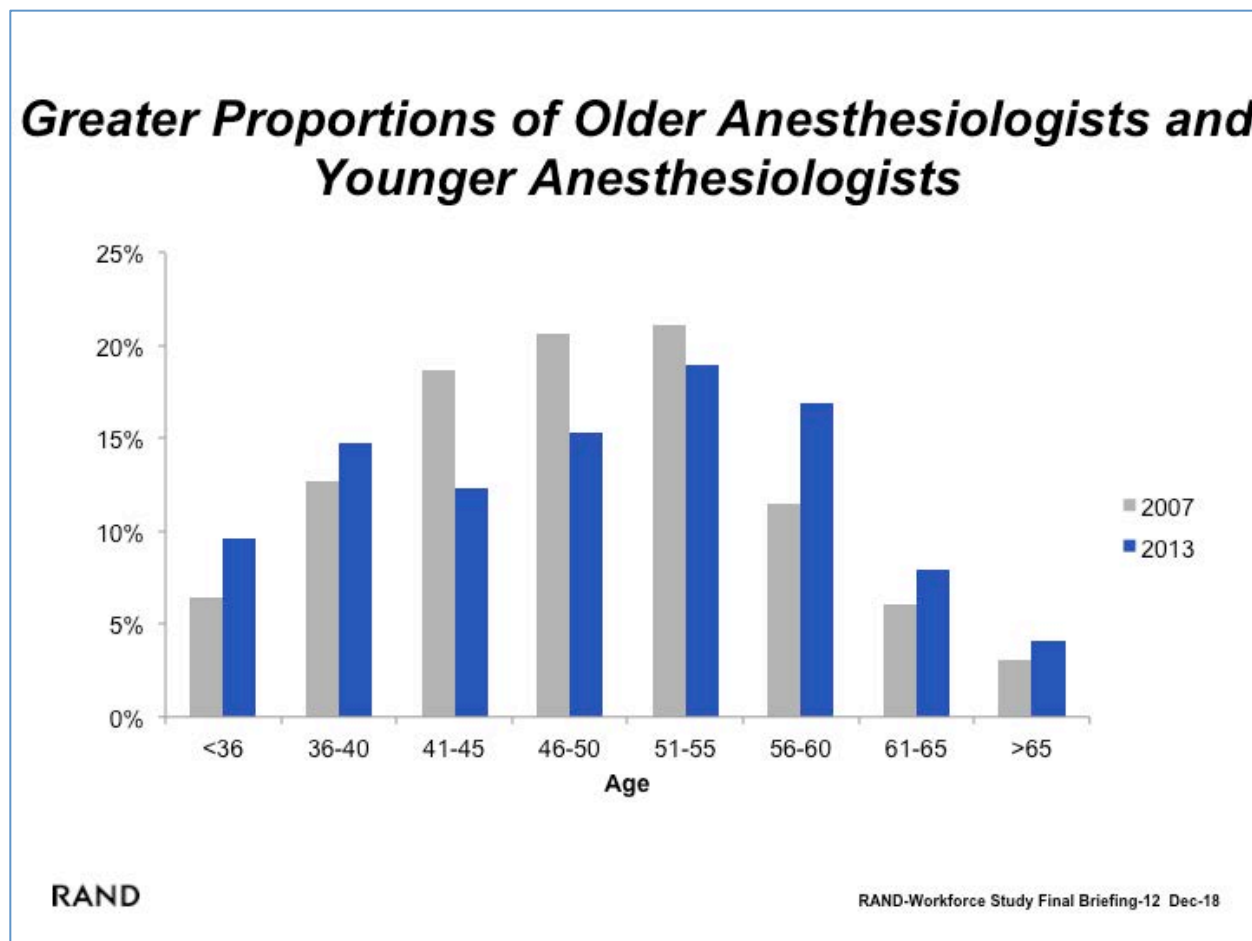
^a Due to a lack of specificity in the previous survey, we asked respondents to include residency in the new survey, so this change in item likely led to differences in results for experience

RAND ** Indicates statistical significance at the p<0.01 level. * at the p<0.05 level. RAND-Workforce Study Final Briefing-11 Dec-18

Anesthesiologists in 2013 look similar to anesthesiologists in 2007 across most demographics, but there are a few differences. Anesthesiologists in 2013 appear to be slightly older, on average. We examine this more closely later. As mentioned, 2013 anesthesiologists were more likely to be female. In addition, anesthesiologists in 2013 were less likely to have children and were more likely to be born and educated in the United States than 2007 anesthesiologists. Many of these changes mirror general trends in the population. For example, workforces in many areas are aging and seeing greater numbers of women, and individuals in the United States are having fewer children.

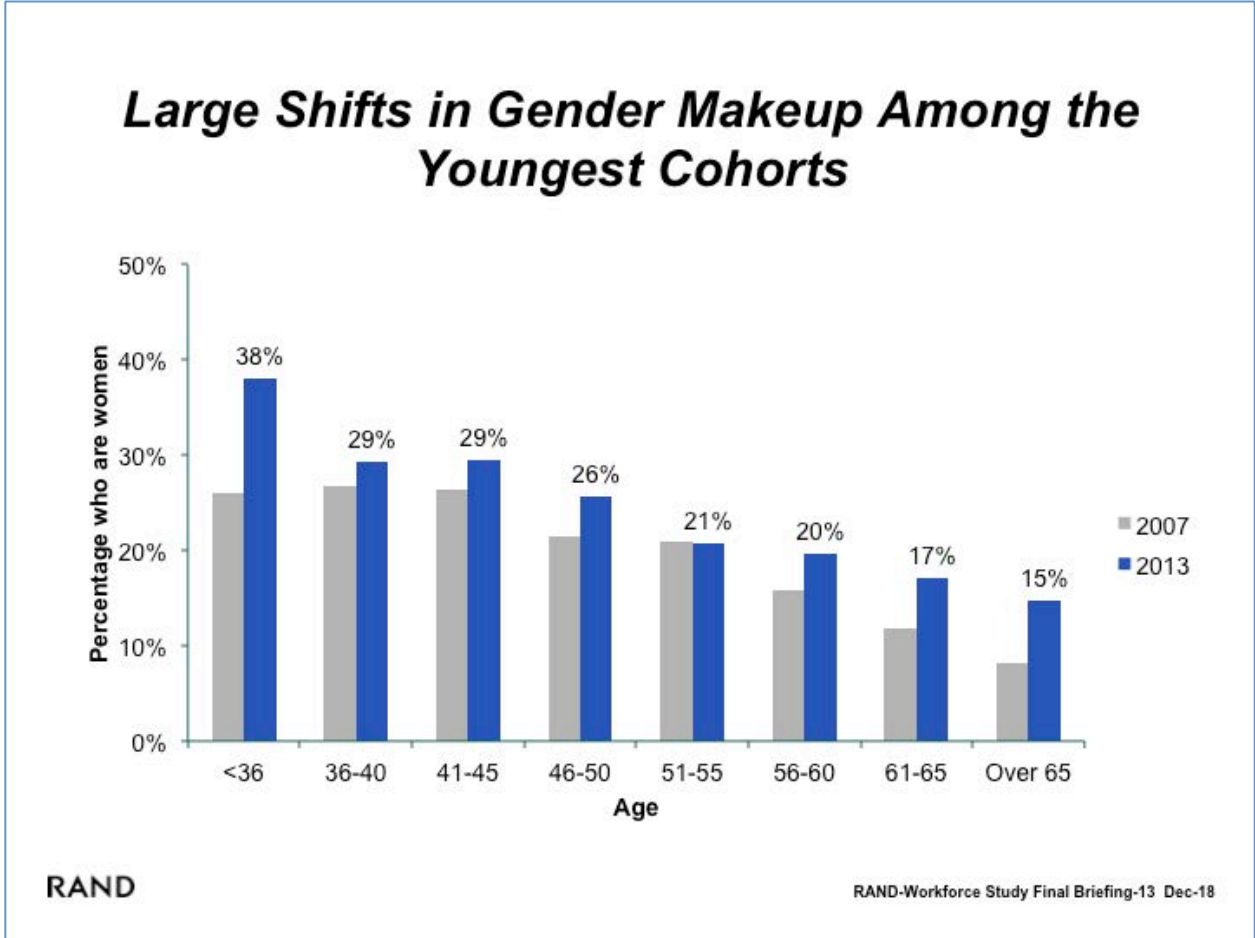
The change in reported experience was likely driven by a change in the question that asked anesthesiologists about experience. Following advice from the ASA advisory group, in the 2013 survey, we explicitly instructed respondents to include residency in their experience as an anesthesiologist; in the 2007 survey, we did not specify this.

There Were Greater Proportions of Older and Younger Anesthesiologists in the 2013 Sample



The data indicate that the average age of anesthesiologists had increased; in light of concerns about an aging workforce, it would be useful to examine the full age distribution of anesthesiologists. The 2013 data show greater proportions of anesthesiologists ages 40 or younger and 55 or older. This bulge in the population at older ages likely reflects the aging of baby boomers and potential delays in retirement brought about by the financial crisis. The greater proportions at younger ages likely reflect the increase in residencies over the past decade. The smaller proportions of anesthesiologists between the ages of 40 and 55 likely reflect the cut in anesthesiology residencies that occurred in the early to mid-1990s.

There Have Been Large Shifts in Gender Makeup Among the Youngest Cohorts



When we look at the percentage of female anesthesiologists by age, we find greater proportions of women in 2013 than in 2007 for nearly every age group. Nearly 40 percent of young anesthesiologists are female, a substantial increase from the 26 percent of the 2007 sample who were female.

The largest percentage increases in female anesthesiologists between 2007 and 2013 are for the youngest and oldest age groups. This suggests that female anesthesiologists may be more likely than their male counterparts to delay retirement. The large increase in the percentage of women among the youngest anesthesiologists indicates a trend of women being increasingly likely to go into medicine and choose anesthesiology as a specialty.

We Supplemented Our Survey Data for the Econometric Analysis

- **We use several variables in the AHRF to capture characteristics that may influence demand**
 - **Number of surgeons**
 - **Number of nurse anesthetists**
 - **Percentage of population 65 and older**
 - **Income**
- **National Resident Matching Program numbers to estimate new supply**

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In addition to the survey data, we used external, nationally representative data to account for other factors that may affect the demand for anesthesiologists. The AHRF is a data set that is updated annually, providing a range of valuable statistics related to health care and workforces within the health care sector at the county level. We used average state-level values for the number of surgeons, the number of nurse anesthetists, the percentage of the population 65 and older, and the average income adjusted for differences in cost of living.

We also used data from the National Resident Matching Program on the total number of residencies to estimate new supply and the growth in supply for our projections.

Survey Results

Employment Arrangements

Outline

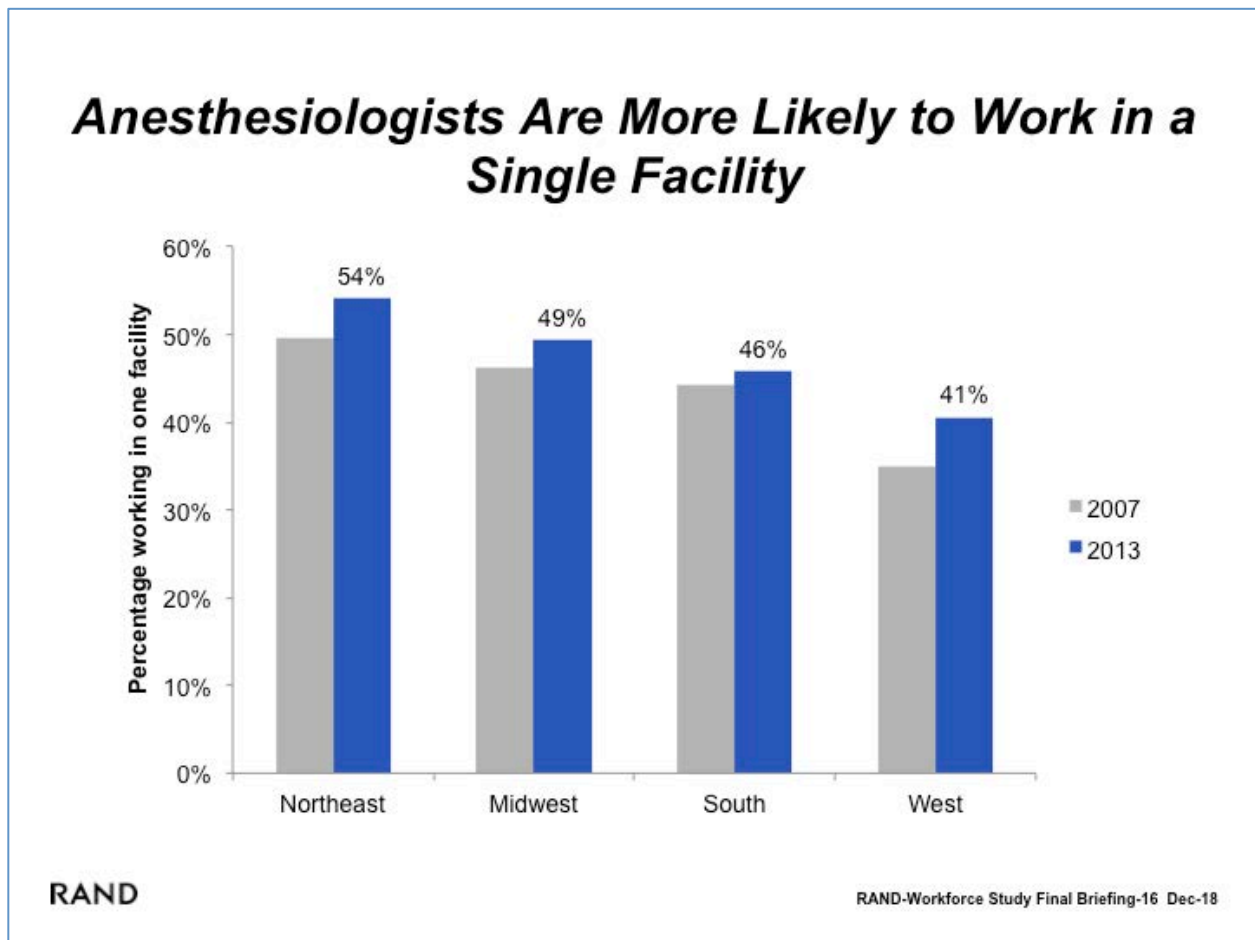
- **Background and significance**
- **Data and methods**
- **Survey results**
 - **Employment arrangements**
 - **Team care**
 - **Time use**
 - **Shortage indicators**
- **Econometric analysis**
- **Projections**

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We next describe some of few key results from the survey. First we look at the employment arrangements of anesthesiologists, including the employers for which anesthesiologists work, the facilities with which they work, and the way in which anesthesiologists are compensated.

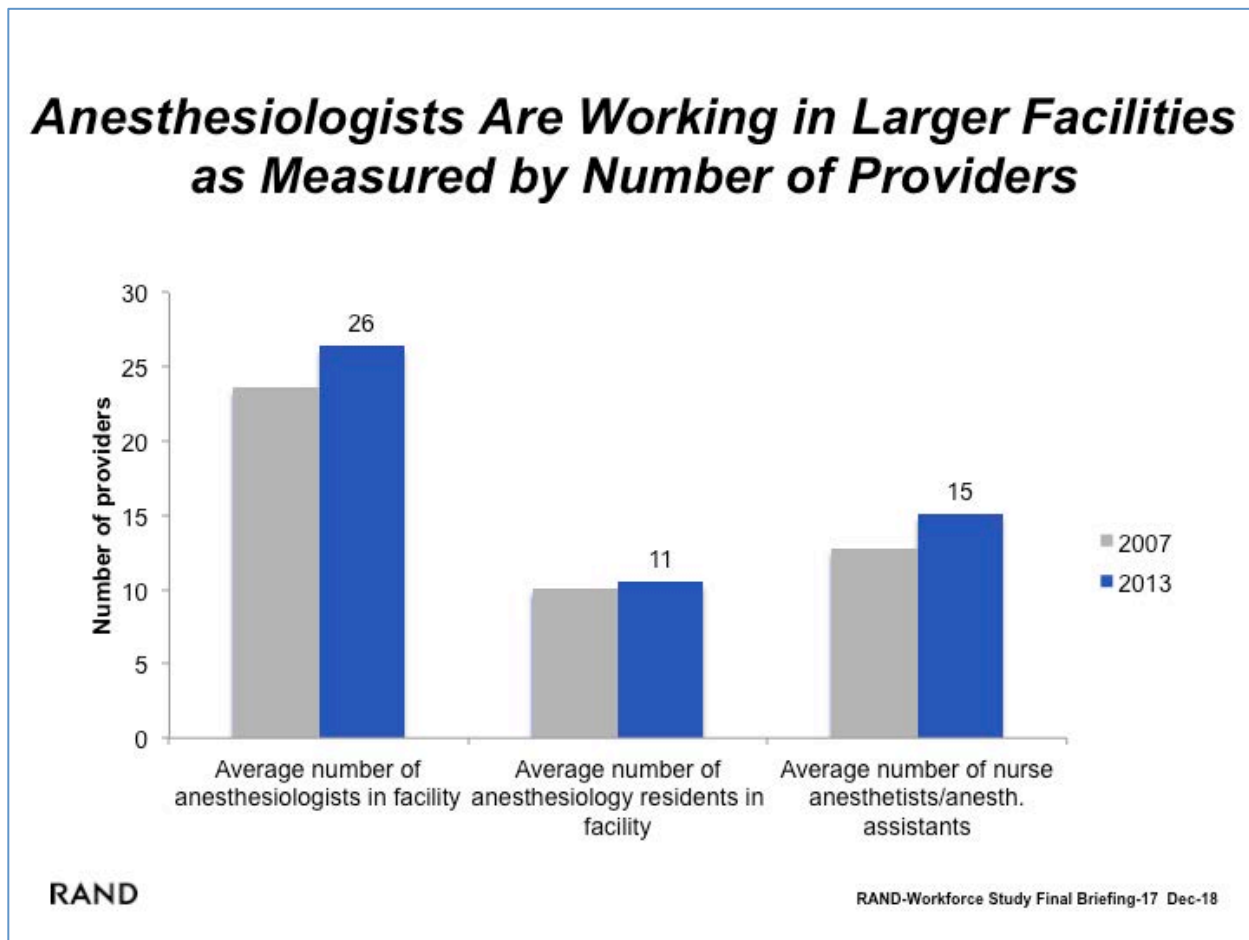
An Anesthesiologist Is More Likely to Work in a Single Facility in 2013 Than in 2007



In the past six years, the percentage of anesthesiologists who work in single facilities has increased slightly, from 44 percent to 47 percent. Regional data indicate increases across all regions, though only the differences for the Northeast and West are statistically significant. Western anesthesiologists had the largest increase, with a 16-percent increase in the percentage of anesthesiologists working in one facility.

However, anesthesiologists in the West remain the least likely to work in single facilities. Anesthesiologists in the West are more likely than those in other regions to be employed by groups, and this trend is what is likely driving the pattern of cross-facility practice.

Anesthesiologists Are Working in Larger Facilities as Measured by the Number of Providers



Anesthesiologists appear to be working in larger facilities if we define facility size by the number of anesthesiology providers. The average number of anesthesiologists in a facility has grown by two anesthesiologists, an 8-percent increase, over the past six years. The average number of nurse anesthetists and anesthesiology assistants in a facility has also grown by two, representing an increase of more than 15 percent, in the past six years. There was no change in the average number of anesthesiology residents during that time period.

Unfortunately, because the 2007 survey combined nurse anesthetists and anesthesiology assistants into one group, we cannot distinguish between growth in the number of one from growth in the number of the other.

There Are Regional Differences in Employer Types

Regional Differences in Employer Type

	Northeast	Midwest	South	West	West Versus Other
Employer Characteristics					
Employed by one facility	38%	34%	29%	28%	↓
Average number of anesthesiologists	46	38	37	51	↑
Group receives direct compensation	57%	66%	64%	71%	↑
Facility Characteristics					
Work in one facility	54%	49%	46%	41%	↓
Work in multiple facilities	42%	48%	51%	56%	↑
Primary facility is ambulatory facility	9%	8%	10%	10%	↑
Primary facility is nonprofit	68%	72%	60%	63%	
Primary facility is for profit	29%	24%	35%	31%	
Primary facility is governmental	2%	4%	5%	6%	↑
Primary facility is teaching facility	56%	49%	43%	30%	↓
Average number of anesthesia providers	66	59	54	41	↓
Average number of surgeons	51	55	48	54	

Note: Bolded results indicate significantly significant differences from the West at the $p < 0.10$ level. Arrows indicate the direction of western results relative to those of all other regions.

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Regional differences are apparent across a range of different employer and facility characteristics. For most of the employer and facility characteristics, anesthesiologists in the West are the outliers, showing distinctly different arrangements from anesthesiologists in other regions. We provide arrows to indicate the direction of the difference between the West and other regions, with a downward arrow indicating that the West has lower values for the statistic than other regions do. Bolded numbers are those that are statistically significantly different from the value for western anesthesiologists at the $p < 0.10$ level.

We noted previously that anesthesiologists in the western United States are less likely work in one facility and more likely to work across multiple facilities; this analysis indicates that they are also less likely to be employed by a single facility. We defined facilities to include university hospitals, academic medical facilities, health care systems (e.g., Mayo, Kaiser, Geisinger), ambulatory surgical centers, office suites, and the like. We defined groups to include physician group practices (including groups that employ individuals working at health care systems or academic hospitals), publicly traded companies, and national anesthesia companies.

Groups are likely to be somewhat larger than the total number of anesthesiologists who can be employed by a single facility, so it seems reasonable that western anesthesiologists would work for employers with larger numbers of total anesthesiologists. In addition, anesthesiologist groups in the West are more likely than those elsewhere to receive direct compensation for their services.

One area in which western anesthesiologists are not found to be an outlier is in the financial arrangement of their primary facilities. Instead, midwestern anesthesiologists are most likely of all anesthesiologists to work for nonprofit facilities, while southern anesthesiologists are most likely of all anesthesiologists to work for for-profit facilities.

There Are Regional Differences in Employer Types (continued)

Regional Differences in Employer Type

	Northeast	Midwest	South	West	West Versus Other
Employer Characteristics					
Employed by one facility	38%	34%	29%	28%	↓
Average number of anesthesiologists	46	38	37	51	↑
Group receives direct compensation	57%	66%	64%	71%	↑
Facility Characteristics					
Work in one facility	54%	49%	46%	41%	↓
Work in multiple facilities	42%	48%	51%	56%	↑
Primary facility is ambulatory facility	9%	8%	10%	10%	↑
Primary facility is nonprofit	68%	72%	60%	63%	
Primary facility is for profit	29%	24%	35%	31%	
Primary facility is governmental	2%	4%	5%	6%	↑
Primary facility is teaching facility	56%	49%	43%	30%	↓
Average number of anesthesia providers	66	59	54	41	↓
Average number of surgeons	51	55	48	54	

Note: Bolded results indicate significantly significant differences from the West at the p<0.10 level. Arrows indicate the direction of western results relative to those of all other regions.

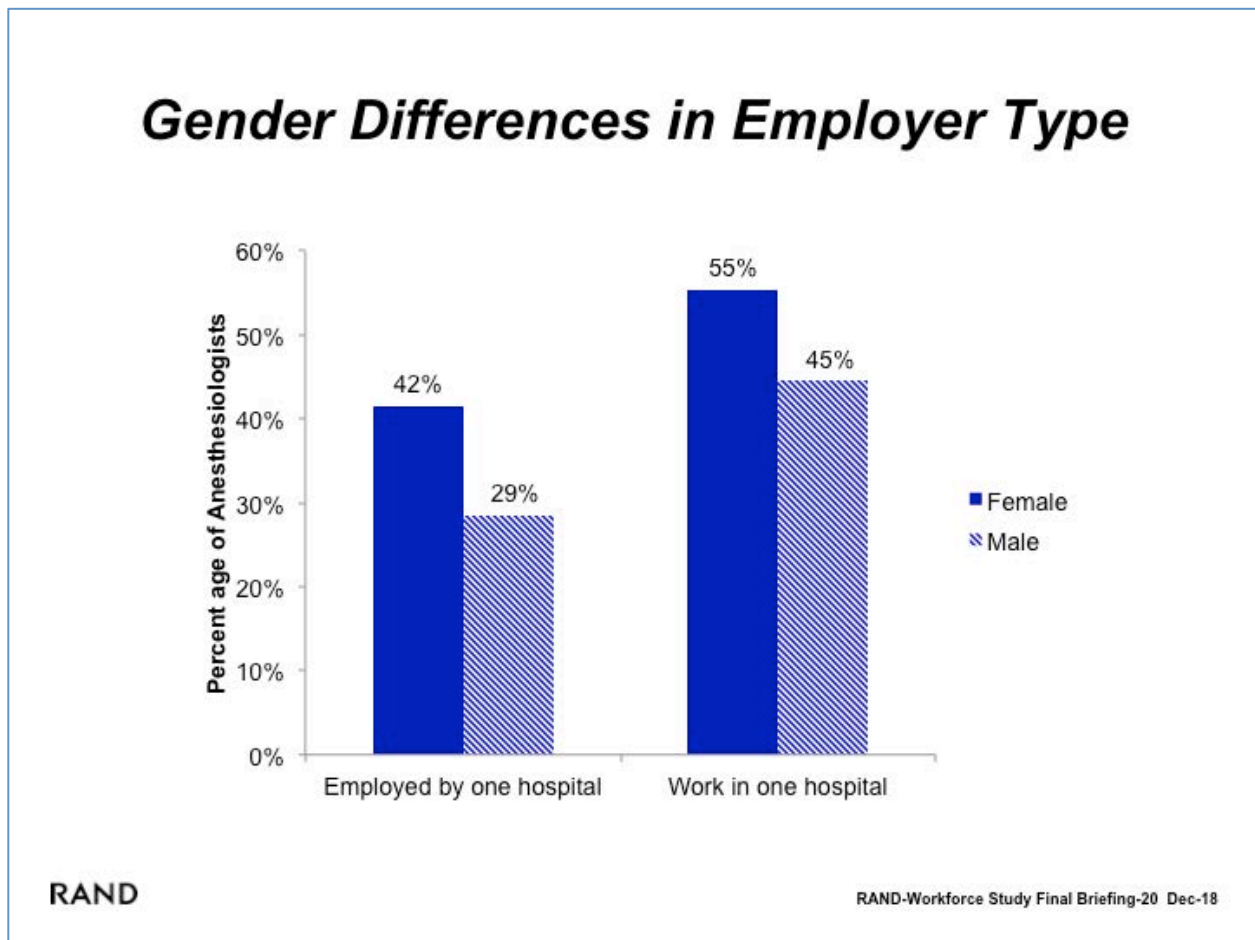
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Western anesthesiologists are slightly more likely than their northeastern or midwestern counterparts to work in governmental facilities and slightly more likely to work in ambulatory surgical centers. Western anesthesiologists are much less likely than those in other regions to work in teaching facilities.

If facility size is defined by the total number of surgeons, southern anesthesiologists work in slightly smaller facilities. However, when we look at the total number of anesthesia providers in a facility, the picture looks quite different. Western facilities appear to employ substantially fewer anesthesia providers for a given number of surgeons. We find that this difference is driven by differences in the numbers of nonphysician anesthesia providers at facilities rather than by differences in the number of anesthesiologists. Western facilities employ similar or greater numbers of anesthesiologists, on average, than those in other regions, but they employ substantially fewer nurse anesthetists. We discuss this issue more in “Team Care.”

Next, we describe differences by gender in employment arrangements.

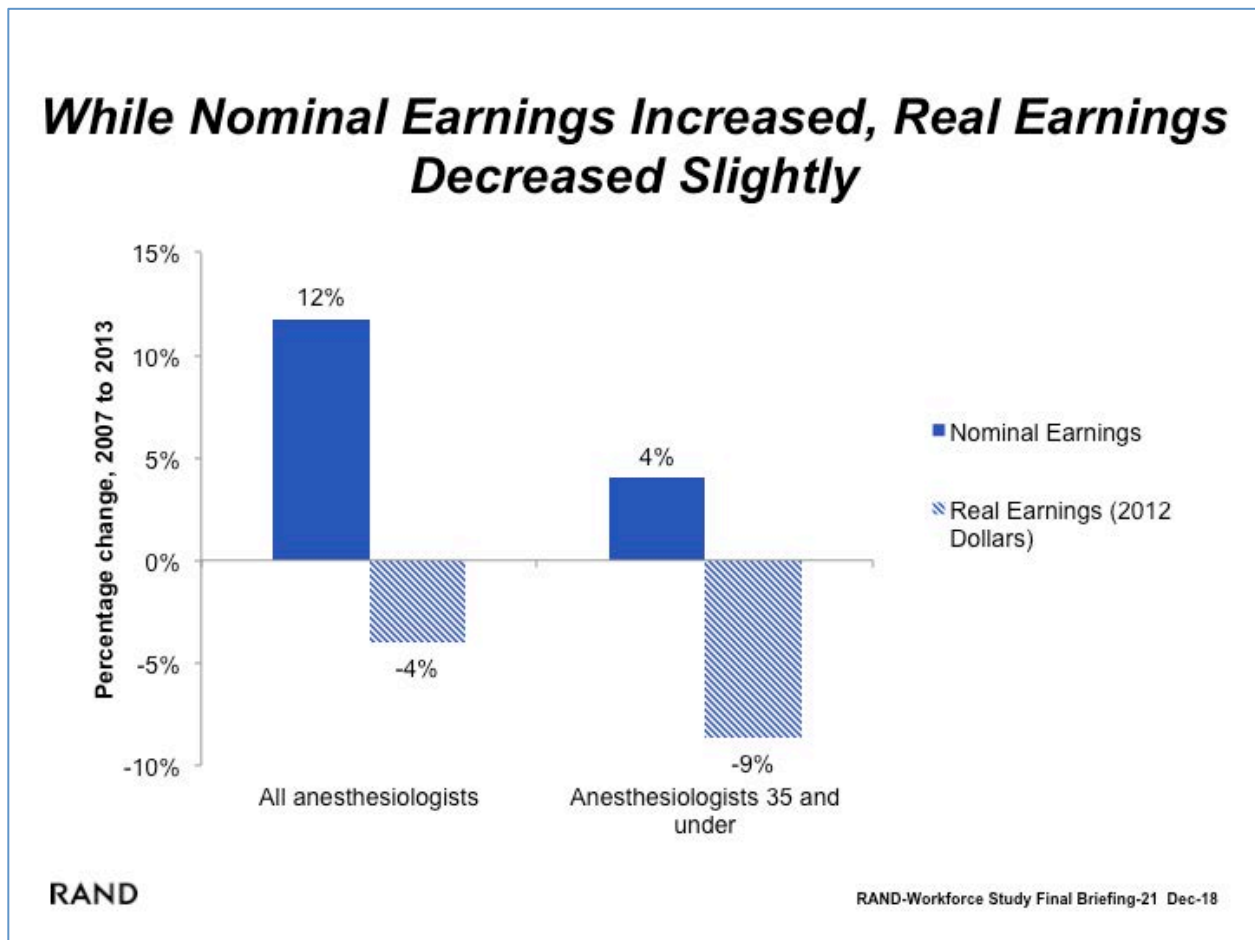
There Are Gender Differences by Employer Type



A female anesthesiologist is significantly more likely than a male anesthesiologist to be employed by a single facility and work in a single facility. The difference in employer types is particularly large, with women nearly 50 percent more likely than men to be employed by single facilities.

One possible explanation for the differences in employer types is that female anesthesiologists prefer more-structured employment arrangements, with a single location and a more predictable schedule. However, when we look at the likelihood that a female anesthesiologist is employed by a single facility, we find that female anesthesiologists who are married or have children are no more likely to work for a single facility than single female anesthesiologists or those who do not have children.

Although Nominal Earnings Increased, Real Earnings Decreased Slightly



In nominal terms, the average reported annual income increased by nearly 12 percent over two years. However, when we adjust for inflation to examine real earnings, we find a small decrease in earnings, of approximately 4 percent.

Earnings have decreased more among the youngest anesthesiologists than in other age groups. The average real annual compensation for anesthesiologists ages 35 or younger dropped by 9 percent. This may be partially explained by changes in weekly hours, which dropped by 5 percent between 2006 and 2012. The difference in earnings per hour, therefore, is just 3.4 percent, a decrease from \$123 in 2006 to \$119 in 2012. The decreases in annual compensation for young anesthesiologists (not shown) were twice as large for those employed by facilities (13.6 percent) than for those employed by groups (6 percent).

There Are Some Regional Differences in Compensation

There Are Some Regional Differences in Compensation

	Northeast	Midwest	South	West	West Versus Other
Average hourly compensation	\$141	\$146	\$153	\$142	↑
Percentage of compensation fee-for-service	20%	32%	31%	57%	↓
Percentage of compensation salary	66%	56%	59%	35%	↓
Percentage of compensation bonus	14%	11%	10%	8%	

Note: Bolded results indicate significantly significant differences from the West at the $p < 0.10$ level. Arrows indicate the direction of western results relative to those of all other regions.

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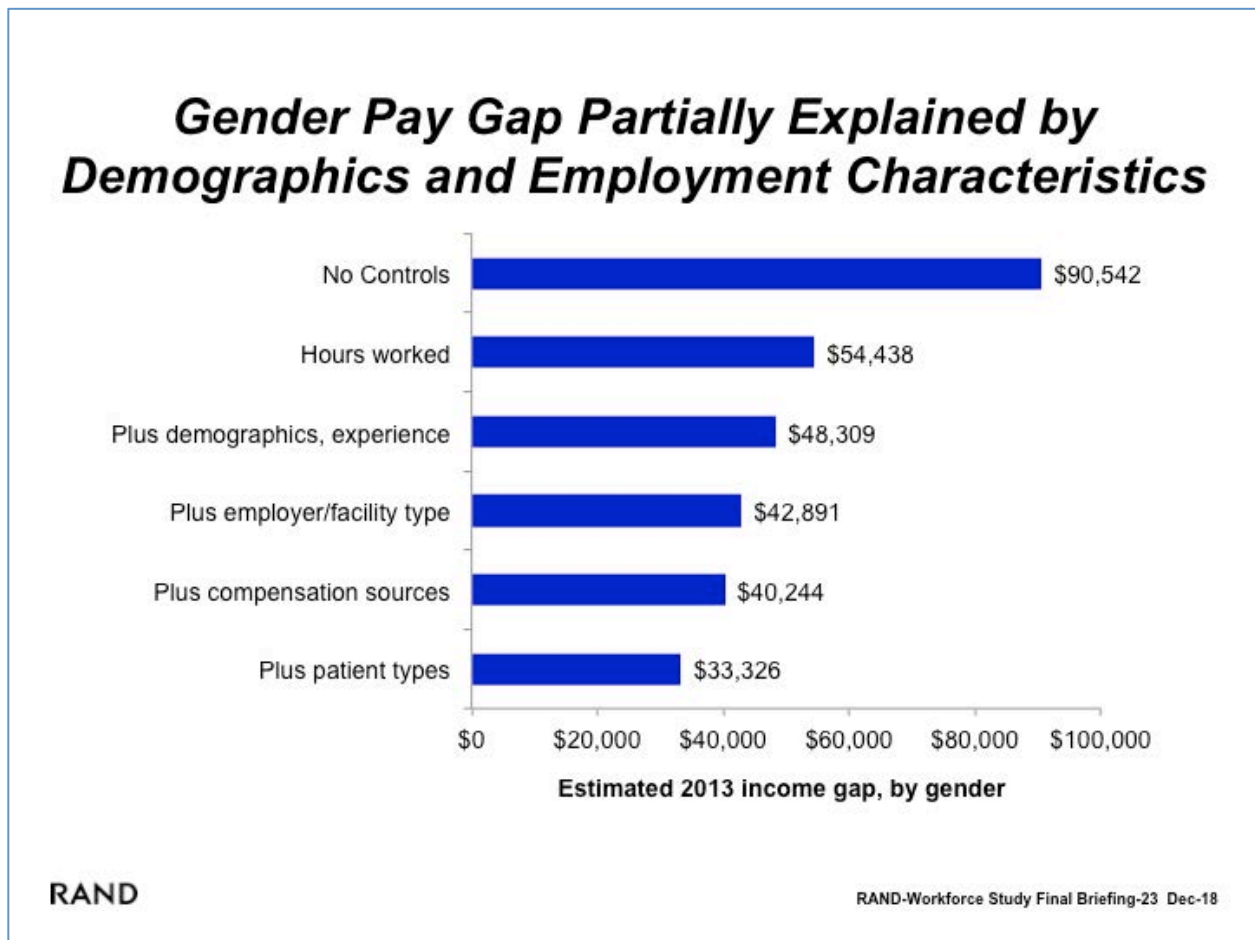
When looking at compensation by region, we find that most regions have similar earnings, but the compensation arrangements are quite different from one region to another.

To compare levels of compensation, we looked at hourly earnings to account for differences in hours per week worked in different regions. Anesthesiologists in the South have somewhat higher earnings than those elsewhere, while anesthesiologists in other regions have similar earnings to one another.

When we look at compensation arrangements, we find that the West is again an outlier. The percentage of compensation in the West that is obtained through fee-for-service payments is nearly double what is reported by anesthesiologists in the West and South and nearly triple what is reported for anesthesiologists in the Northeast. Rather than being compensated through fee-for-service payments, the anesthesiologists in the other regions are compensated through salaries and bonuses.

When we compare patterns in the compensation-arrangement data and the patterns in employer types, we see that regions with large percentages of anesthesiologists employed by

facilities are also regions where compensation is more likely to be paid by salary. It is likely, therefore, that these compensation patterns are being driven by employer type.

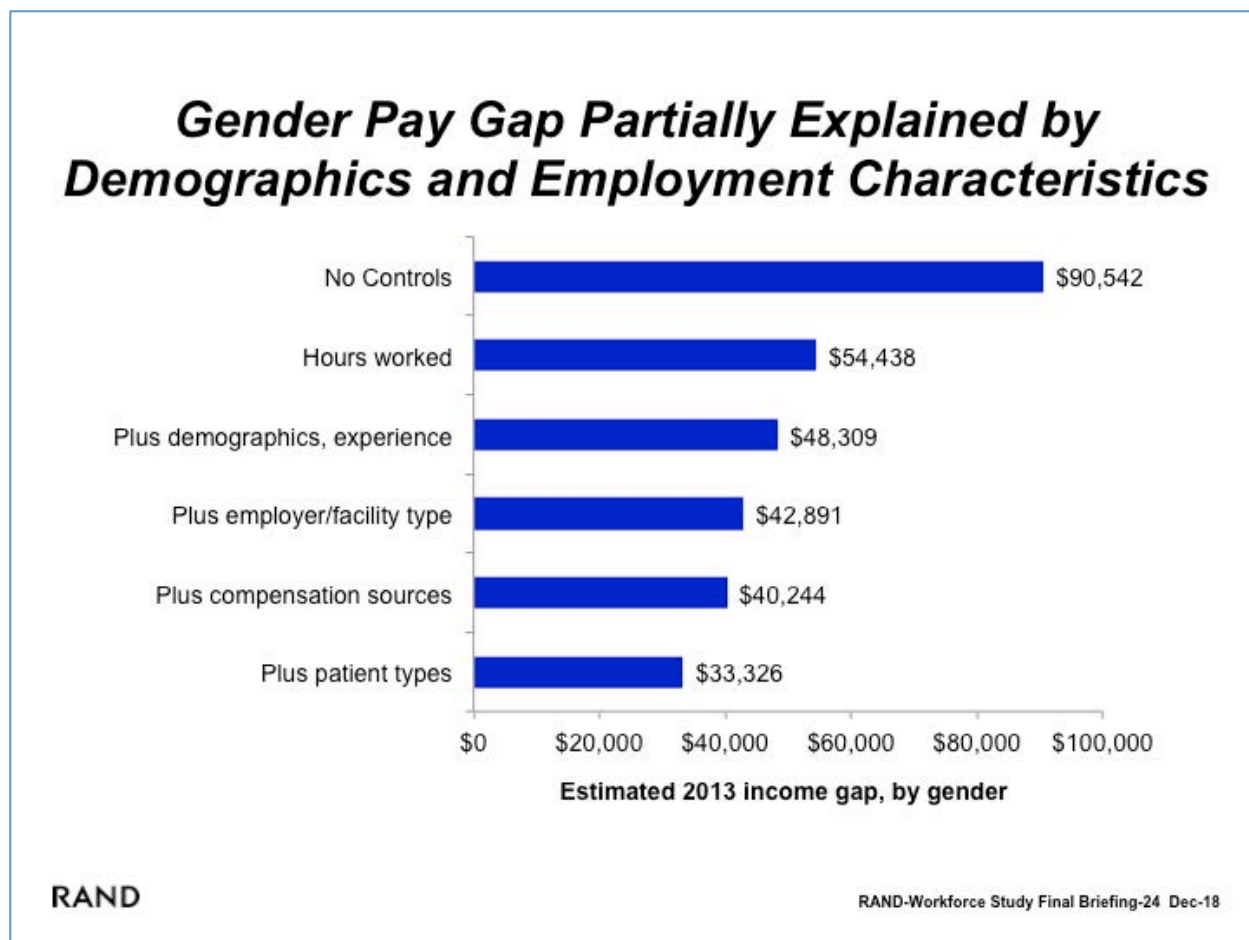


When comparing annual earnings, we observe a gap of more than \$90,000 between the average male anesthesiologist and the average female anesthesiologist. That leads us to ask, how much of the differences in earnings can be explained by observable differences in demographics or employment situations?

One of the largest differences between male and female anesthesiologists is the total number of hours worked, which we describe in the next section. When we account for differences in hours worked, the gender gap in earnings decreases by more than one-third. We also showed that female anesthesiologists are largely concentrated among the youngest cohorts of anesthesiologists. To the degree that earnings increase with experience, accounting for this should decrease the gender gap in earnings. The results of regression analysis indicate that adding demographics and experience reduces the gender pay gap by more than \$6,000. Earlier, we discussed how employer type differs by gender, and compensation type similarly differs by gender. When we control for employer, facility, and compensation arrangement, the gender pay gap is further reduced by \$8,000. We discuss the gender differences in patient types later, with female anesthesiologists more likely to spend time with pediatric patients (see “Female

Anesthesiologists Spend More Time Than Male Anesthesiologists on Pediatric Care”). When we control for these, the gender gap is reduced to just \$33,326, just a little more than one-third of the raw gap in earnings.

The Gender Pay Gap Is Partially Explained by Demographics and Employment Characteristics
(continued)



To the degree that the differences in employer, patients, and hours stem from decisions made by female anesthesiologists based on their preferences, we may not be worried about the portion of the gender pay gap that can be explained by observable differences in employment situations. If female anesthesiologists are working fewer hours to accommodate personal responsibilities or are choosing to work with pediatric patients because of a passion for children, the accompanying pay differences may be an acceptable trade-off for flexibility and job satisfaction. However, if women are channeled to certain types of patients, less likely to be hired as group employers, or prevented from working their desired hours more often than men, we may be concerned that these gaps reflect illegal discrimination rather than explaining why women’s preferences may drive salary differences. From the data from our survey, we are unable to distinguish between these two possibilities.

Even though a large portion of compensation can be explained by the characteristics of the anesthesiologist’s employer, facility, and practice, a substantial \$33,000 difference by gender still remains and needs to be better understood.

Outline

- **Background and significance**
- **Data and methods**
- **Survey results**
 - Employment arrangements
 - **Team care**
 - Time use
 - Indicators of shortage
- **Econometric analysis**
- **Projections**

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Next, we discuss the data on team care. This is an important issue in the anesthesiologist workforce literature: the impact of a growing workforce of nonphysician anesthesia providers. Nurse anesthetists and anesthesiology assistants are licensed professionals with master's degrees and the training necessary to participate in the delivery of anesthesia. Nurse anesthetists are far more prevalent in the United States than anesthesiology assistants, with more than 40,000 nurse anesthetists and approximately 1,000 anesthesiology assistants nationally. The primary model of team anesthesia care is the supervision of nonphysician providers by an anesthesiologist. For payments to be made, except in states that opt out of the Medicare provision, Medicare policy requires that nonphysician providers be supervised by an anesthesiologist.

As the nurse anesthetist workforce has grown and policy has led to increases in independent anesthesia provision, there has been considerable debate on the implications that nonphysician providers have on cost and patient safety (ASA, 2004; American Association of Nurse Anesthetists [AANA], 2007). The studies tend to focus on comparing physician and nonphysician providers as direct substitutes. However, in a constrained workforce, nonphysician providers may additionally act as a complement to anesthesiologists, improving the effectiveness

of anesthesiology by increasing staffing ratios and freeing up anesthesiologists to focus more on cases for which their direct presence is required.

Anesthesia Teams Can Vary

- **Team care: Anesthesiologists can supervise nurse anesthetists in the same facilities on the same procedures**
 - **Shifts throughout health care are putting a greater emphasis on nurses as providers**

- **In states where nurse anesthetists are exempted from supervision requirements**
 - **Nurse anesthetists can work in the same facility on separate procedures**
 - **Nurse anesthetists can work in different facilities on separate procedures**

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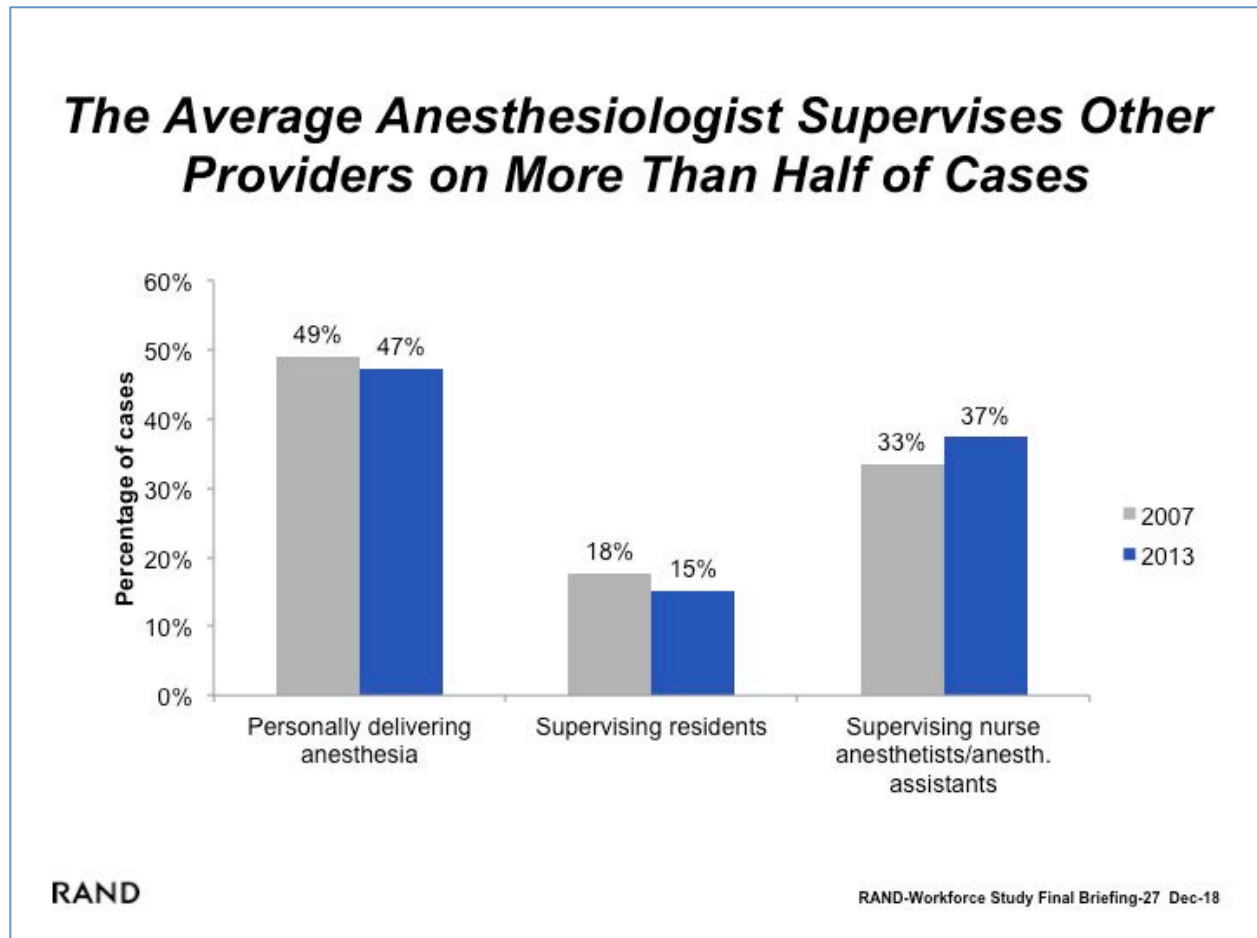
In the provision of anesthesiology, it has become common to use teams to deliver care, with teams often made up of a nurse anesthetist or anesthesiology assistant who is delivering care and an anesthesiologist who is supervising the care provider. In most states, physician supervision of nurses providing anesthesia is required by the U.S. Department of Health and Human Services Centers for Medicare and Medicaid Services. This means that nurse anesthetists and anesthesiologists are always working together on the same procedures in the same facilities.

Because of concerns about anesthesia-provider shortages in rural areas, in 2001, the Centers for Medicare and Medicaid Services offered states the opportunity to opt out of the requirement that nurse anesthetists be supervised by a physician. Seventeen states have opted out of the physician-supervision regulation—from earliest to latest, Iowa, Nebraska, Idaho, Minnesota, New Hampshire, New Mexico, Kansas, North Dakota, Washington, Alaska, Oregon, South Dakota, Wisconsin, Montana, California, Colorado, and Kentucky (AANA, undated). In these states, nurse anesthetists can take on an expanded role. They can work in the same facilities as anesthesiologists but work on different procedures, and they can work in separate facilities that do not have any anesthesiologists on duty. It is important to note that nurse anesthetists working

in facilities without anesthesiologists will not be captured anywhere in these data because, in this study, we surveyed only anesthesiologists.

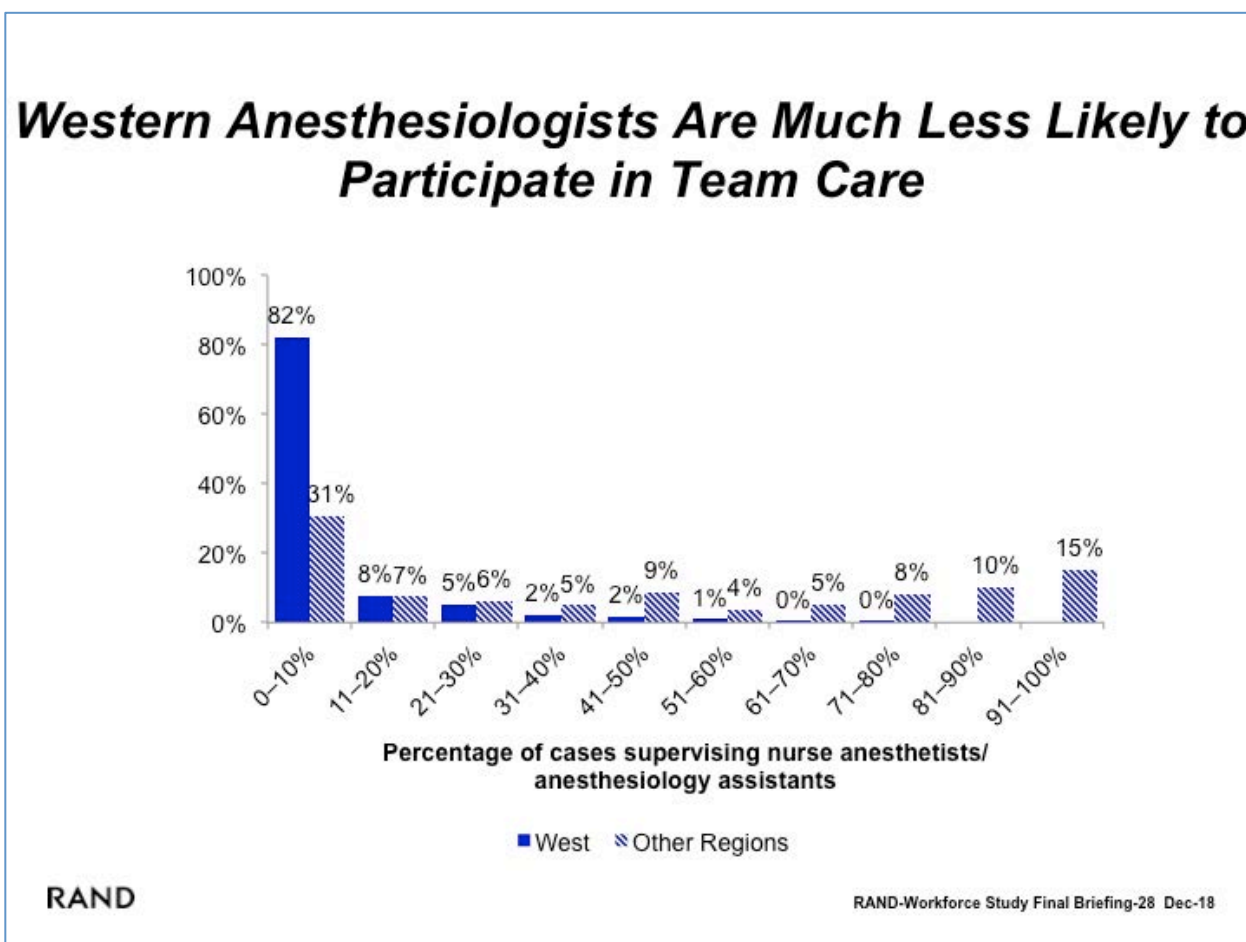
It is important to note that all data on team care in the 2013 wave of the survey were reported by anesthesiologists. For findings from CRNAs, please reference our report on the findings from the previous survey wave (Daugherty et al., 2010).

The Average Anesthesiologist Supervises Other Providers on More Than Half of His or Her Cases



The average anesthesiologist delivers anesthesia personally on approximately half of his or her cases and supervises other anesthesia providers on the remaining cases. Supervision of nurse anesthetists and anesthesiology assistants accounts for a larger percentage of cases in 2013 than in 2007, with an statistically significant increase from 33 percent to 37 percent in those six years.

We cannot separate trends over time for nurse anesthetists and anesthesiology assistants because the 2007 survey combined these anesthesia providers into a single group. However, we find in the 2013 data that supervision of nurse anesthetists accounts for a much greater portion of an anesthesiologist's supervisory time, with just 2 percent of cases reported to involve supervision of anesthesiology assistants in 2013, than the 35 percent of cases involving supervision of nurse anesthetists.



When looking at the percentage of cases that involve supervision of nonphysician anesthesia providers by region, we find distinctly different patterns for western anesthesiologists and anesthesiologists in other regions. The vast majority of western anesthesiologists supervise non-anesthesia providers on 10 percent or fewer of their cases. There are very few western anesthesiologists who supervise on at least 50 percent of cases, and there is not a single western anesthesiologist who supervises on more than 75 percent of cases. Anesthesiologists in regions outside the western United States seem to have a much wider range of supervision arrangements. One-third of anesthesiologists outside the western United States supervise on relatively few of their cases (0 to 10 percent), one-third supervise on some of their cases (11 to 70 percent), and one-third supervise on most of their cases (70 to 100 percent).

One possible explanation for the greater participation in team care is that western anesthesiologists are more likely to work for groups and multiple facilities. And team care may be more prevalent in facility-based employment situations, in which facilities have incentives to maximize the efficiency of their anesthesia providers. However, in three of the four regions, we do not find facility-employed anesthesiologists spending more time supervising nonphysician

anesthesia providers. In the Northeast and South, group-employed anesthesiologists spend a larger percentage of their cases than facility-employed anesthesiologists in the same regions supervising (41 percent versus 33 percent in the Northeast and 57 percent versus 47 percent in the South). In the West, the opposite is true, with facility-employed anesthesiologists spending a larger percentage of their cases than group-employed anesthesiologists do supervising (8 percent versus 20 percent).

Nurse Anesthetists Are Less Prevalent in the West and Midwest Than in Other Regions

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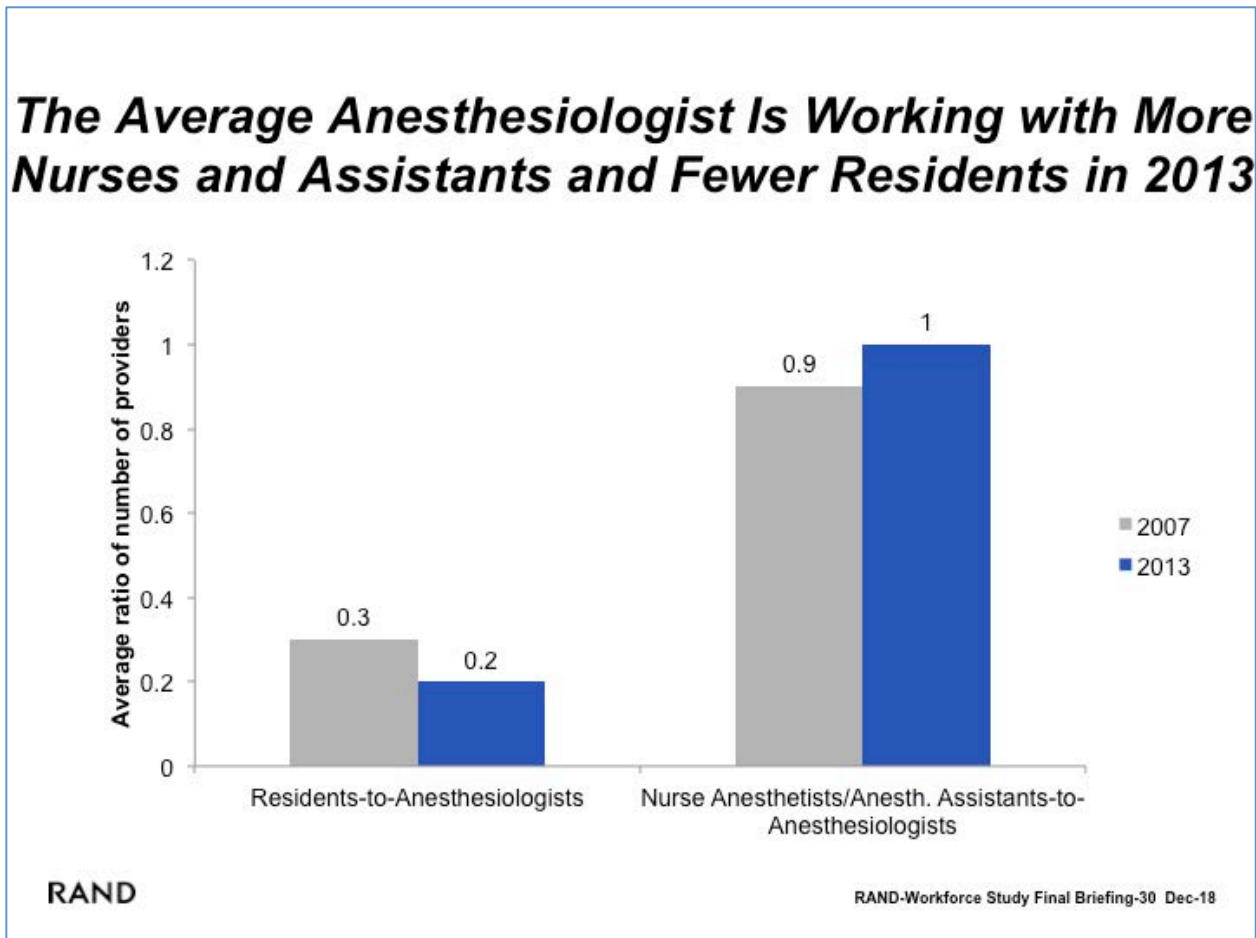
	Nurse Anesthetists	Anesthesiologists	Ratio of Nurse Anesthetists to Anesthesiologists
Northeast	8,933	8,698	1.03
Midwest	5,426	9,665	0.56
South	15,758	14,174	1.11
West	3,272	10,127	0.32

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This table presents the total number of nurse anesthetists and anesthesiologists in 2011 according to the AHRF. The data indicate that there are fewer nurse anesthetists per anesthesiologist in the West and Midwest than in the Northeast and South. This is an interesting finding given that most of the states that allow nurse anesthetists to work without supervision are in the Midwest and West, and there were concerns that nurse anesthetists would be substituted for anesthesiologists if exemption from the requirement of anesthesiologist supervision were permitted.

The Average Anesthesiologist Is Working with More Nurse Anesthetists and Anesthesiology Assistants and Fewer Residents in 2013



When we examine the mix of anesthesia providers at the facility level, we find that the ratio of nonphysician anesthesia providers to anesthesiologists has increased by 10 percent in the past six years. The ratio of residents to anesthesiologists appears to have decreased slightly.

There are Regional Differences in Anesthesia-Provider Use

Regional Differences in Anesthesia Provider Use

	Northeast	Midwest	South	West	West Versus Other
Average number of anesthesiologists	32	25	23	28	↓
Average number of nurse anesthetists	17	21	21	6	↓
Average number of anesthesiologist assistants	0	1	2	0	↓
Average number of residents	17	12	8	7	↑
Percentage of facilities using anesthesiologists only	11%	14%	11%	48%	↓
Percentage of facilities using any nurse anesthetists	87%	82%	89%	43%	

Note: Bolded results indicate significantly significant differences from the West at the p<0.10 level. Arrows indicate the direction of western results relative to those of all other regions.

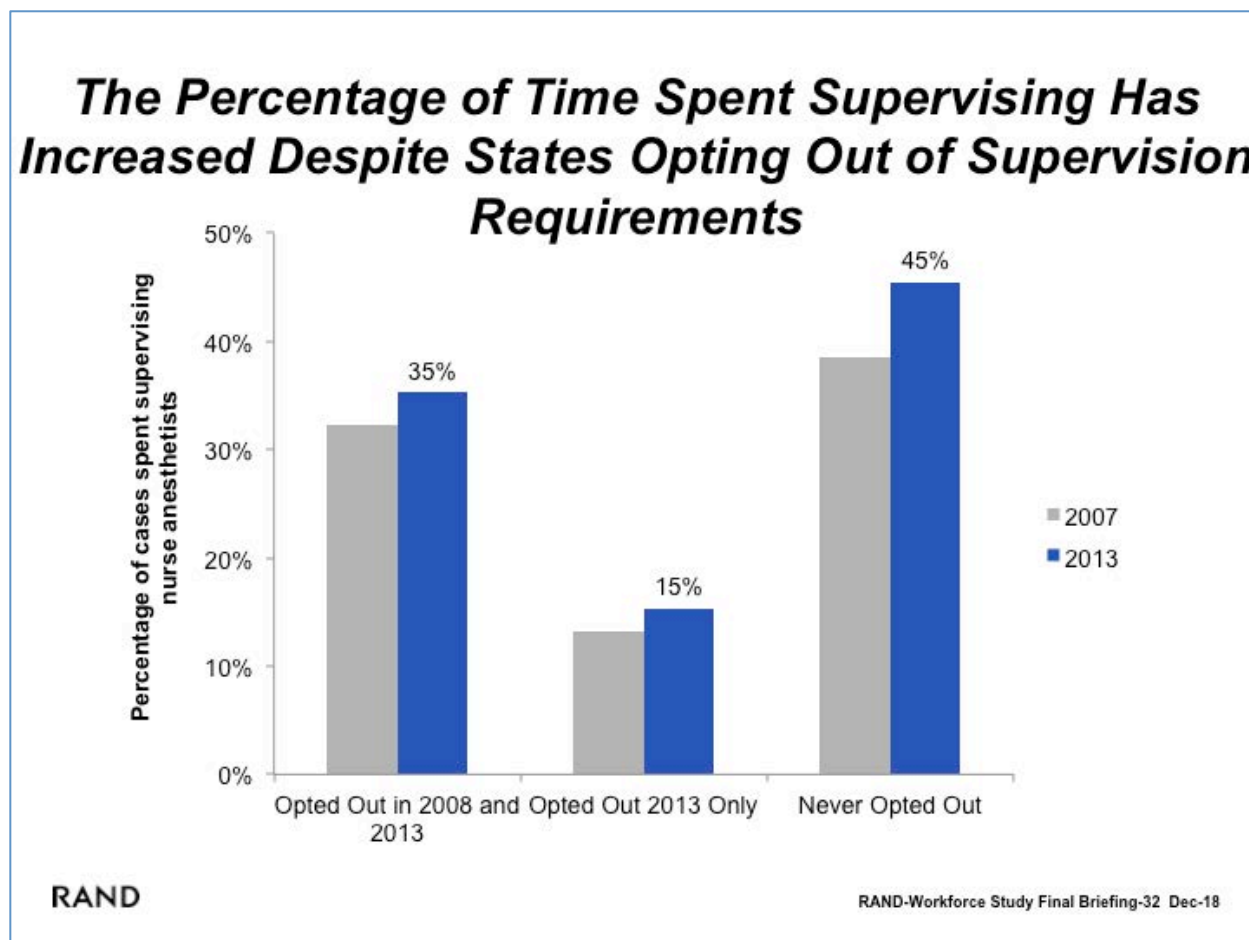
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Regional differences in the mix of anesthesia providers also highlight the West as a clear outlier. The average anesthesiologist in the western United States works in a facility with less than one-third as many nurse anesthetists as the number with which anesthesiologists in other regions work. Only 43 percent of the facilities at which western anesthesiologists work use nurse anesthetists, compared with more than 80 percent of the facilities in other regions. Western facilities appear to rely largely on a physician-only staff mix for the provision of anesthesia, while facilities in other regions tend to use a mix of anesthesia providers. It is important to note, however, that these are regional averages. There is substantial variation within regions in the use of team care for anesthesia.

The facilities at which western anesthesiologists work also use few anesthesiology assistants and have fewer residents, on average. The facilities at which northeastern anesthesiologists work have more anesthesiologists and residents, on average, than other regions have.

The Percentage of Time Spent Supervising Has Increased Despite States Opting Out of Supervision Requirements



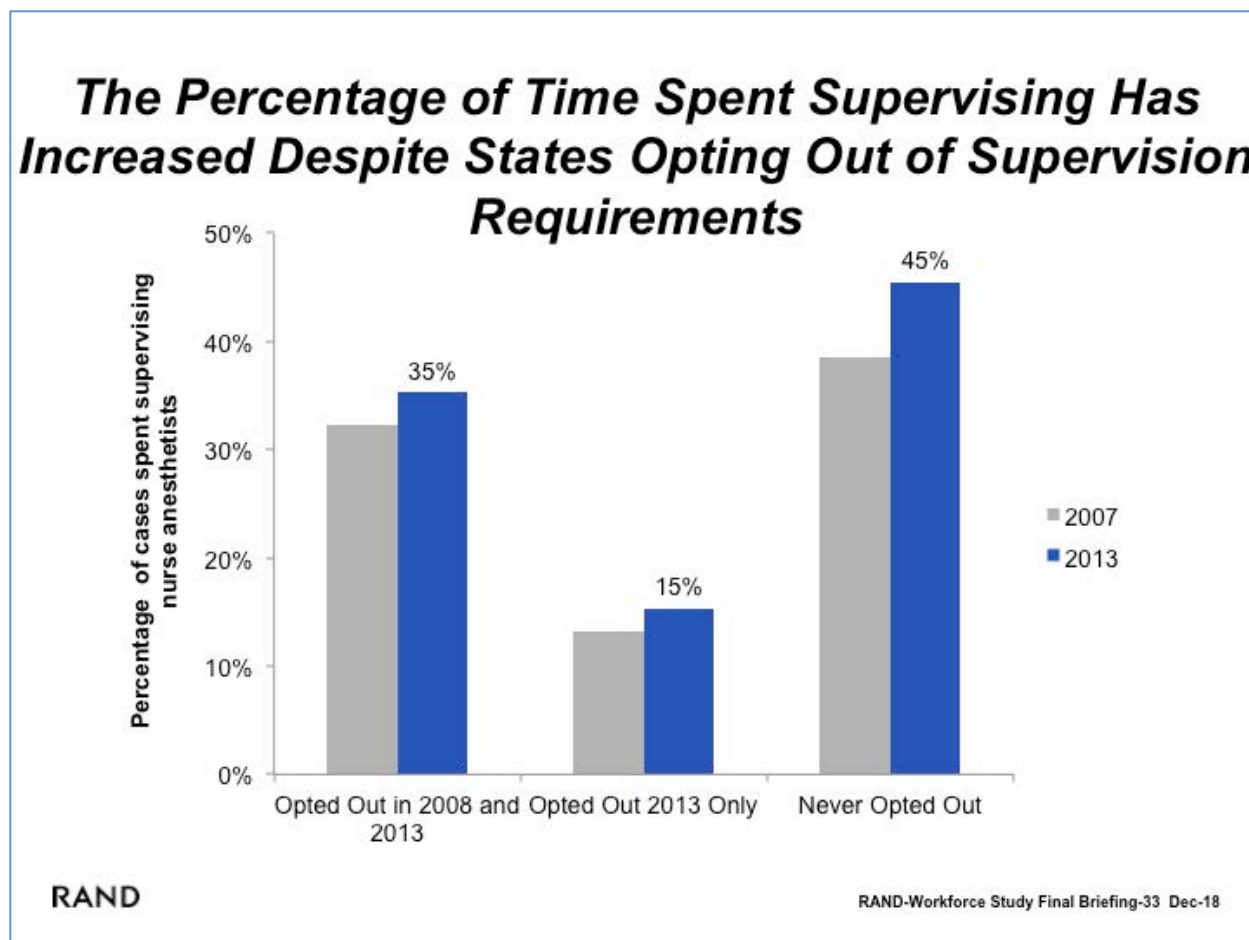
In “The Gender Pay Gap Is Partially Explained by Demographics and Employment Characteristics,” we described the decision of 17 states to opt out of the requirement that nurse anesthetists must be supervised by anesthesiologists. Between 2007 and 2013, three states transitioned to opting out of the physician-supervision regulation.

A question we ask is, how has the opt-out provision affected supervision by anesthesiologists? Because the survey was conducted at the anesthesiologist level rather than the facility level, we cannot directly examine changes in the mix in anesthesia providers across all facilities. We showed that the average facility was employing a larger number of nurse anesthetists than it had in 2007, but there is not clear evidence that these additional nurse anesthetists are substituting for anesthesiologists.

Although we cannot assess the impact that opting out has on the displacement of anesthesiologists by nurse anesthetists, we can look at the trends in supervision by opt-out status. It appears that cases spent in supervision increased across all of the different groups; however, the largest increases occurred in states that had not opted out of the regulation. This is in line

with expectations because nurse anesthetists do not need to be supervised in states that opt out. However, it is notable that facilities in opt-out states continue to use anesthesiologists in a supervisory role.

The Percentage of Time Spent Supervising Has Increased Despite States Opting Out of Supervision Requirements



We find that the three states that opted out of the regulation between 2007 and 2013 have anesthesiologists who are much less likely to spend time supervising nurse anesthetists than personally delivering anesthesia. This is largely driven by California and Colorado, western states where few facilities use both anesthesiologists and nurse anesthetists. The tendency of facilities to use anesthesiologists as the sole providers of anesthesia in the western United States may mean that there are substantial barriers to the movement of nurse anesthetists into western facilities. On the other hand, it may be the case that nurse anesthetists are used in western facilities where anesthesiologists are not employed, and the practice of these nurse anesthetists would not be accounted for, given that the survey focuses only on data provided by anesthesiologists.

Regional Differences Are Not Driven by Differences in State Exemption Status

Percent age of Time Spent Supervising Nurse Anesthetists

	States Where Nurse Anesthetists Must be Supervised	States Opting Out of Supervision
Northeast	40	44
Midwest	41	46
South	49	47
West	7	13

In fact, states opting out of supervision have anesthesiologists who spend more time supervising nurse anesthetists.

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One possible explanation for the evidence of lower reported time spent in team care among anesthesiologists in the western United States than elsewhere is that nurse anesthetists are exempt from supervision in many western states, and this may lead to nurse anesthetists working separately in these states. However, when we break down the data by region and exemption status, we find that, in all regions except the South, anesthesiologists in states that have opted out of supervision spend *more* time supervising nurse anesthetists than anesthesiologists in states that have not opted out. In addition, anesthesiologists in the western United States spend much less time supervising, regardless of whether their states have opted out of supervision requirements. This provides evidence that opt-out status is not driving regional differences.

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Several questions on the survey asked for time use: total hours and clinical hours; the degree to which call time is spent on-site versus off-site; time spent by stage of care (preoperative, postoperative); time spent by case type, patient type, or anesthesia type; time spent doing administrative work; time spent teaching; and delays in cases for different situations.

Examining time usage might give important clues on the likelihood of shortage and how to address shortage when it exists.

Time Use Stayed Relatively Consistent Between 2007 and 2013

- **Small, nonsignificant decrease in hours**
- **Same number of procedures per week**
- **Same percentage of time spent in different aspects of care (e.g., preoperative, postoperative)**
- **Same percentage of time spent in different types of patients (e.g., cardiac/vascular, pain management)**
- **Same percentage of time spent on different types of anesthesia (e.g., monitored anesthesia care, general anesthesia)**

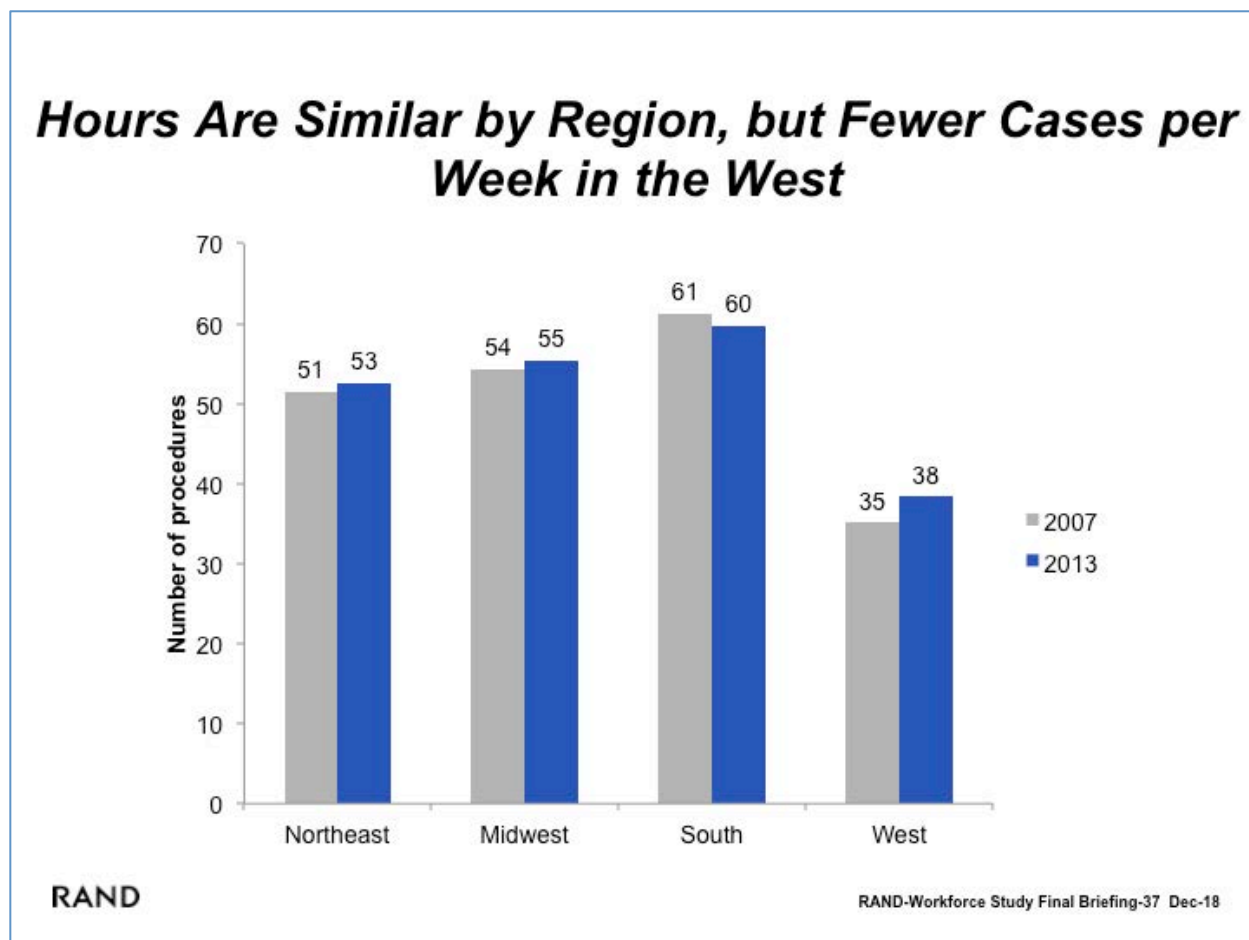
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We find very few changes in anesthesiologists' time use between 2007 and 2013. Anesthesiologists worked the same number of hours and completed the same number of procedures each week in 2013 as in 2007. There are no differences in the percentage of time spent on different aspects of care, on different types of patients, or on different types of anesthesia.

The stability of these findings over time provides us additional confidence in the validity of the survey. There may be no reason to expect a change in many of these time-use variables, and the consistency over time would be unlikely if there were substantial biases or errors in the survey responses.

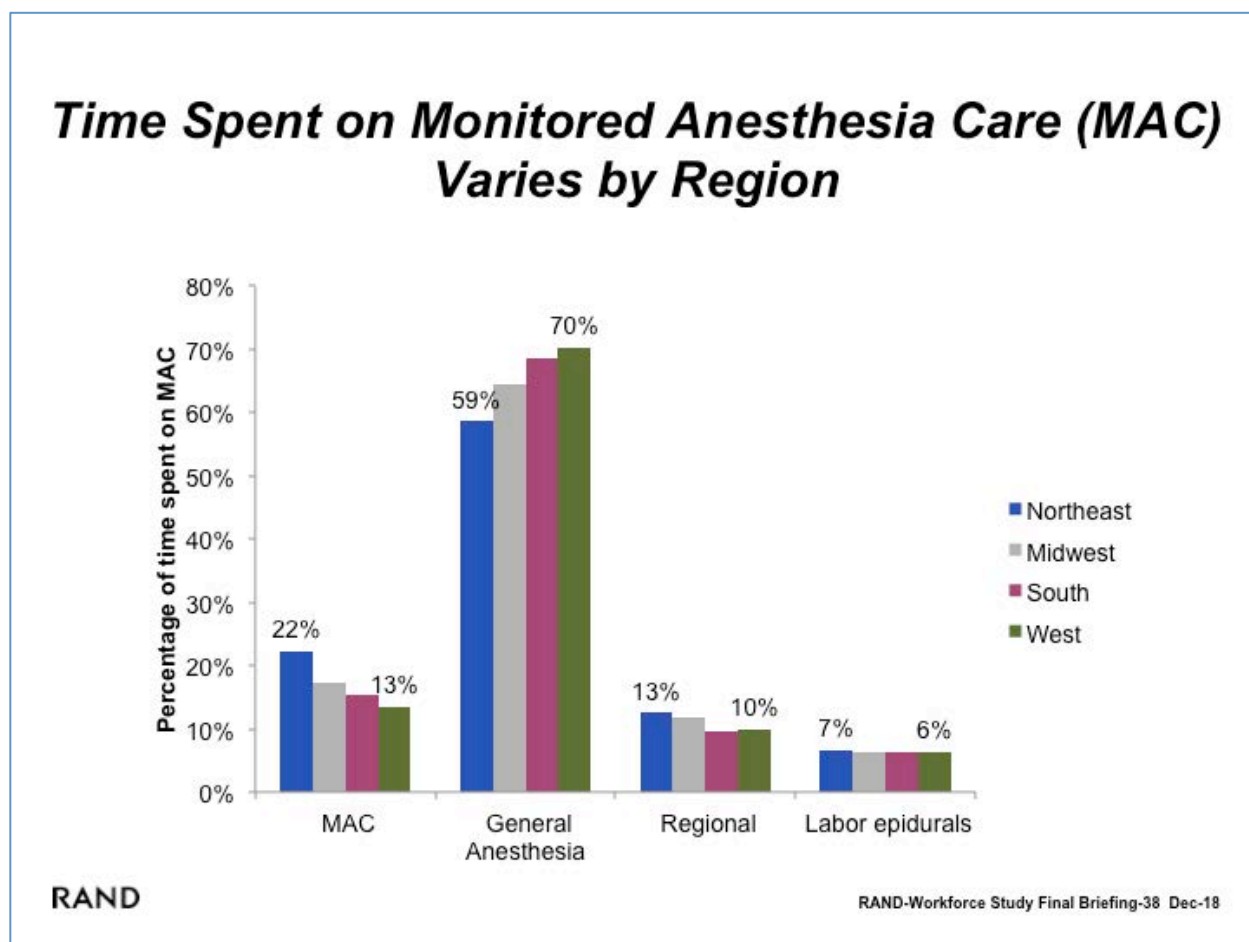
Hours Are Similar by Region, but Anesthesiologists Have Fewer Cases per Week in the Western United States



The data indicate that weekly clinical hours are similar across regions, though northeastern and western anesthesiologists work approximately one to two hours less per week than midwestern and southern anesthesiologists. However, the average number of procedures completed by western anesthesiologists in a week is substantially lower than anesthesiologists in the other regions. This result is largely driven by the use of team care in facilities. In team-care settings, anesthesiologists are able to supervise two to four cases simultaneously, allowing them to complete more procedures in a week than anesthesiologists not working in a team-care setting.

However, it is important to note that the data speak only to the supply of anesthesiologist labor. In team-care settings, facilities are also employing and compensating nonphysician anesthesia providers to supplement anesthesiologist care. So it is incorrect to conclude from these data that western anesthesiologists are any less productive than anesthesiologists in other regions. To examine the efficiency of different care models, one would need to examine all resources and compare these resource requirements with the value of services produced, an examination that is beyond the scope of our survey or study.

Time Spent on Monitored Anesthesia Care Varies by Region



Anesthesiologists in all regions spend the majority of their time providing general anesthesia. Yet there are substantial regional differences in the use of anesthesiologist time for different types of anesthesia. Western anesthesiologists spend the most time on general anesthesia and the least time on MAC. Northeastern anesthesiologists spend the most time on MAC and the least time on general anesthesia. There were smaller differences for regional anesthesia and labor epidurals. These regional differences were observed in the 2007 survey data and have changed little over time.

There are myriad reasons that anesthesiologists may devote different proportions of time to different types of anesthesia. Patterns of anesthesia time use could be driven by a different mix of procedures for the population served, use of different types of anesthesia providers for different types of procedures, and the use of anesthesia for procedures in which anesthesia is optional.

Use of Monitored Anesthesia Versus Sedation Varies by Region (2007 Data)

	Northeast	Midwest	South	West	West Versus Other
Percentage of Cases in Which MAC Delivered by Anesthesia Provider					
Colonoscopy	57%	39%	43%	30%	↓
Transesophageal Echocardiogram	30%	17%	14%	10%	↓

Note: Bolded results indicate significantly significant differences from the West at the $p < 0.10$ level. Arrows indicate the direction of western results relative to those of all other regions.

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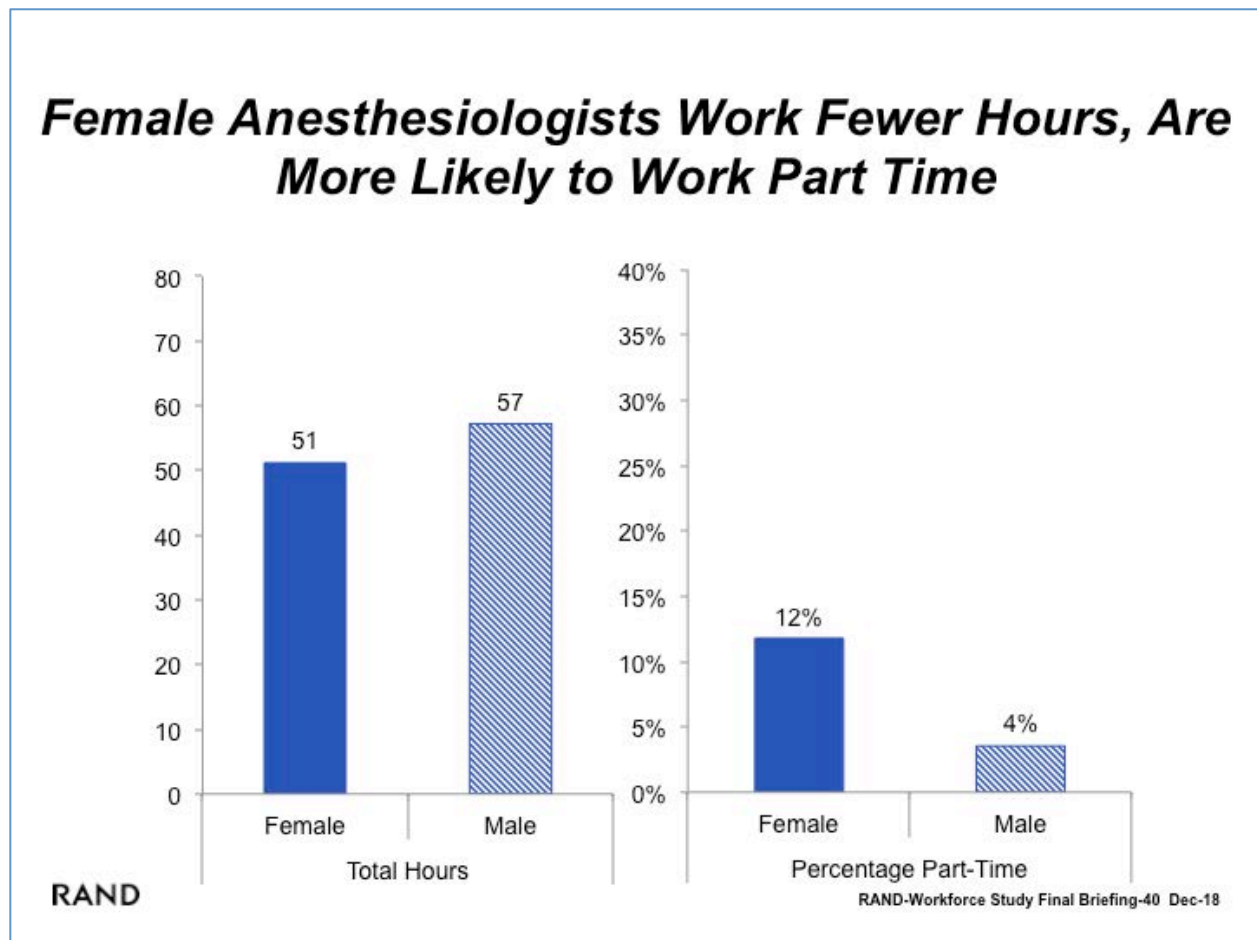
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It is useful to review findings from the 2007 survey on the use of anesthesia for procedures on which anesthesia is optional for low-risk patients. (This item was removed from the 2013 survey, so we could not look at more-updated data.) We find that these results are closely related to those found on the percentage of time spent on MAC (see “Time Spent on Monitored Anesthesia Care Varies by Region”). There are large regional differences in the percentage of colonoscopies and transesophageal echocardiograms for which MAC is used. Anesthesiologists in the Northeast report that a greater percentage of these cases use MAC, while western anesthesiologists report that it is less often used on these two types of cases. In fact, northeastern anesthesiologists report using MAC three times as often for transesophageal echocardiograms as western anesthesiologists report and nearly twice as often for colonoscopies in the Northeast than out West.

A recent RAND study indicated that there has been substantial growth in the use of anesthesia for gastrointestinal endoscopies and colonoscopies among low-risk individuals with private insurance (Liu et al., 2012). Using a complementary data source, the study also showed even wider variation by region, with only 15 percent of colonoscopy patients in the western

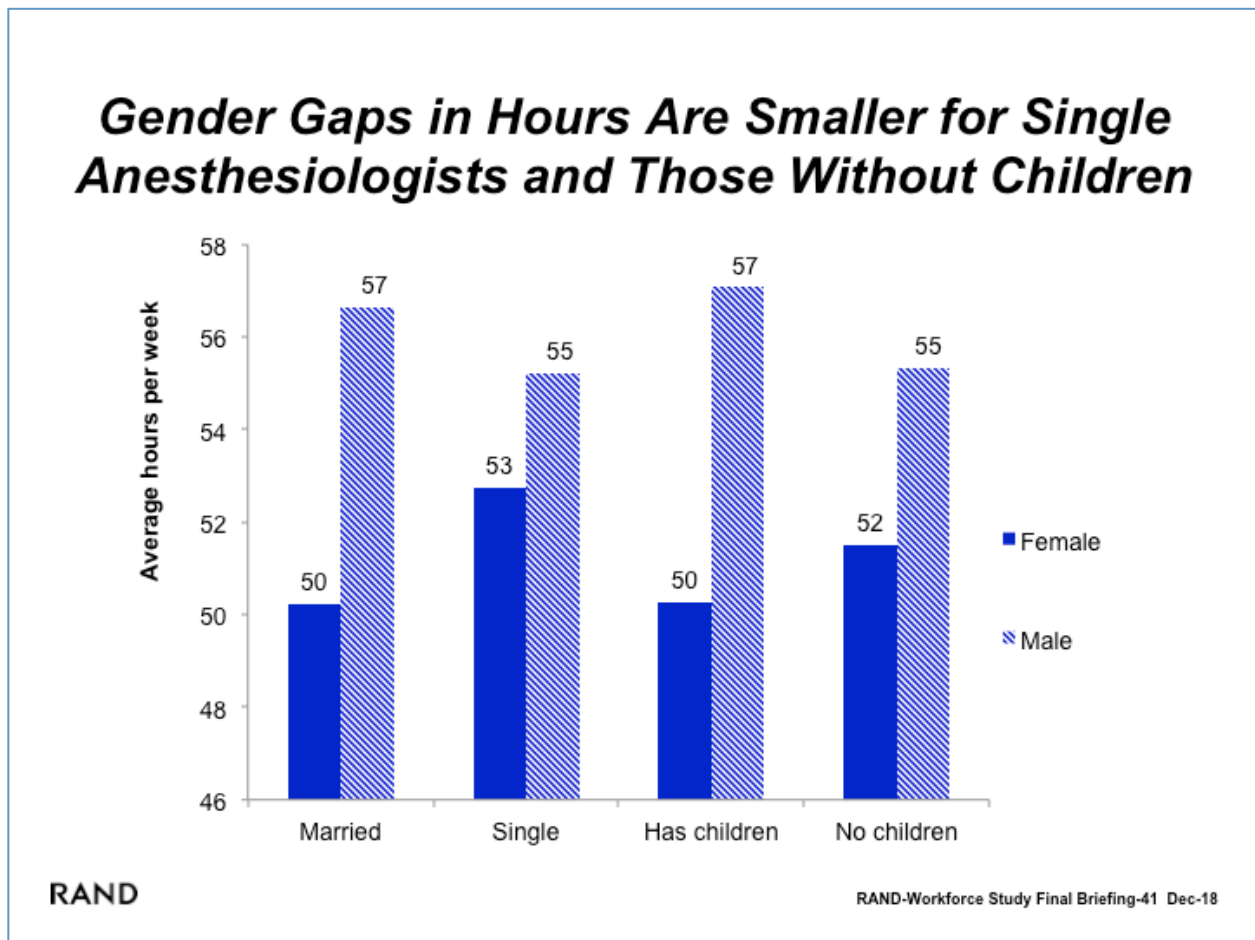
United States receiving anesthesia, compared with 59 percent in the Northeast. The lower numbers for the West in the Liu et al. study than in our survey findings suggest that anesthesiologists may overestimate rate of anesthesia use for colonoscopies, and this may be driven by a limited knowledge about the procedures that take place. Liu et al. argue that the use of anesthesia in these cases should be of concern because it is driving up the cost of care for basic procedures. If the rate of MAC continues to increase, this will put additional demands on anesthesiologist time and potentially lead to shortages of anesthesiologists if they are unable to accommodate this demand.

Female Anesthesiologists Work Fewer Hours and Are More Likely Than Male Anesthesiologists to Work Part Time



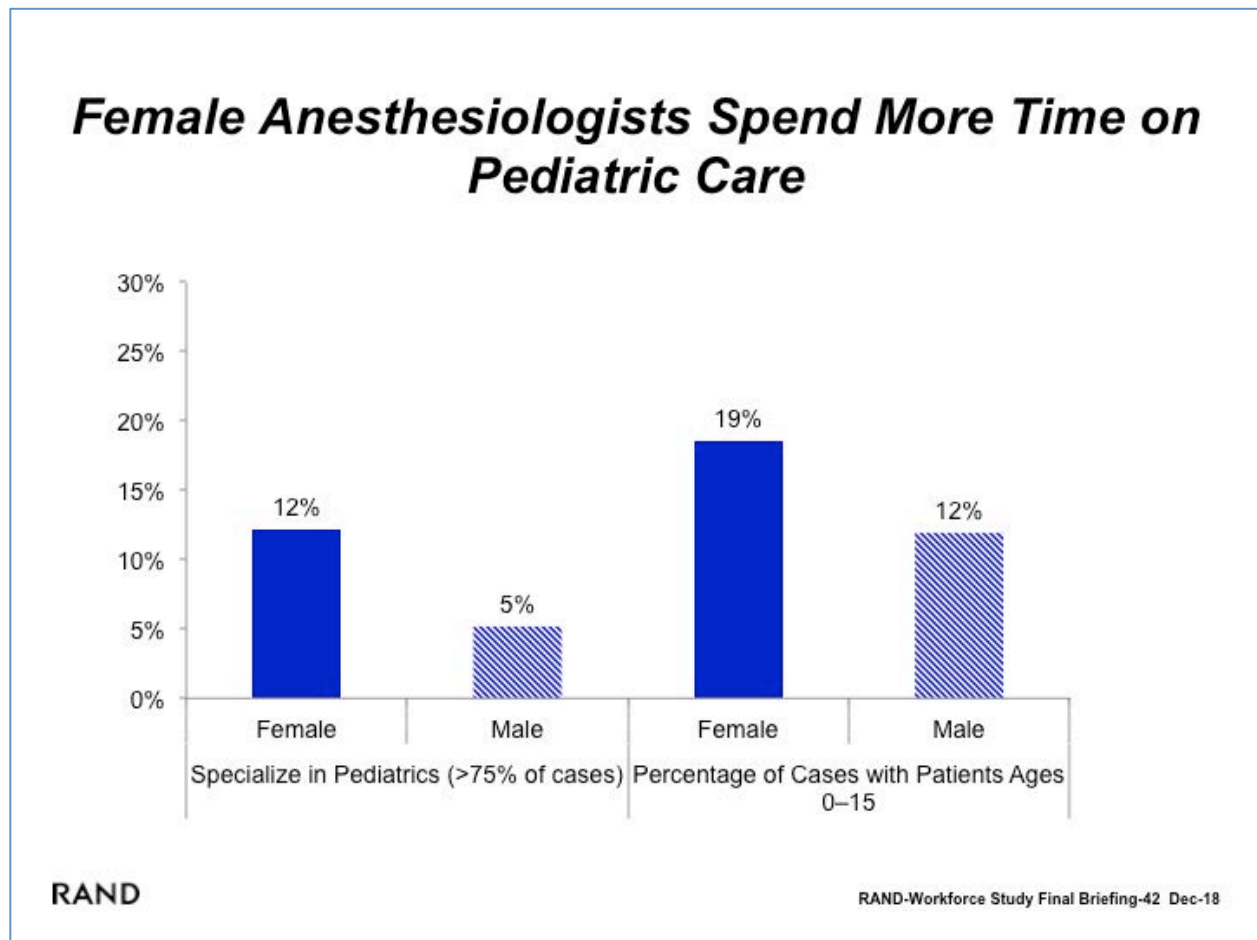
The data on variation in hours worked by gender suggest that female anesthesiologists work an average of six fewer hours per week than their male counterparts. Analysis of part-time work indicates a similar pattern. We define part-time work as it is defined by the U.S. Department of Labor to include anyone who works 35 hours per week or less. The data from the 2013 survey indicates that nearly 12 percent of female anesthesiologists worked part time, a rate that is three times the rate for male anesthesiologists.

Gender Gaps in Hours Are Smaller for Anesthesiologists Without Children



The most common explanation for reduced work hours among women is that family responsibilities limit the number of hours that can be worked. When we look at the gender gap in work hours by marital status and whether an anesthesiologist has children, we find that the gap is much smaller for single anesthesiologists and for anesthesiologists without children. These descriptive findings support the notion that differences in hours are at least partially driven by family makeup.

Female Anesthesiologists Spend More Time Than Male Anesthesiologists on Pediatric Care



Analysis of patterns in the time spent on different types of patients and cases indicates that there has been little change in patient mix over time, and there are few significant regional differences. However, when we look at patient type by gender, we do find one substantial difference: a greater percentage of time spent on pediatric patients. Female anesthesiologists are more than twice as likely as male anesthesiologists to specialize in pediatric anesthesia, where specialization is defined as one type of patient accounting for more than 75 percent of all cases.

Another item on the survey addressed time use by patient age from a different perspective; anesthesiologists were asked what percentage of cases involved patients ages 0 to 15 years (pediatric), 16 to 65 years (adult), and 65 years and older (elderly). Again, we find that female anesthesiologists are more likely than their male counterparts to see pediatric patients, with 19 percent of patients pediatric, compared with 12 percent for male anesthesiologists.

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To wrap up our summary of the most prominent survey results, we look at a range of indicators of shortage. In the next section, we describe how these indicators of shortage are both of interest in themselves and used to develop the econometric model.

Several items on the survey may speak to the presence of shortage or surplus in the anesthesiologist workforce. Some of these indicators may be stronger than others. For example, the item “To cover our current volume of cases, my group/practice would prefer to have more anesthesiologists” seems to provide a clear indicator of shortage because we would expect facilities to be able to find sufficient numbers of anesthesiologists to meet current case volume in labor markets that are in equilibrium. That said, there may be factors other than a shortage of anesthesiologists that could lead respondents to respond “yes” to this item. For example, the number of surgeons could act as a limiting factor.

An example of a weaker indicator of shortage is the item “My group/practice could handle more cases if we could hire more anesthesiologists.” This question focuses on the issue of anesthesiologists as a limiting factor in the facilities’ ability to increase demand. However, what this item cannot determine is whether there is actually additional demand out there to be met.

Facilities with excess surgical capacity may be able to handle additional cases with increased numbers of anesthesiologists, but, if there are not additional cases to handle, then the anesthesiologist market is not in shortage. This is distinct from the previous item, which establishes that current demand is beyond what can be handled by the current number of anesthesiologists.

Shortage Indicators Show Little Movement, and the Direction of Movement Is Mixed

Shortage Indicators Show Little Movement, and Direction of Movement Mixed

Shortage Indicator	Mean 2007	Mean 2013	Change in Probable Shortage
Facility would prefer more anesthesiologists to cover current case volume	0.473	0.503	↑
Number of anesthesiologist openings at facility / number of anesthesiologists at facility	0.129	0.279	↑
Elasticity of labor supply	0.353	0.365	↓
Facility could handle more cases if more anesthesiologists were hired	0.354	0.41	↑
Normalized change in real wages	-0.008		↓

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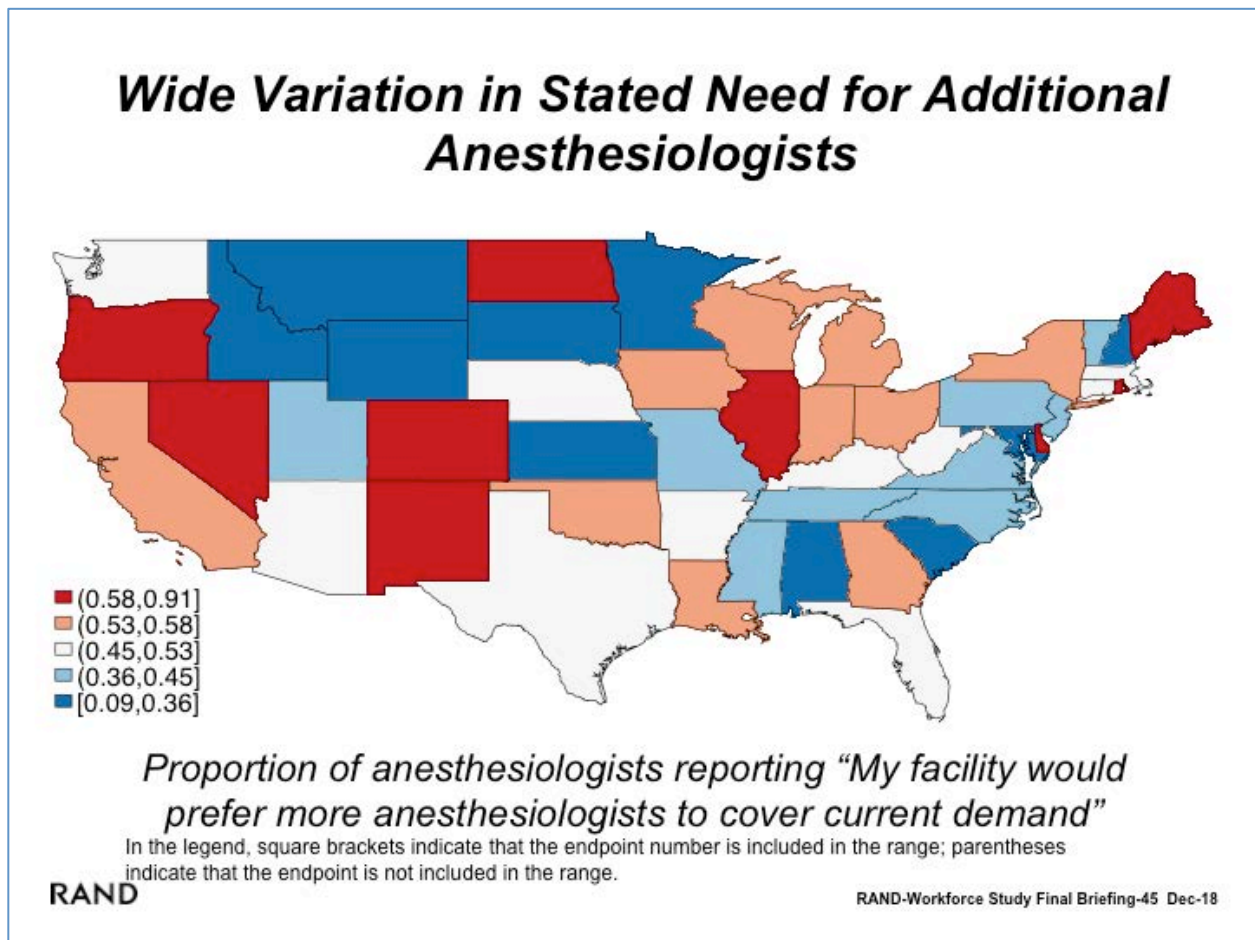
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Overall, we find that trends in shortage indicators over time are mixed. In 2007, nearly half of all anesthesiologists reported that *additional anesthesiologists are needed to meet current demand*, and, by 2013, the proportion of anesthesiologists reporting this need had increased. The item on the need for additional anesthesiologists to meet demand showed similar patterns. Another indicator that demonstrated a potential increase in shortage was the number of anesthesiologist openings as a percentage of all positions. In 2007, approximately one in eight positions was open, on average; by 2013, this proportion of positions open had more than doubled.

Other indicators of shortage indicated that the probability of anesthesiologist shortage had decreased. The elasticity of labor supply is the percentage increase in hours that an anesthesiologist would be willing to provide if wages were increased by 1 percent. Low elasticity of labor supply is likely indicative of a shortage, indicating that anesthesiologists are less likely to increase hours for a given increase in wages. The increase in elasticity provides evidence that shortage is less likely in 2013 than in 2007.

Another indicator of shortage is the change in real wages because wages should increase when anesthesiologists are in shortage and facilities are forced to compete for anesthesiologists by offering higher wages. The fact that real wages have decreased slightly over time indicates that the anesthesiologist workforce may be less likely to be in shortage.

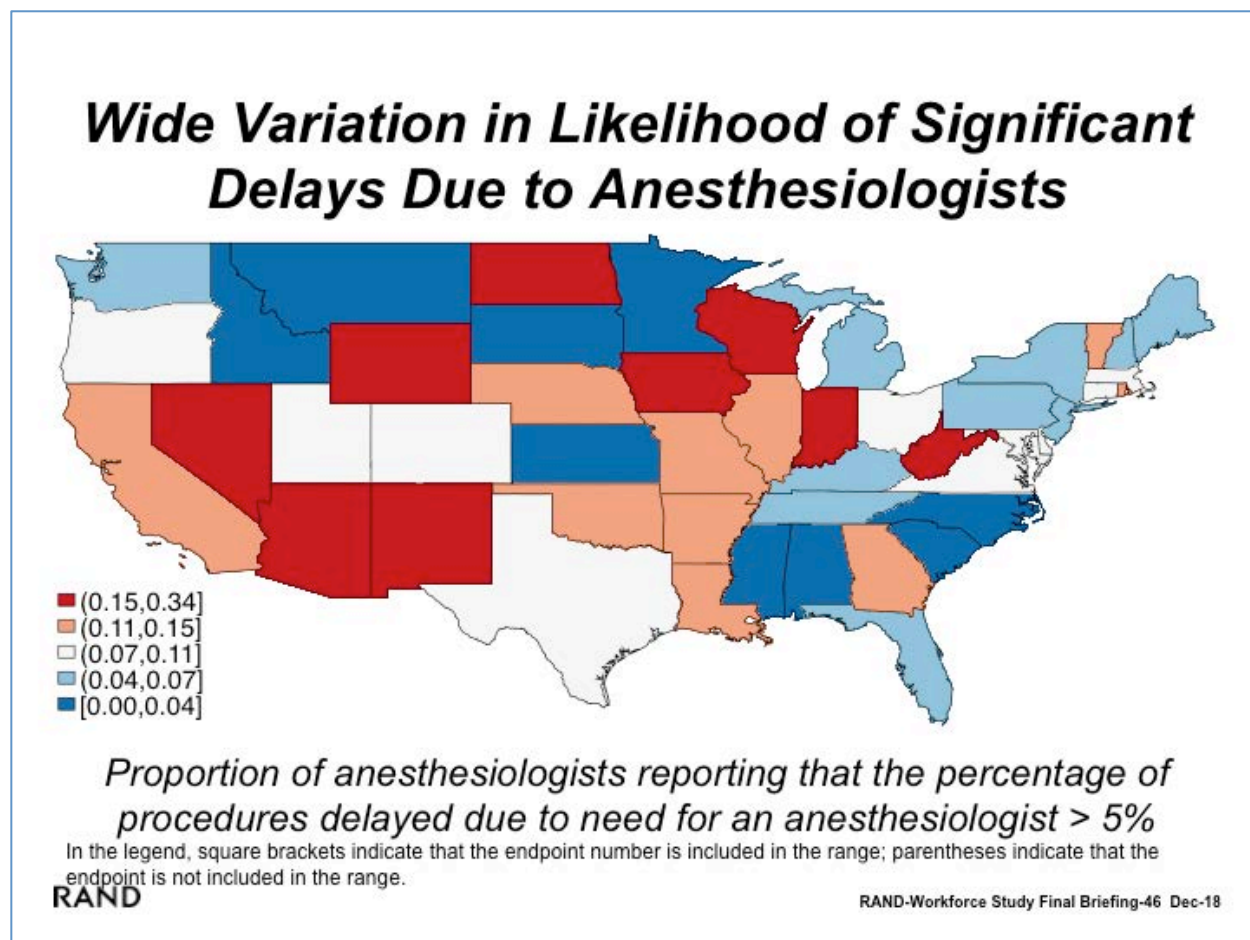
There Is Wide Variation in the Stated Need for Additional Anesthesiologists



We also look at regional variation in shortage. We find wide variation in the percentage of anesthesiologists in different states reporting “My facility would prefer more anesthesiologists to cover current demand.” In one state, 91 percent of anesthesiologists reported this to be true; in another state, only 9 percent of anesthesiologists reported this to be true. The states with higher percentages of anesthesiologists reporting “more anesthesiologists preferred” have a greater probability of being in shortage.

According to this indicator alone, the West and Midwest appear to have the greatest proportions of states in shortage.

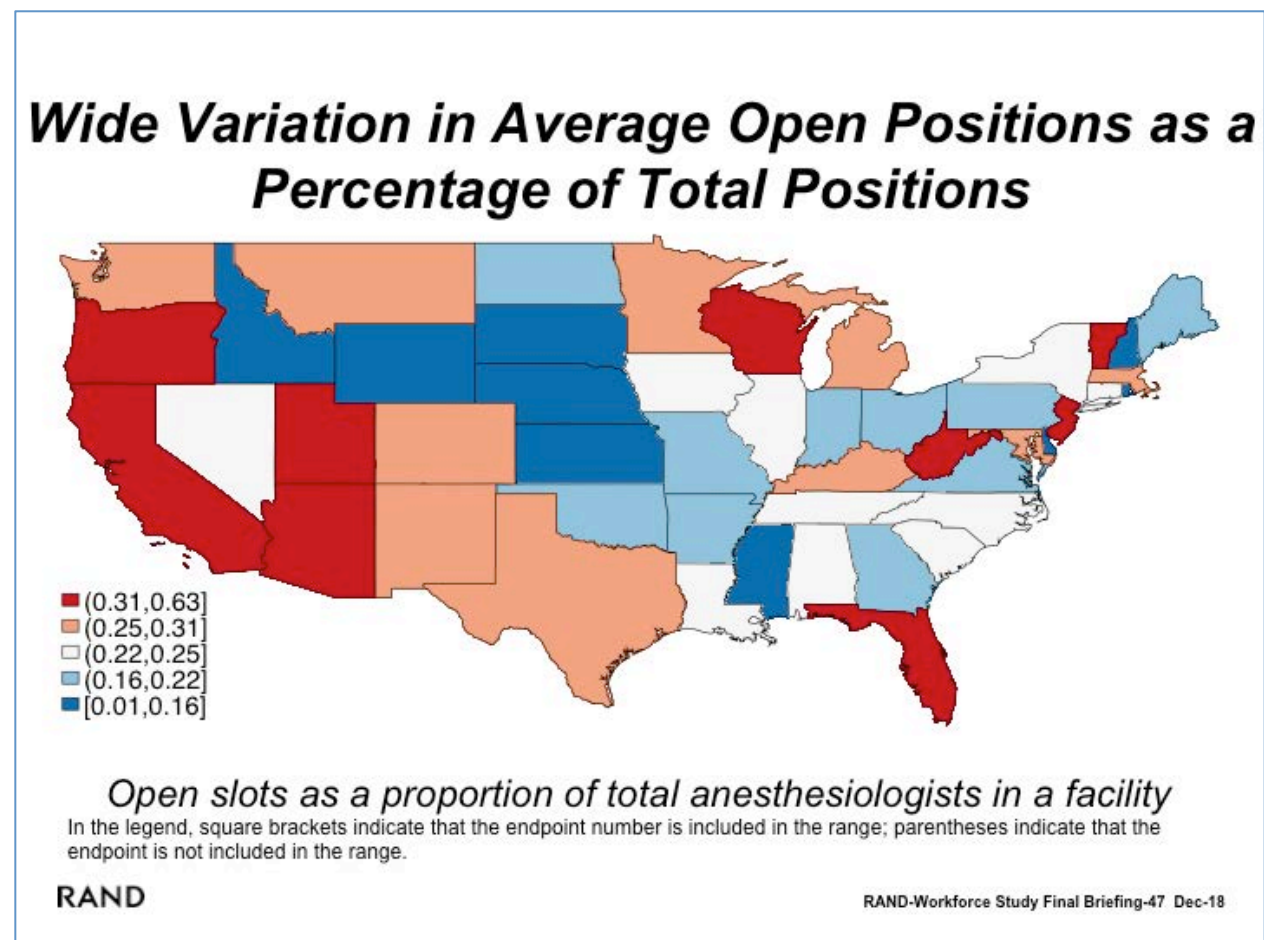
There Is Wide Variation in the Likelihood of Significant Delays Due to a Need for an Anesthesiologist



Another item on the survey asked what percentage of procedures are delayed due to the need for an anesthesiologist. We determined that a delay of more than 5 percent of procedures due to the need for an anesthesiologist may be a sufficient indicator of shortage. We find wide variation in the percentage of anesthesiologists reporting this to be true for their facilities. In one state, more than one-third of anesthesiologists reported this to be true; in another state, none of the anesthesiologists responding to the survey reported this to be true. The states with higher percentages of anesthesiologists reporting “more than 5 percent of procedures delayed due to the need for an anesthesiologist” have a greater probability of being in shortage.

According to this indicator alone, the West and Midwest appear to have the greatest proportions of states in shortage. The Northeast has relatively few states in shortage according to this measure.

There Is Wide Variation in the Average Number of Open Positions as a Percentage of the Number of Total Positions



As previously noted, another indicator of shortage is the number of open positions as a percentage of the number of total positions. We find wide variation in the proportion of positions that are reported to be open. In one state, anesthesiologists report that 63 percent of all positions are open on average; in another state, anesthesiologists report that just 1 percent of all positions are open. The states reporting that open positions account for a greater proportion of positions have a greater probability of being in shortage.

According to this indicator alone, shortages are largely concentrated in the western United States, with a few states in shortage scattered across the other region.

Outline

- **Background and significance**
- **Data and methods**
- **Survey results**
 - **Employment arrangements**
 - **Team care**
 - **Time use**
 - **Indicators of shortage**
- **Econometric analysis**
- **Projections**

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We next summarize our results on our econometric estimation of the shortage of anesthesiologists.

We Use an Econometric Model

- **Labor outcomes depend on labor demand and labor supply in a market**
- **But quantities are jointly decided with prices (wages)**
- **Labor supply: Anesthesiologists will supply more labor when the wage increases**
- **Labor demand: Facilities will demand less labor when the wage increases**

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Labor markets are often assumed to be relatively flexible, with wages adjusting in aggregate to clear the market, and workers receiving close to the value of their marginal product of labor. However, such assumptions are more difficult to defend in the case of highly specialized segments of the labor market, which require years of training and subsequent licensure. Anesthesiologists represent an important example of such exceptions.

In the basic economic model, the output of a good or service and the price of that good are jointly determined as a function of demand for that good or service and the supply of it. In this framework, the service (hours worked by anesthesiologists) is jointly determined with the wage. Labor supply designates the number of total hours (or, analogously, full-time equivalents [FTEs]) that anesthesiologists will be willing to supply in a state at any given average wage. As the wage increases, anesthesiologists will be willing to work more hours on the margin. This may happen either from an increase in the number of anesthesiologists (new residents, delayed retirement, labor-market reentry) or from increased hours worked by some or all already working anesthesiologists. Thus, the labor supply curve will be upward sloping from the positive relationship between wages and hours of anesthesiology supplied.

We Use an Econometric Model

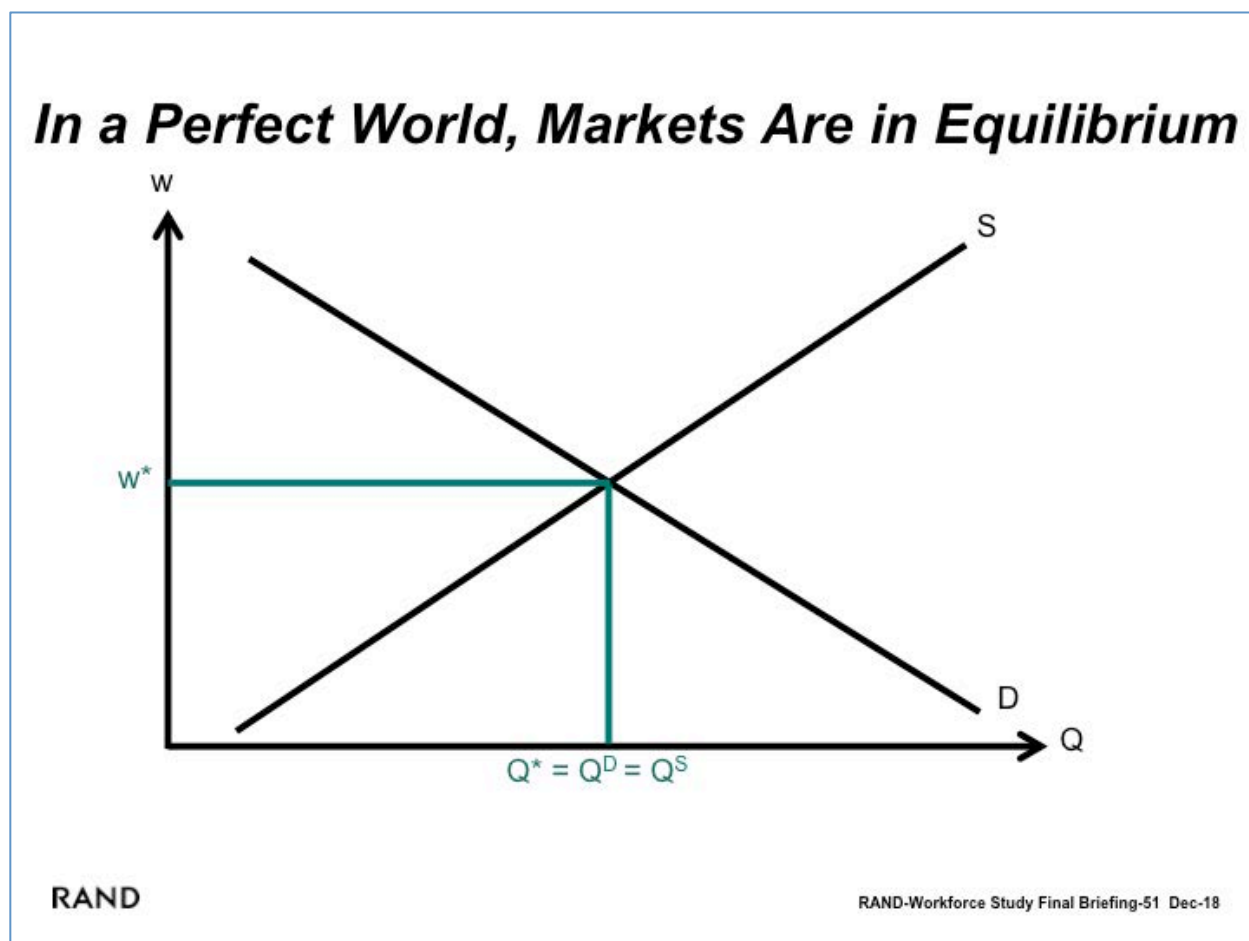
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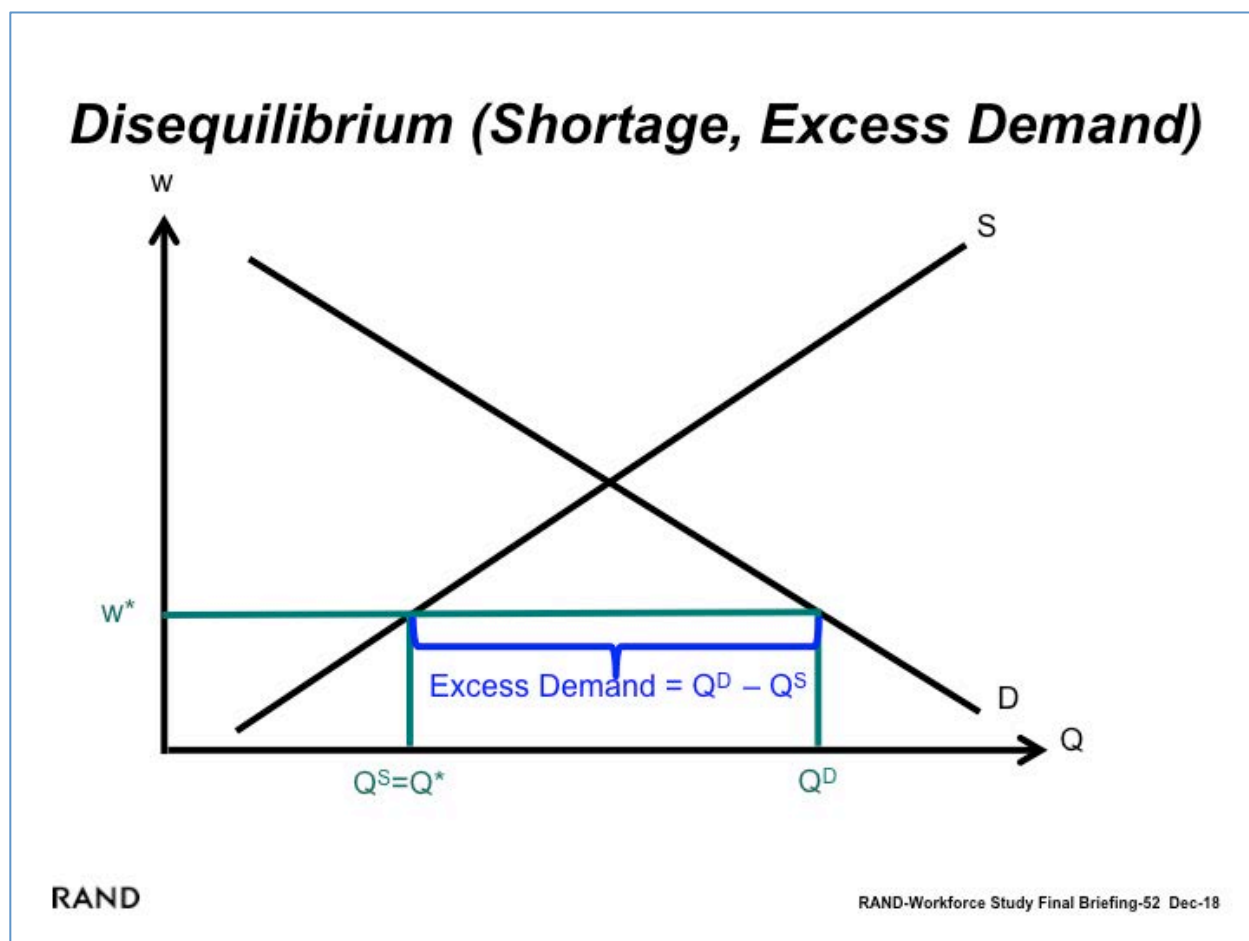
Labor demand designates the number of total hours per FTE that a facility, such as a hospital, will want to have anesthesiologists work at any given wage. As the average anesthesiologist wage increases, facilities will demand fewer hours from the anesthesiologists, and some facilities in opt-out states may substitute nurse anesthetists for anesthesiologists. Thus, the labor demand curve will be downward sloping from the negative relationship between wages and hours of anesthesiology demanded.

In a Perfect World, Markets Are in Equilibrium



When labor markets are perfectly flexible, then, conditional on all of the underlying demand and supply factors, the wage will be such that the market clears, or labor supply equals labor demand. To see why this is the case, imagine that, in a flexible market, the wage is higher than w^* (the market-clearing wage). In that case, supply will exceed demand, and there is a surplus. However, there will be workers willing to work for a lower wage (whether anesthesiologists not working who would like to or anesthesiologists working who would like to work more but are unable) and facilities willing to expand hours at a lower wage. This will put downward pressure on wages because hours of anesthesiology will be requested by facilities and willingly supplied by some portion of the anesthesiologists. The reverse process occurs when wages are below the market-clearing wage w^* . Upward pressure on wages from facilities wanting more hours of anesthesiology that are willing to pay a higher wage will push the wage up. In this perfectly flexible market, the wage will then serve to equilibrate the two curves, such that supply is equal to demand.

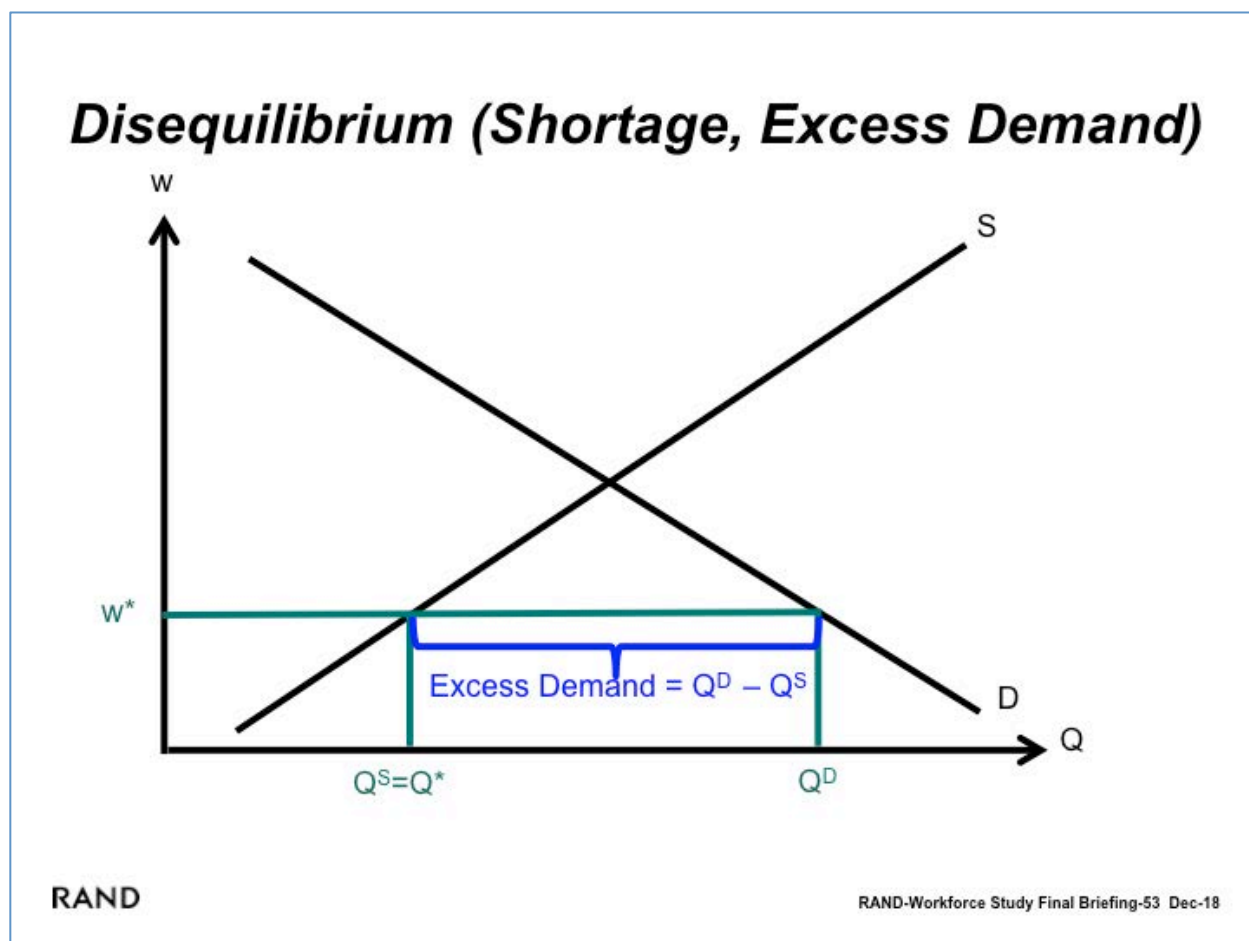
Disequilibrium Occurs When There Is a Shortage, or Excess Demand



However, not all markets are flexible enough to ensure continual market clearing. For the labor market of anesthesiologists, there are market imperfections that can lead to the labor markets (assumed in this analysis to be a state) not clearing at any given point in time. For example, there is a lag with which supply can respond in terms of new anesthesiologists entering; it takes years for a potential anesthesiologist to go through medical school and complete a residency in anesthesiology. Should the market have a demand shock for anesthesiologist services, higher wages will make no difference at the time on that important margin. A similar story might be told for negative demand shocks, a situation in which anesthesiologists may be protected by contracts in the short run. As for current anesthesiologists working, our survey reveals numerous cases in which anesthesiologists were unable or unwilling to increase their numbers of hours, even with any pay increase. Twenty-seven percent of anesthesiologists interviewed responded that they would not increase their hours because they do not have any more time available. Only 36.9 percent said they would be willing to increase their hours if compensation were high enough. When asked why they would not increase hours for any compensation, answers included some personal reasons (family, work-life balance), but also

included were replies of being unable to increase hours because of institutional restrictions, including that they were already operating at the maximum allowed number of hours.

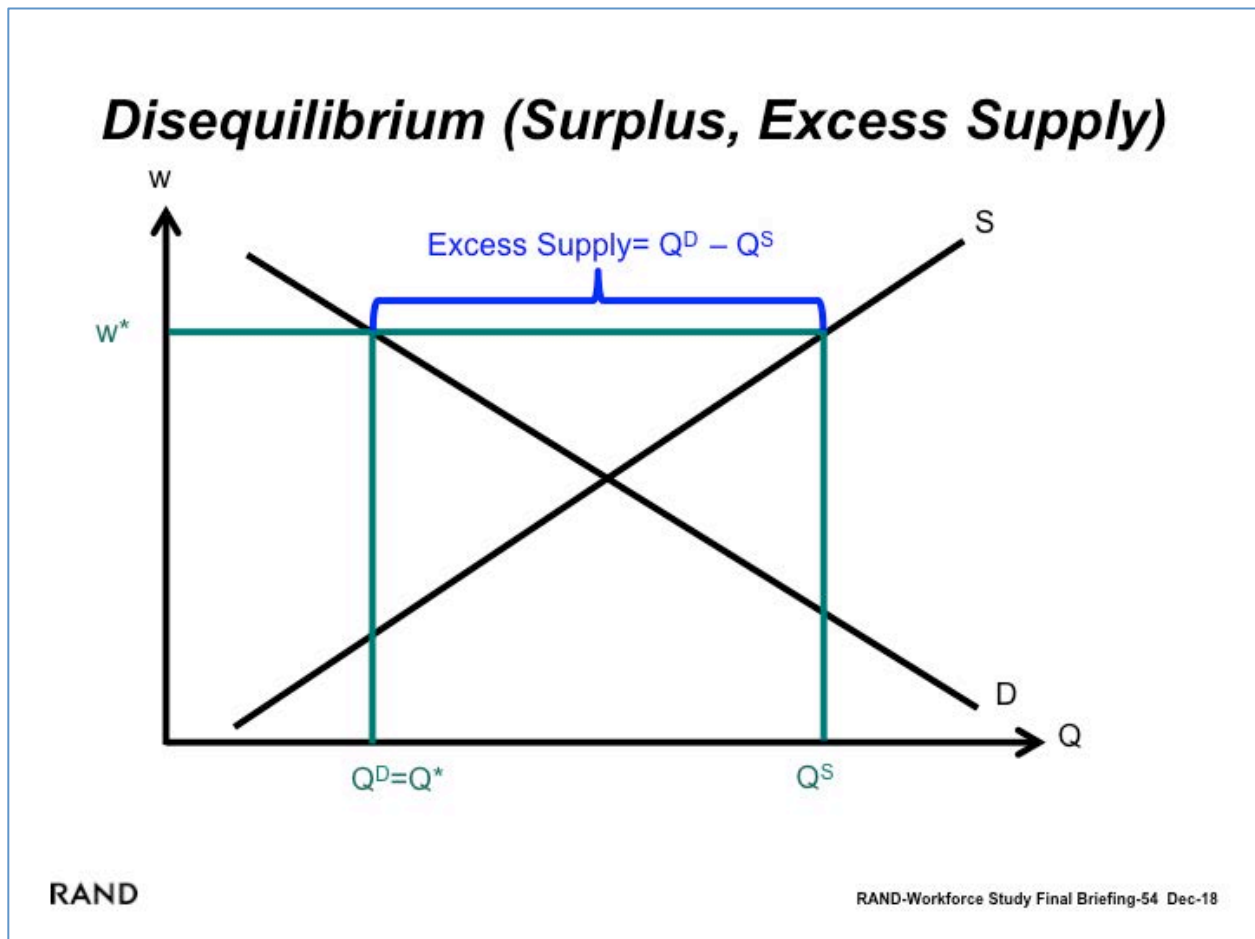
Disequilibrium Occurs When There Is a Shortage, or Excess Demand (continued)



There are also potential barriers to market clearing on the demand side. Hospitals and the medical industry in general perform under heavy regulation. Further, health maintenance organizations (HMOs) and pay-for-service arrangements create wedges between market-clearing wages and what can be offered to anesthesiologists.

As a result, the wage may be such that demand does not equal supply. In the case of a wage below the market-clearing wage, demand will exceed supply and there will be a shortage. The lower wage will induce facilities to hire more anesthesiologists and have them work more hours, but, given the low wage, anesthesiologists are less willing to extend hours worked, and there will be little incentive for nonworking anesthesiologists to start working or for new anesthesiologists to enter. As a result, the quantity demanded, Q^D , will exceed the quantity supplied, Q^S . The constraining factor, as in all cases, will be the minimum of the two, which, in this case, is the quantity supplied. That quantity, Q^* , will be the observed quantity in the state. The excess demand, or shortage, is the number of hours per FTE demanded minus the number supplied.

Disequilibrium Also Occurs When There Is Surplus, or Excess Supply



On the other hand, the wage might, at any given time, exceed the market-clearing wage. This will induce a shortage because anesthesiologists will want to supply more hours, but there will not be sufficient demand at that high wage, in which some facilities will decrease hours demanded and potentially hire less anesthesiologists or switch over entirely to anesthesiologist substitutes (such as nurse anesthetists in opt-out states). The observed quantity will again be the minimum of the two; however, in this case, the minimum is the quantity demanded and not the quantity supplied. The excess supply, or surplus, is the number of hours per FTE supplied minus the number demanded.

We Can Use Indicators to Help Determine Whether in Shortage or Surplus

- **We don't know which states are in shortage or surplus**
- **But we can use shortage indicators available from the survey to help place a probability on whether the state is in shortage**
- **Intuitively, a state that consistently has high values for shortage indicators is more likely to be in shortage than other states**
 - **For that state, the estimation procedure puts more weight on matching the observed quantity with the predicted supply than with demand**
 - **The converse is true for a state with consistently low values for shortage indicators.**

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The problem in estimating the demand and supply functions is the uncertainty of which state is in which situation (shortage, surplus, or equilibrium) and by how much in the case of shortage and surplus. In any given state and year, we observe only the minimum of the two (of demand and supply), without knowing which one it is. Should we know what labor demand *and* labor supply in each market were, we could not only estimate the shortage or surplus but also estimate the demand and supply functions (with wage and all other relevant curve shifters).

However, we may use a series of shortage indicators from our survey to provide insight into the probability that a state in a given year is in shortage or in excess. Aggregating these shortage indicators into one single shortage variable allows us to estimate a probability that a state is in shortage, which we can then use to estimate the demand and supply functions and back out predictions of what the quantity demanded and quantity supplied are in each state and year. The econometric method then searches for the form of the demand and supply functions, which, conditional on observed quantities, wages, and control variables, more closely match the predicted quantity demanded with observed quantity if there is, in that state, a high value for the shortage variable (because we then are predicting that the state is in shortage, so that quantity

demand is the minimum and therefore the quantity observed). The shortage variable serves as a weight for each state and year, which determines whether the observed quantity should more closely match the demand function or the supply function.

The National Shortage Observed in 2007 Has Disappeared, but Regional Shortage Remains

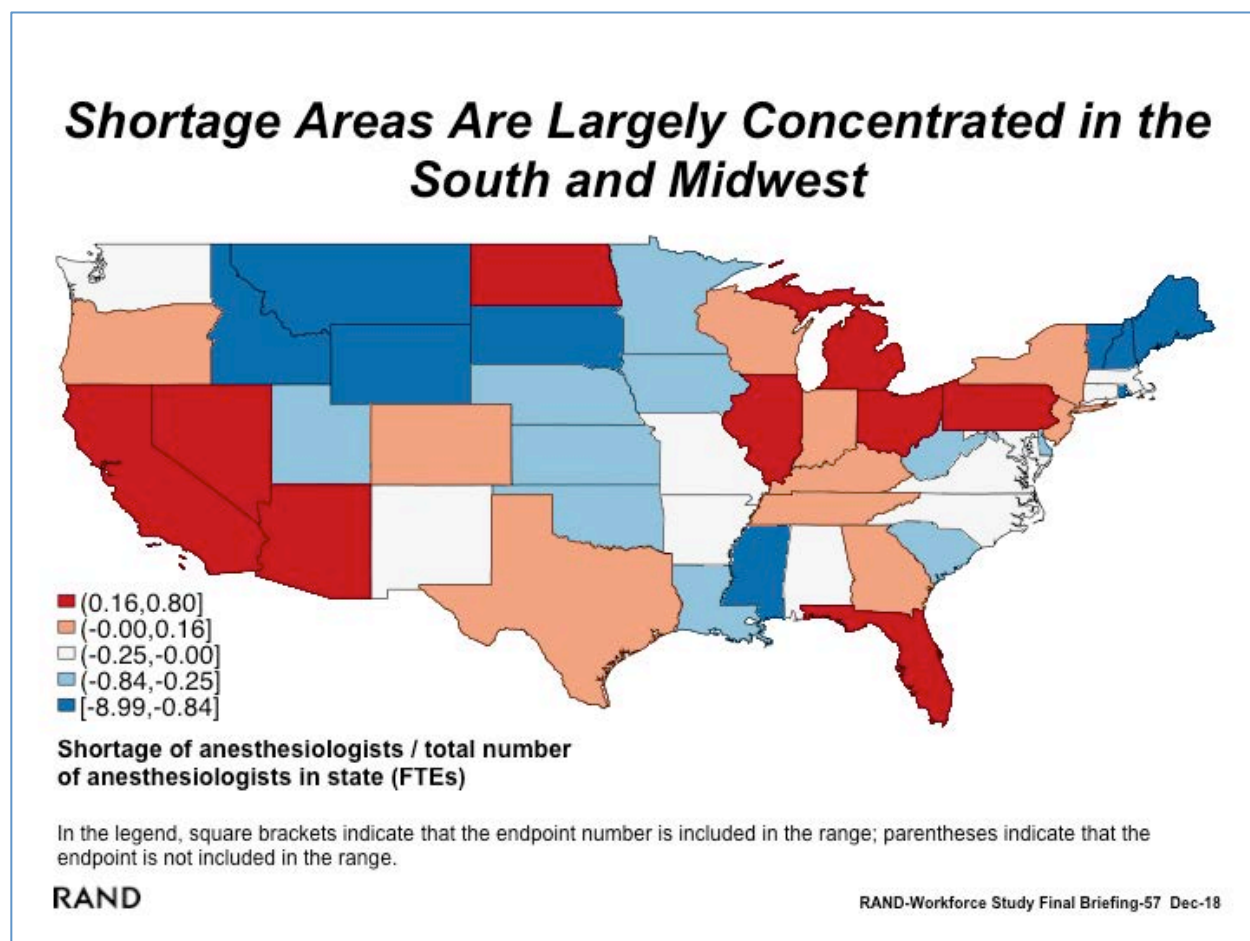
- **Our estimates**
 - **2007: Shortage of 2,023 anesthesiologists**
 - **2013: Surplus of 308 anesthesiologists**
- **Some regions continue to have high likelihood of shortage**

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We estimate this model of disequilibrium using maximum likelihood and a few different strategies to reduce the collection of shortage indicators into one shortage variable. Our best estimate using these models is that, anchoring the national shortage in 2007 at around 2,000 FTE anesthesiologists (aligned with estimates in Schubert, Eckhout, Ngo, et al., 2012); in 2013, that shortage has been erased, and, in effect, there is an equilibrium (a small surplus of around 300 FTE anesthesiologists).

Shortage Areas Are Largely Concentrated in the South and Midwest



However, although we find roughly an equilibrium nationally at present, this does not imply that *each* state is in equilibrium. Instead, we find shortages in the Midwest and West generally, with somewhat fewer states in shortage in the South and Northeast, and a few scattered states roughly at equilibrium. These regional differences and relative rankings were stable across our different estimation procedures.

Results That Are Robust to Various Specifications

- **We tested multiple algorithms and estimation strategies, and while point estimates varied, two results were consistent**
 1. **Excess demand has decreased from 2007 to 2013 by about 1,000–4,000 anesthesiologists**
 2. **Regional variation indicates shortages more common in the Pacific West and Midwest than in the Northeast and Mountain West/Great Plains**

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We have two robust findings that persist across different models and handling of the shortage indicators to arrive at the probability of shortage. First, we find that there has been a decrease in the excess demand (shortage) for anesthesiologists from 2007 to 2013 of a magnitude approximately equal to 1,000 to 4,000 anesthesiologists; our best estimates are a decrease of 2,000. We hypothesize that this is due, in part, to the Great Recession, which would serve both to decrease demand for anesthesiologists (due likely to a decrease in patient demand for elective surgeries and a decrease in demand from facilities as they substitute into other potentially low-cost methods of delivery) and to an increase in supply of anesthesiologists (such as through delayed retirement in the face of the financial crisis).

Second, as previously mentioned, we find consistent regional patterns—namely, that shortages are more persistent in the West and Midwest than the Northeast and Mountain West. These results suggest a need for regional policies to address labor-market imbalance and attempts to increase labor supply mobility.

Outline

- **Background and significance**
- **Data and methods**
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 - Team care
 - Time use
 - Indicators of shortage and future plans
- **Econometric analysis**
- **Projections**

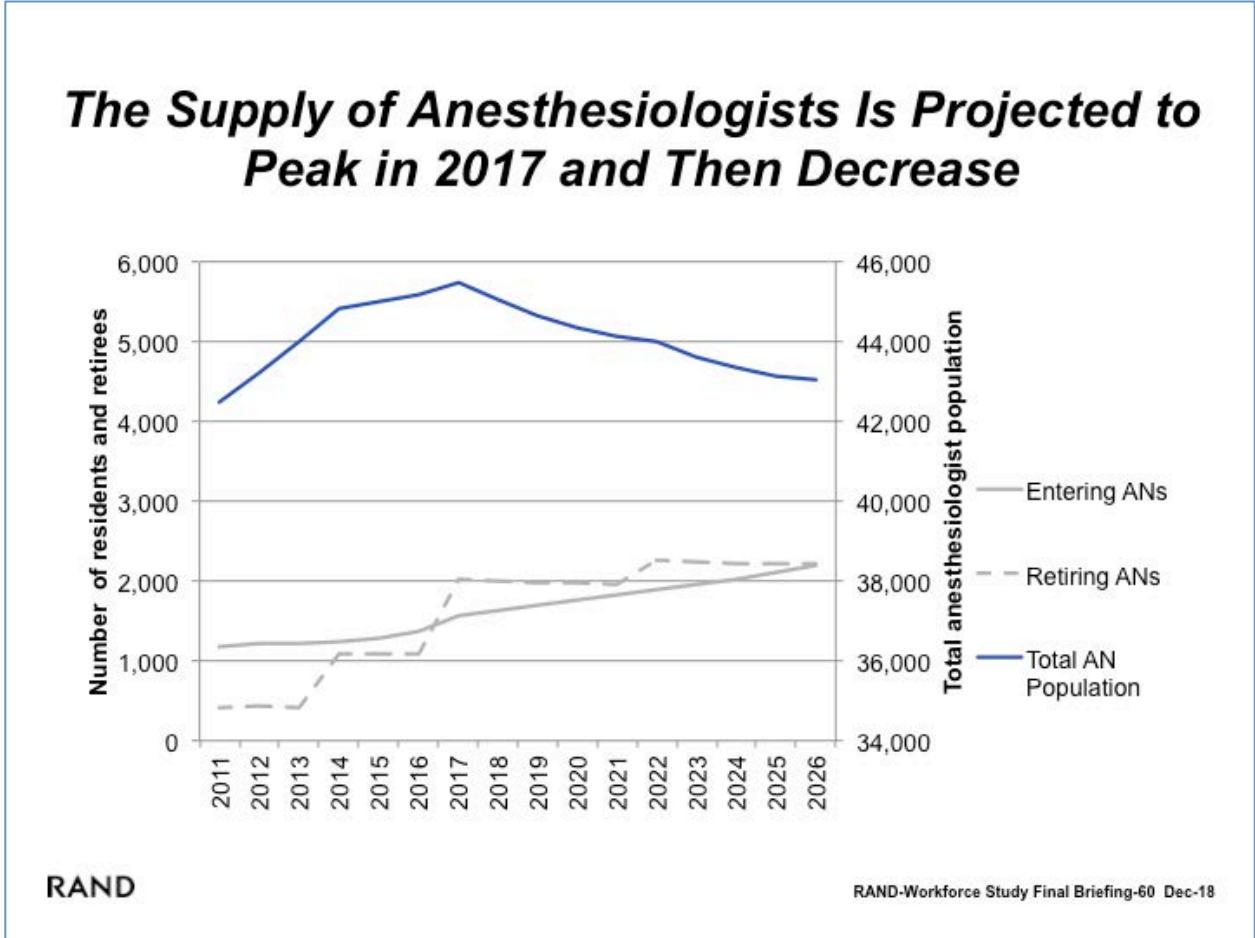
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We next discuss projections for the national shortage or surplus of anesthesiologists until 2025.

Note that we use a simple linear projection of supply and demand to examine the evolution the anesthesiologist labor market. Although we choose parameters for entry and exit anticipating trends, our model cannot account for unexpected events. In this sense, these projections are best viewed as scenarios under various assumptions rather than forecasts.

The Supply of Anesthesiologists Is Projected to Peak in 2017 and Then Decrease



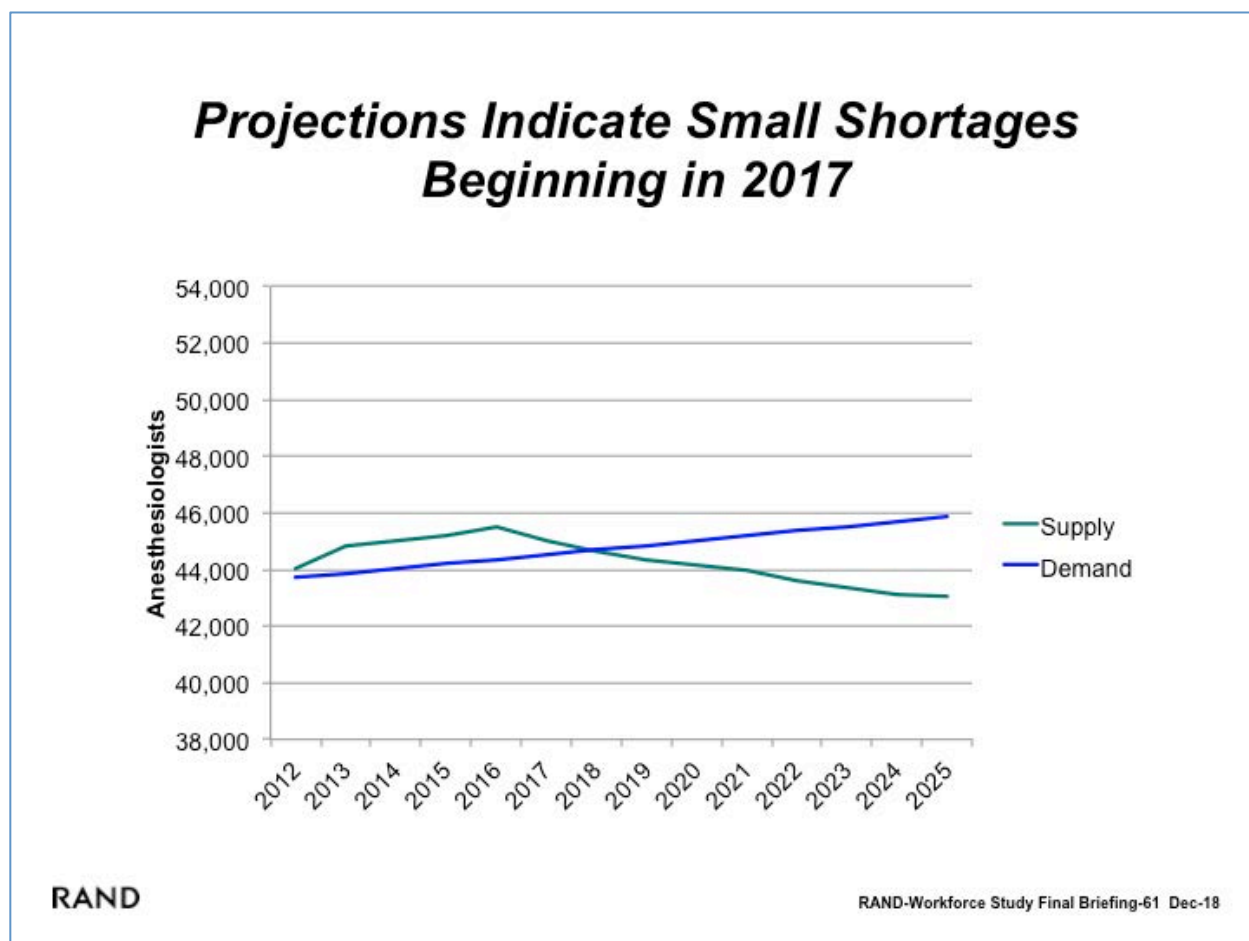
This slide presents the total number of anesthesiologists entering and leaving the workforce, as well as the total supply of anesthesiologists. The number of entering anesthesiologists is based on the number of slots for anesthesiologists that have been filled through the National Resident Matching Program. We assumed a 95-percent completion rate for those entering residencies, so numbers for entering anesthesiologists include 95 percent of slots filled four years prior. To project numbers of entering anesthesiologists beyond 2016, we assume a constant growth rate of 3.76 percent, the rate of growth in anesthesiology residency slots in the past five years.

The number of retiring anesthesiologists is based on an item from the survey. We asked individuals to report their years of planned retirements, with options including this year, 2014 through 2016, 2017 through 2021, 2022 through 2026, and after 2026. Informed by these responses, we calculated expected annual rates of retirement for each year through 2026 and multiplied this by the total anesthesiologist population size.

According to these projections, we see that, through 2016, the number of entering anesthesiologists will outpace the number of retiring anesthesiologists, and the supply of anesthesiologists will increase to nearly 46,000. If residency slots continue to grow at

3.76 percent next year and in years moving forward, the number of retirees will begin to outpace the number of incoming anesthesiologists, and supply will begin to increase. However, even with this decrease in the supply of anesthesiologists after 2016, the number of anesthesiologists in 2026 is projected to be nearly equivalent to the total supply today.

Projections Indicate Small Shortages Beginning in 2017



We then add the demand for anesthesiologists to look at the full picture of the anesthesiologist workforce. We start with the current state of the workforce as estimated through the econometric analysis, a surplus of 308 anesthesiologists. We assume growth in demand equivalent to the ten-year historical rate of growth in surgeries, which is 0.37 percent according to data from the AHRF.

In the short run, we see that the supply of anesthesiologists is projected to increase more quickly than demand, so the anesthesiologist workforce will experience a small surplus. However, by 2018, as retirements increase, demand will surpass supply and the workforce will be in shortage. By 2025, projections indicate that there will be a shortage of approximately 3,000 anesthesiologists.

However, as mentioned earlier, we recommend that these projections should be viewed with caution because they are based on assumptions that may or may not hold true in upcoming years. As described, there are factors that may cause demand, in particular, to shift in ways that are unpredictable using current data. We next present several scenarios under which projections

would look somewhat different as a theoretical exploration of the impact these changes would have on workforce shortage or surplus.

A Few Scenarios Could Lead to Greater Shortage

- **Some trends could increase demand, leading to greater likelihood of shortage**
 - **Older, sicker patients in an aging population**
 - **Increasing coverage rates with the Affordable Care Act**
- **Some trends could decrease supply, leading to greater likelihood of shortage**
 - **Increasing proportion of women who work fewer hours**
 - **Retirement of aging anesthesiologist population**

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A few plausible scenarios could lead to greater shortage than the situation considered above. First, there are trends that may cause demand to increase, which would lead to a greater likelihood of shortages among anesthesiologists (all else equal). One of these trends is the aging of the population. Experts have predicted that, as the population ages and becomes less healthy, the number of needed medical procedures will increase. In addition, the expansion of insurance under recent health care reforms is likely to increase health care consumption among the previously uninsured.

There are also some trends that may lead to decreases in supply, which would lead to an increased likelihood of shortage. We described previously how the movement of women into the anesthesiologist workforce has led to lower average hours, which means lower levels of supply for a given number of anesthesiologists. In addition, the impending retirement of baby boomers means that additional anesthesiologists may be needed to replace retiring anesthesiologists.

A Few Scenarios Could Lead to Greater Surplus

- **Some trends could decrease demand, leading to greater likelihood of surplus**
 - **Cost-cutting efforts**
 - **Shifts toward nonphysician anesthesiology providers**
- **Some trends could increase supply, leading to greater likelihood of surplus**
 - **Growth in residencies at a rate of ~4% (though it is not clear this recent rapid growth will continue)**

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On the other hand, a few scenarios could result in lower shortage, or even a surplus, of anesthesiologists. There are potential trends in health care that may lead to decreases in demand for anesthesiologists, which would lead to a greater likelihood of surpluses (all else equal). For example, pressure to cut costs may lead hospitals to make services more efficient and may reduce the number of procedures performed if some procedures are seen as unnecessary. In addition, there is a movement toward expanding the role of nurses in health care, partially to cut these costs. As facilities shift toward team-care models, they may reduce their demand for anesthesiologists.

There are some trends that may increase supply, which would also lead to an increased likelihood of surplus. In the past five years, residency slots have been increasing at a rate of approximately 4 percent per year, and this has helped to supplement the supply of anesthesiologists. However, the number of residency slots in anesthesiology has been somewhat volatile in the past several decades. National Resident Matching Program data indicate that the number of first-year residency positions declined from 526 in 1981 to 270 in 1988, rebounded to 376 by 1991, hit a low of 248 in 1996, and then climbed steadily to more than 900 positions by

2012. It is not clear, therefore, that we can assume that slots will continue to grow at the rapid rate seen in recent years.

Areas for Future Research

- **Why might certain regions be seeing greater likelihood of shortage?**
- **Is regional variation associated with variation in cost or quality of care?**
- **Why do female anesthesiologists end up with different employers, compensation arrangements, and patients?**
- **What are the implications of the shift in delivery models on demand for anesthesiologists?**

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The research we have presented suggests that the national anesthesiologist workforce is basically in equilibrium, though there are particular regions that may be experiencing shortages or surplus. In addition to regional differences in likelihood of shortage, there are large differences in employment and practice patterns, with the western United States as a particular outlier relative to other regions of the country across a wide range of measures. These regional patterns raise questions about why certain regions may experience greater likelihood of shortage, and answers to them will shed light on how labor-market imbalances may be addressed. In addition, if the variation in practice results in differences in costs or the quality of care, it may be important to learn from this variation to adopt promising practices across the country to improve quality of care while also ensuring that care is delivered efficiently.

In addition, we described the entrance of women into the workforce at a rapid pace, and a shift in the gender mix of anesthesiologists may have implications for the supply of anesthesiologists and may suggest a need for changes in employment arrangements. However, additional research is required to understand why these differences are present in order to properly accommodate these differences.

Finally, an important question facing the anesthesiologist workforce today is the impact that the shift to team care could have on the demand for anesthesiologists. There has been substantial research done on the implications that nonphysician anesthesia care has for quality. However, given the movement toward greater use of team care, it is important to understand how this may affect the anesthesiologist workforce so that residency slots can be adjusted if appropriate. Detailed facility-level surveys of teams may be useful in shedding light on this issue.

Thank you!

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