Hypothesis: The overall supply of general surgeons per 100,000 population has declined in the past 2 decades, and small and isolated rural areas of the United States continue to have relatively fewer general surgeons per 100,000 population than urban areas.

Design: Retrospective longitudinal analysis.

Setting: Clinically active general surgeons in the United States.

Participants: The American Medical Association’s Physician Masterfiles from 1981, 1991, 2001, and 2005 were used to identify all clinically active general surgeons in the United States.

Main Outcome Measures: Number of general surgeons per 100,000 population and the age, sex, and locale of these surgeons.

Results: General surgeon to population ratios declined steadily across the study period, from 7.68 per 100,000 in 1981 to 5.69 per 100,000 in 2005. The overall urban ratio dropped from 8.04 to 5.85 (−27.24%) across the study period, and the overall rural ratio dropped from 6.36 to 5.02 (−21.07%). The average age of rural surgeons increased compared with their urban counterparts, and women were disproportionately concentrated in urban areas.

Conclusions: The overall number of general surgeons per 100,000 population has declined by 25.91% during the past 25 years. The decline has been most marked in urban areas. However, more remote rural areas continue to have significantly fewer general surgeons per 100,000 population. These findings have implications for training, recruiting, and retaining general surgeons.


General surgeons play a pivotal role in the health care systems of the United States, particularly in rural areas. They provide surgical backup to rural primary care physicians, ensure the success of rural trauma systems, and contribute to the financial viability of small rural hospitals. Urban general surgeons also provide important surgical services, including emergency and trauma care that some surgical subspecialists may not offer. There is some question as to whether there will be an adequate number of general surgeons to care for an increasingly elderly population, with its attendant increased demand for surgical care.

Recent studies have indicated that the overall number of general surgeons has remained static since 1994, despite an increase in population of 1% per annum during this period. This fact, coupled with the rise in surgical specialization, the decreased interest of medical students in general surgical careers, and the changes in demographics of medical students and surgery residents, has generated concern that there will soon be a shortage of general surgeons. Recent publications by the Institute of Medicine and the American College of Surgeons attest to staffing and availability problems of general, and other, surgeons for emergency services. Our study group found that the general surgeon to population ratio in the more remote rural areas of the United States was almost half that of urban areas. The present study builds on this previous work by adding a longitudinal dimension and describing the trends in the number, distribution, and characteristics of general surgeons in the United States during the 25 years from 1981 to 2005, with particular emphasis on surgeons in small and isolated rural areas.
isolated rural areas. Examination of such trends is crucial to predicting and addressing future workforce problems.

**METHODS**

**PHYSICIAN DATA**

Data from the American Medical Association (AMA) Masterfile from 1981, 1991, 2001, and 2005 were used to identify the population of active general surgeons in each year. The AMA Masterfile contains information on all allopathic and osteopathic physicians in the United States, including international medical graduates (IMGs), who are licensed to practice medicine in at least 1 state. Membership in the AMA is not a requirement for inclusion. Throughout a physician's career, data are collected on medical school, residency, licensure, and board certification. Professional activity data are updated regularly via survey.19 General surgeons were defined as physicians who listed their primary specialty as general surgery, abdominal surgery, trauma surgery, or critical care. In addition to the specialty criteria, we included only surgeons who reported their major professional activity as office-based practice, hospital staff, or locum tenens. A final requirement for inclusion was that the surgeon be 62 years or younger during the study year. This requirement was based on the average age of retirement reported by the Fellows of the American College of Surgeons.20 Surgical residents were excluded from the study. This definition of active, nonresident surgeons is similar to the “minimum scenario” calculation used by Jonasson et al19 and identical to the one used by Thompson et al,21 except that federal surgeons are included in the present study.

**LOCATION CLASSIFICATION**

To classify the location of each surgeon, a county-level definition of rural and urban status was applied to the address (assumed to be a work address) of each physician. We chose a county-level urban-rural taxonomy, the Urban Influence Codes (UICs), based on data from the middle of the study period (1990 Census data) and applied it to the data from all study years.21-23 The UIC scheme was developed by the Economic Research Service of the US Department of Agriculture based on 1990 Census data. The UICs classify every county in the United States into 1 of 9 categories. For this study, the 9 categories were aggregated into 4. Categories 1 and 2 represent counties in metropolitan areas as defined by the Office of Management and Budget and were collapsed into a single category in this study called “urban.” Categories 3 through 6 represent counties that are physically adjacent to metropolitan counties and where there is at least 2% of intercounty commuting for work. These counties were grouped into a category called “adjacent rural” for this study. Category 7 counties are not adjacent to metropolitan counties and contain at least 1 large city of 10,000 to 50,000 residents. These counties are referred to as “large nonadjacent.” Finally, nonadjacent counties whose largest cities have fewer than 10,000 residents are classified as category 8 or 9. In this study, they are combined into a category called “small nonadjacent.”

**DATA ANALYSIS**

Demographic characteristics of the surgeon population in each study year are reported, including sex, age, IMG status, and board certification. Surgeons were considered to be IMGs if they graduated from a medical school outside of the United States or Canada. To examine changes in the supply of surgeons, county-level population data were collected from the Area Resource File24-25 for each of the study years and were linked to the AMA data to calculate surgeon to population ratios for each of the aggregated UIC categories across the nation. Surgeon to population ratios for 2005 are based on county population estimates for 2004 because 2005 estimates were unavailable. Actual changes in surgeon to population ratios (given as surgeons per 100,000 population) are shown along with the percentage change in those ratios between 1981 and 2001.

Although data from the AMA Masterfile constitute a virtual census of the general surgeons in the United States in each of the study years, confidence intervals (CIs) were calculated for the proportions and surgeon to population ratios given in the tables to facilitate comparisons across years. In the case of population proportions (eg, percentage female), 95% CIs for proportions were calculated. No finite population correction factor was used, which would have narrowed CIs. The 95% CIs for surgeon population ratios were calculated using bootstrapped estimates of the standard error of county-level surgeon to population ratios.26 The University of Washington’s institutional review board/human subjects review committee approved this study.

**RESULTS**

**OVERALL DEMOGRAPHY AND DISTRIBUTION OF GENERAL SURGEONS**

During the study period, the overall number of active general surgeons fluctuated from 17,394 in 1981 to a high of 17,922 in 2001 to a low of 16,662 in 2005 (Table 1). Although general surgery remains a predominantly male specialty, the proportion of women in the specialty increased substantially across the study period from 1.4% (95% CI, 1.2%-1.6%) of active general surgeons in 1981 to 13.4% (95% CI, 12.9%-13.9%) in 2005. The proportion of surgeons younger than 40 years dropped substantially from 25.1% (95% CI, 24.5%-25.7%) in 1981 to 16.2% (95% CI, 15.6%-16.8%) in 2005. In 2005, 46.2% (95% CI, 45.4%-47.0%) of active general surgeons were 50 to 62 years of age compared with 41.7% (95% CI, 41.0%-42.4%) in 1981. The proportion of general surgeons who were IMGs decreased from 26.7% (95% CI, 26.0%-27.4%) to 17.4% (95% CI, 16.8%-18.0%).

At the national level, the overall rural vs urban distribution of general surgeons remained stable across the study period, with approximately 82% of general surgeons practicing in urban areas and 18% in rural areas. Although the age profiles of rural and urban surgeons were similar in 1981, by 2005 rural areas had experienced a greater decrease in the proportion of general surgeons younger than 40 years (from 24.5% [95% CI, 23.0%-26.0%] to 13.6% [95% CI, 12.3%-14.9%]) than urban areas (from 25.2% [95% CI, 24.5%-25.9%] to 16.8% [95% CI, 16.2%-17.4%]). In addition, the increase in the proportion of general surgeons 50 to 62 years of age during this period was greater in rural areas (from 39.5% [95% CI, 37.8%-41.2%] to 52.0% [95% CI, 50.2%-53.8%]) than in urban areas (from 42.2% [95% CI, 41.4%-43.0%] to 45.1% [95% CI, 44.3%-45.9%]).
The relative number of general surgeons in the United States has fallen by 25.91% since 1981. There are several factors besides population increase that may explain this phenomenon. The number of chief surgical residents finishing their training and entering practice has remained static at approximately 1000 per year since 1980.27 This may be because the Residency Review Committee for Surgery has been more conservative than other specialties in approving new general surgery positions. Moreover, the Balanced Budget Act of 1997 froze the number of federally funded residency positions. Furthermore, the proportion of general surgical residents who go on to pursue fellowship training has increased from approximately 55% to greater than 70% since 1992.28 The increasing number of surgical subspecialists may eventually displace general surgeons, and technological changes may eventually reduce the scope of practice of general surgeons in the United States, 1981 to 2005

The 4.2% decrease in the absolute number of general surgeons occurred in conjunction with population growth in the United States from 226 to 292 million between 1981 and 2005. As a result, the national general surgeon to population ratio declined by 25.91%, from 7.68 (95% CI, 7.14-8.23) per 100 000 in 2005, a 15.97% decrease. Small nonadjacent counties had the fewest surgeons per 100 000 population in 1981 and 2005 and experienced a 16.31% decline (from 5.15 [95% CI, 4.75-5.55] to 4.31 [95% CI, 3.94-4.69]) during that period.


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<tbody>
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<td>Sex</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>M</td>
<td>88.1 (87.6-88.7)</td>
<td>11.9 (11.4-12.4)</td>
<td>88.1 (87.6-88.7)</td>
<td>11.9 (11.4-12.4)</td>
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<td>F</td>
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<td>11.9 (11.4-12.4)</td>
<td>88.1 (87.6-88.7)</td>
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<tr>
<td>40-49</td>
<td>37.8 (37.0-38.6)</td>
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<td>50-62</td>
<td>41.1 (40.3-41.9)</td>
<td>47.5 (45.8-49.2)</td>
<td>41.1 (40.3-41.9)</td>
<td>47.5 (45.8-49.2)</td>
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<tr>
<td>Graduate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States or Canada</td>
<td>78.2 (77.5-78.9)</td>
<td>81.9 (80.6-83.2)</td>
<td>78.2 (77.5-78.9)</td>
<td>81.9 (80.6-83.2)</td>
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<tr>
<td>Board certified in GSa</td>
<td>94.8 (94.4-95.2)</td>
<td>97.6 (97.0-98.2)</td>
<td>94.8 (94.4-95.2)</td>
<td>97.6 (97.0-98.2)</td>
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<tr>
<td>Missing board certification data</td>
<td>19.3</td>
<td>20.7</td>
<td>19.3</td>
<td>20.7</td>
</tr>
</tbody>
</table>

Abbreviations: GS, general surgery; IMG, international medical graduate.

a Data are given as percentage (95% confidence interval).
b Among individuals for whom data are available.

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general surgeons, but there is no evidence that either of these factors is responsible for the recent relative decline in the number of general surgeons.

We speculate that the greater relative decline in numbers of general surgeons in urban areas and the areas adjacent to urban areas compared with larger and small rural areas may be a result of health maintenance organization (HMO) penetration and the numbers of surgical subspecialists. Urban areas have higher rates of market penetration by HMOs, which tend to employ fewer general surgeons per 100,000 patients than are found in areas where there are no HMOs. In addition, surgical subspecialists are disproportionately concentrated in urban areas because these are the only settings that can support their numbers. Nonmetropolitan/rural counties adjacent to urban areas also experienced a rate of decline similar to urban areas, probably because the population of these areas receive most of their care in the adjacent urban centers and are affected by similar trends. Large nonadjacent rural areas experienced the lowest rate of decrease, probably because these regions have a lower penetration of HMOs and fewer surgical subspecialists but often have medical centers large enough to support a larger referral base of primary care providers and a variety of medical specialists (ie, gastroenterologists, radiologists, and oncologists) who support a wider scope of practice for a larger number of general surgeons. Small nonadjacent counties experienced a rate of decline similar to the large nonadjacent counties. Note, however, that the small nonadjacent counties have the fewest number of surgeons per 100,000 population and lower levels of geographic access to surgical services than urban residents. Indeed, in some of these areas there is only 1 general surgeon for 30,000 people, and many small towns have no surgeon.

Does the decline in the supply of general surgeons that we report signify a shortage of providers of general surgical services and a concomitant decrease in access to surgical care? Defining health workforce shortages is difficult, locale specific, and subjective. Defining and measuring adequate access to surgical care is even more difficult. It is clear, however, that the effects of the decline in the general surgical workforce will differ across rural and urban settings. In urban and surrounding areas, it is possible that increased HMO efficiencies (eg, using relatively fewer surgeons than private practice norms) and increasing provision of general surgical care by surgical subspecialists will avoid any reduction in surgical services resulting from the decreased number of general surgeons. The issue remains, however, of who will take general surgical call, particularly at night, for abdominal emergencies and trauma because some surgical subspecialists (although qualified as general surgeons) seek to avoid this burden, which is bound to increase as the population ages. Although smaller rural areas experienced the smallest decline in numbers, the implications of even small decreases in general surgeons in these areas cannot be underestimated. Our previous study showed that there are often one-third to one-half fewer general surgeons in smaller rural areas than in urban areas. The fact that their demographics increasingly suggest that they are not being replaced by younger general surgeons tends to support the claim that there is an impending “crisis” in small nonadjacent or isolated rural areas. In addition, more recently qualified general surgeons who go into rural practice may not have the broad surgical capability of their predecessors (ie, the ability to perform orthopedic, gynecologic, and obstetrical procedures, etc) due to the more restricted nature of modern general surgical training. It will probably take more than 1 surgeon to replace such retiring “omnisurgeons.” Finally, in the era of growing concerns about the work-life balance, some rural surgeons already report difficulty in recruiting new colleagues to their practices, where call is more frequent and the caseload is greater.

Data used in this study are subject to several potential limitations. Defining rural and urban locations across a 25-year period in the United States presents some challenges given the dramatic growth of the population during that time. We chose a single, county-based definition from the early 1990s and applied it across the period from 1981 to 2005 to facilitate comparison of the relative numbers of general surgeons across time. Any misclassification that might occur with this method would tend to slightly underestimate the supply of rural sur-

Table 2. Numbers of General Surgeons and General Surgeon to Population Ratios by Location Category, 1981-2005

<table>
<thead>
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<tbody>
<tr>
<td>Surgeons, No.</td>
<td>Ratio (95% CI)b</td>
<td>Surgeons, No.</td>
<td>Ratio (95% CI)b</td>
<td>Surgeons, No.</td>
</tr>
<tr>
<td>Overall US</td>
<td>17,394</td>
<td>7.68 (7.44-7.91)</td>
<td>17,757</td>
<td>7.04 (6.79-7.29)</td>
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<tr>
<td>Urban</td>
<td>2,840</td>
<td>8.04 (7.76-8.33)</td>
<td>3,146</td>
<td>7.31 (7.01-7.62)</td>
</tr>
<tr>
<td>Rural</td>
<td>14,554</td>
<td>6.36 (6.12-6.60)</td>
<td>14,611</td>
<td>5.69 (5.78-6.20)</td>
</tr>
<tr>
<td>Adjacent rural</td>
<td>1,603</td>
<td>5.97 (5.69-6.25)</td>
<td>1,523</td>
<td>5.38 (5.12-5.65)</td>
</tr>
<tr>
<td>Small nonadjacent</td>
<td>671</td>
<td>5.15 (4.75-5.55)</td>
<td>700</td>
<td>5.45 (5.06-5.82)</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.

a See the “Location Classification” subsection in the “Methods” section for definitions of the categories.
b Number of general surgeons per 100,000 population.

c Alaska is not included in the overall US rural and urban counts and ratios, 1981 and 1991.
Surgeons in the 1980s (when fewer counties were considered urban) and slightly overestimate the supply of rural surgeons in 2001 and 2005 (when more counties were considered urban). We assumed that each address listed in the AMA data was a practice address. Therefore, surgeons who resided and practiced in different counties could have been misclassified with respect to the rural vs urban status of their county of practice. This also discounts the effect of “itinerant” surgeons (ie, urban-based surgeons who provide surgical services in rural areas a few days per month). We chose a definition of general surgeons that could be reasonably applied across a 20-year period, and that was consistent with previously published research.9,11 The exclusion of residents, surgeons older than 62 years, and subspecialists who may provide some general surgical services may underestimate the general surgeon supply. Finally, note that this is a study of the availability of general surgeons at various geographic levels, not the utilization of surgical services. Patients may choose to travel to nonlocal settings for surgery regardless of whether the service is available locally.

The 25% reduction in the relative number of general surgeons in the United States that we report suggests that the United States may be facing a severe shortage of general surgeons. The US medical system has shown the ability to adjust to changing workforce demands by increased use of IMGs and “physician extenders,” including nurse practitioners, physician assistants, and other non-physician health care providers.37-49 However, none of these practitioners or phenomena will completely fill the vital role currently filled by the general surgeon in the nation’s health care system.20 Surgeons, their professional organizations, and the entities that control the number of general surgeons trained annually need to consider ways to address the decline in the supply of general surgeons. These might include increased funding of residency positions, and exploring and addressing the issues surrounding training, remuneration, and lifestyle that seem to have made general surgery less attractive than other specialties to medical students, especially women. Finally, given that rural communities are particularly dependent on the services provided by general surgeons, medical schools and surgical residencies should seek to ensure that general surgical residents are sufficiently exposed to rural surgical practice through rural training tracks and rural-based residencies.41,50,51 A growing and aging population, especially in rural areas, will continue to require a workforce of well-trained general surgeons who can provide a wide spectrum of surgical services.

Accepted for Publication: April 17, 2007.
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Author Contributions: Dr Christian Lyne had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Christian Lyne, Larson, Thompson, Rosenblatt, and Hart. Acquisition of data: Larson and Hart. Analysis and interpretation of data: Christian Lyne, Larson, Thompson, Rosenblatt, and Hart. Drafting of the manuscript: Christian Lyne, Larson, and Thompson. Critical revision of the manuscript for important intellectual content: Christian Lyne, Larson, Thompson, Rosenblatt, and Hart. Statistical analysis: Larson and Hart. Administrative, technical, and material support: Christian Lyne, Larson, Rosenblatt, and Hart. Study supervision: Christian Lyne and Thompson.

Financial Disclosure: None reported.

Funding/Support: This study was supported by the Washington-Wyoming-Alaska-Montana-Idaho Rural Health Research Center in the School of Medicine at the University of Washington.

Additional Contributions: Martha Reeves, BS, of the Washington-Wyoming-Alaska-Montana-Idaho Rural Health Research Center assisted with manuscript preparation.

REFERENCES


