

# Characterizing the General Surgery Workforce in Rural America

Matthew J. Thompson, MBChB; Dana Christian Lynge, MD; Eric H. Larson, PhD; Pantipa Tachawachira, PhD; L. Gary Hart, PhD

**Background:** General surgeons form a crucial component of the medical workforce in rural areas of the United States. Any decline in their numbers could have profound effects on access to adequate health care in such areas.

**Hypothesis:** We hypothesize that the rural areas of the United States are relatively undersupplied with general surgeons.

**Design and Setting:** The American Medical Association's Physician Masterfile was used to identify all clinically active general surgeons as well as their locations and characteristics. Their geographic distribution was examined using the ZIP code version of the Rural-Urban Commuting Areas. Surgeons were classified as practicing in urban areas, large rural areas, or small/isolated rural areas.

**Results:** There are currently 17243 general surgeons practicing in the United States. Nationally, the number

of general surgeons per population of 100 000 varies from 6.53 in urban areas to 7.71 in large rural areas and 4.67 in small/isolated rural areas. Only 10.6% of the nation's general surgeons are female. Wide variations in numbers of general surgeons were found between and within individual states. General surgeons in the smallest rural areas are more likely than those in urban areas to be male (92.7% vs 88.3%,  $P < .001$ ), 50 years of age or older (51.6% vs 42.1%,  $P < .001$ ), or international medical graduates (25.2% vs 20.1%,  $P < .001$ ).

**Conclusions:** The overall size of the rural general surgical workforce has remained static over the last decade, but its demographic characteristics suggest that numbers will decline. Many rural residents have limited access to surgical services. Steps to reverse this trend are needed to preserve the viability of health care in many parts of rural America.

*Arch Surg.* 2005;140:74-79

## Author Affiliations:

Departments of Family Medicine (Drs Thompson, Lynge, Larson, and Hart) and Surgery (Dr Lynge), Washington, Wyoming, Alaska, Montana, Idaho (WWAMI) Rural Health Research Center (Drs Larson and Hart), and School of Business Administration (Ms Tachawachira), University of Washington, Seattle. Dr Thompson is currently affiliated with the Department of Primary Health Care, University of Oxford, Oxford, England.

**G**ENERAL SURGEONS ARE A crucial component of the health care workforce in rural America. A 1993 conference on rural health care, sponsored by the University of Alabama, concluded that the presence of a general surgeon was a requirement for adequate health care in the rural setting. General surgeons provide essential support for rural family physicians by performing emergency surgeries and critical care services. Additionally, where other specialists are unavailable, they often perform necessary obstetrical, gynecological, orthopedic, and endoscopic procedures. The presence of general surgical services has been shown to be critical to the financial viability of rural hospitals and the success of rural trauma systems.<sup>1-5</sup> Indeed, in many smaller hospitals, general surgery is the second most common specialty after family practice.<sup>6</sup> Given the importance of general surgeons to rural health care, determining their numbers relative to the populations they serve and detecting any

significant trends are essential to ensuring an adequate supply in rural areas.

Although there are few prior estimates of the number of rural general surgeons per se, workforce studies from the mid-1990s estimated that there were between 17 000 and 23 000 general surgeons in the United States, depending on

*CME course available at*  
[www.archsurg.com](http://www.archsurg.com)

the data sources and definitions of general surgeons used.<sup>7,8</sup> However, it is likely that both the overall number of general surgeons and their number in rural areas have declined. First, the general surgery workforce, particularly in rural areas, appears to be aging. A study in rural Missouri, for example, noted that almost half of the general surgeons were within a decade of retirement.<sup>9</sup> Second, the interest of graduating US medical students in general surgery careers, as reported in graduation questionnaires, has declined since the early 1980s.<sup>10</sup> Finally, the proportion of

general surgery residency graduates selecting rural practice declined from 20% in the late 1970s to 13% in the mid-1980s.<sup>8,11</sup> Recognizing this decline in rural general surgeons, the Council on Graduate Medical Education suggested ameliorative policies,<sup>12</sup> including increased attention to residencies that promote rural practice and prepare general surgeons for it.

General surgeons face mounting challenges in rural areas as a result of rural hospital closures, changing referral patterns, increasingly tight reimbursement policies, difficulties with recruitment because of lifestyle issues, and other factors—leading some to describe rural surgery as facing a “crisis.”<sup>13</sup> We report here on the current state of the general surgery workforce in the United States, with particular emphasis on the characteristics and distribution of surgeons in rural areas.

## METHODS

We used the 2001 American Medical Association (AMA) Physician Masterfile data set, which contains information on all 771 491 nonfederal allopathic and osteopathic physicians in the United States, with names omitted. We identified general surgeons on the AMA data set based on the primary specialty listed. We included only surgeons who listed their primary specialty as general surgery, abdominal surgery, trauma surgery, or critical care. We only included surgeons if they were clinically active, namely, if they reported their major professional activity as one of office-based practice, hospital staff, or locum tenens. We excluded physicians in residency training because the purpose of this study is to examine the practice locations of general surgeons who form part of the permanent physician workforce. Finally, we only included general surgeons aged 62 years or younger, based on the average age of retirement of Fellows of the American College of Surgeons.<sup>14</sup> This definition of clinically active, nonresident general surgeons was identical to the minimum scenario calculation used by Jonasson et al,<sup>8</sup> except that they included only those surgeons younger than 62 years of age.

The AMA Masterfile lists a ZIP code, assumed to be of a work address, for each physician. To determine the rural or urban location of a physician's reported practice, we used the ZIP code version of the Rural-Urban Commuting Areas (RUCAs). The RUCAs were developed in a collaboration between the Department of Agriculture's Economic Research Service and the Washington, Wyoming, Alaska, Montana, Idaho (WWAMI) Rural Health Research Center at the University of Washington, supported by the Federal Office of Rural Health Policy.<sup>15</sup> The RUCAs use census tracts (to which ZIP codes are approximated) rather than counties as building blocks to define rurality based on community populations and work-commuting patterns. The RUCAs are currently being used by several federal agencies to define rurality and determine eligibility for some federal programs directed at rural areas and residents.

For the purposes of this study, the 30 RUCA categories were collapsed into 3 groups: urban (metropolitan area core with a population greater than 50 000), large rural (large town core with a population between 10 000 and 50 000), and small or isolated rural (towns with populations of 2500 to 10 000 or areas without an urban core population of at least 2500). The ZIP code-based population estimates from 1998 Claritas (San Diego, Calif) data were used to determine surgeon to population ratios.

We examined the demographic characteristics of general surgeons, including age, sex, country of medical school, and board certification, to identify differences in those practicing in ru-

ral and urban areas. International medical graduate surgeons were defined as those who had graduated from medical schools outside the United States or Canada. Bivariate associations between urban/rural site of practice and the demographic factors were examined using the  $\chi^2$  test.<sup>16</sup> Analysis was performed using SPSS version 6.0 (SPSS Inc, Chicago, Ill).

Using the AMA Masterfile supplemented with county population data, we calculated the absolute numbers of clinically active general surgeons and the general surgeon to population of 100 000 ratios for the 9 Census Bureau divisions as well as for each state. Additionally, we calculated general surgeon to population of 100 000 ratios for urban, large rural, and small/isolated rural areas in each of the regions, divisions, and states. This allowed comparisons across divisions, states, and rural and urban areas by taking into account the wide variations in absolute numbers of general surgeons in such disparate categories.

## RESULTS

### GENERAL SURGEON NUMBERS AND DEMOGRAPHICS

There were 17 243 clinically active, nonresident general surgeons in the United States in 2001, with an overall general surgeon to population ratio of 6.40 general surgeons per population of 100 000 (**Table 1**). Nationally, 10.6% of general surgeons were female, and 80.1% were graduates of US or Canadian medical schools. General surgeons in urban areas were more likely to be female (11.7%) than those in large rural areas (6.1%) or small/isolated rural areas (7.3%) ( $P < .001$ ). General surgeons aged 50 years or older were significantly more likely to be located in small/isolated rural areas than urban areas (51.6% vs 42.1%,  $P < .001$ ) and more likely to be located in small/isolated rural areas than large rural areas (51.6% vs 44.2%,  $P < .001$ ). Board-certification information was not reported for 19% of general surgeons. General surgeons who were international medical graduates were significantly more likely to be located in small/isolated rural areas (25.2%) or urban areas (20.1%), as compared with large rural areas (14.0%) ( $P < .001$  for both), and significantly more likely to be practicing in small/isolated rural areas than urban areas (25.2% vs 20.1%,  $P < .001$ ).

### GEOGRAPHIC DISTRIBUTION OF GENERAL SURGEONS

Nationally, there were 6.40 general surgeons per population of 100 000; however, this varied from 6.53 in urban areas to 7.71 in large rural areas and 4.67 in small/isolated rural areas (**Table 2**). For urban areas, the lowest number of surgeons per population of 100 000 was found in the Pacific (5.41), West South Central (6.11), Mountain (6.17), and East North Central (6.22) census divisions. In large rural areas, the West South Central (6.20) and Pacific (6.82) divisions again had the lowest number of general surgeons relative to the population. Finally, in the small/isolated rural areas, the census divisions with the smallest relative number of general surgeons included the West South Central (3.04), West North Central (3.66), and Pacific (4.22) divisions.

**Table 1. Characteristics of General Surgeons in Urban, Large Rural, and Small/Isolated Rural Areas of the United States in 2001\***

	Urban Areas (n = 13647)	Large Rural Areas (n = 1956)	Small/Isolated Rural Areas (n = 1636)	Overall United States (n = 17243)
Sex†				
Female	1594 (11.7)	120 (6.1)	120 (7.3)	1834 (10.6)
Male	12053 (88.3)	1836 (93.9)	1516 (92.7)	15405 (89.4)
Age, y†				
<40	2753 (20.2)	390 (19.9)	249 (15.2)	3392 (19.7)
40-49	5153 (37.7)	702 (35.9)	542 (33.1)	6397 (37.1)
≥50	5741 (42.1)	864 (44.2)	845 (51.6)	7450 (43.2)
Medical school‡				
US or Canadian medical graduate	10900 (79.9)	1682 (86.0)	1223 (74.7)	13805 (80.1)
International medical graduate	2747 (20.1)	274 (14.0)	413 (25.2)	3434 (19.9)
Board certified in general surgery‡				
Yes	10548 (94.7)	1575 (97.6)	1180 (97.7)	13303 (95.2)
No	595 (5.3)	39 (2.4)	28 (2.3)	662 (4.7)

\*Data are presented as number (percentage) unless otherwise indicated. Percentages may not add up to 100 owing to rounding. Overall  $\chi^2$  *P* values <.001.

†Data on sex, age, and country of medical school were missing for 4 individuals.

‡Data on board certification were missing for 3278 individuals.

**Table 2. Ratios of General Surgeons per Population of 100 000 in Urban, Large Rural, and Small/Isolated Rural Areas of Census Bureau Divisions in 2001**

Census Bureau Division	Overall			General Surgeons in Urban Areas		General Surgeons in Large Rural Areas		General Surgeons in Small/Isolated Rural Areas		Population in Small/Isolated Rural Areas		
	No. of General Surgeons	Total Population (1000s)	Ratio	Urban Areas	Population in Urban Areas (1000s)	Ratio	Rural Areas	Population in Large Rural Areas (1000s)	Ratio	Rural Areas	Population in Small/Isolated Rural Areas (1000s)	Ratio
New England	981	13407	7.32	801	11184	7.16	62	755	8.22	118	1467	8.04
Middle Atlantic	2863	38234	7.49	2525	33135	7.62	161	1951	8.25	177	3147	5.62
East North Central	2721	44034	6.18	2122	34138	6.22	345	4496	7.67	254	5399	4.70
West North Central	1167	18650	6.26	736	10897	6.75	249	2775	8.97	182	4976	3.66
East South Central	1152	16433	7.01	712	9081	7.84	235	2875	8.17	205	4476	4.58
South Atlantic	3283	48684	6.74	2565	37659	6.81	344	4183	8.22	374	6842	5.47
West South Central	1699	29918	5.68	1334	21846	6.11	227	3662	6.20	134	4409	3.04
Mountain	1024	16760	6.11	752	12193	6.17	161	2146	7.50	111	2420	4.59
Pacific	2353	43287	5.44	2100	38849	5.41	172	2520	6.82	81	1917	4.22
<b>Total</b>	<b>17243</b>	<b>269407</b>	<b>6.40</b>	<b>13647</b>	<b>208982</b>	<b>6.53</b>	<b>1956</b>	<b>25363</b>	<b>7.71</b>	<b>1636</b>	<b>35053</b>	<b>4.67</b>

The numbers of general surgeons per population of 100 000 for urban, large rural, and small/isolated rural areas of all 50 states and the District of Columbia (**Table 3** and **Figure**) demonstrated an even wider degree of interstate and intrastate variation than was noted at the more aggregated division level. In some states, such as Wyoming, there were proportionately more surgeons in rural and urban areas than the national average. However, in others, such as Washington, there were proportionately fewer surgeons in all types of areas than the national average. Finally, in many states, such as North Dakota, there were proportionately more surgeons in some types of areas and fewer in other types of areas.

#### COMMENT

For almost a decade, there have been concerns raised about the adequacy of the general surgical workforce serving rural America. Any decline in the number of rural general surgeons would have profound effects on pa-

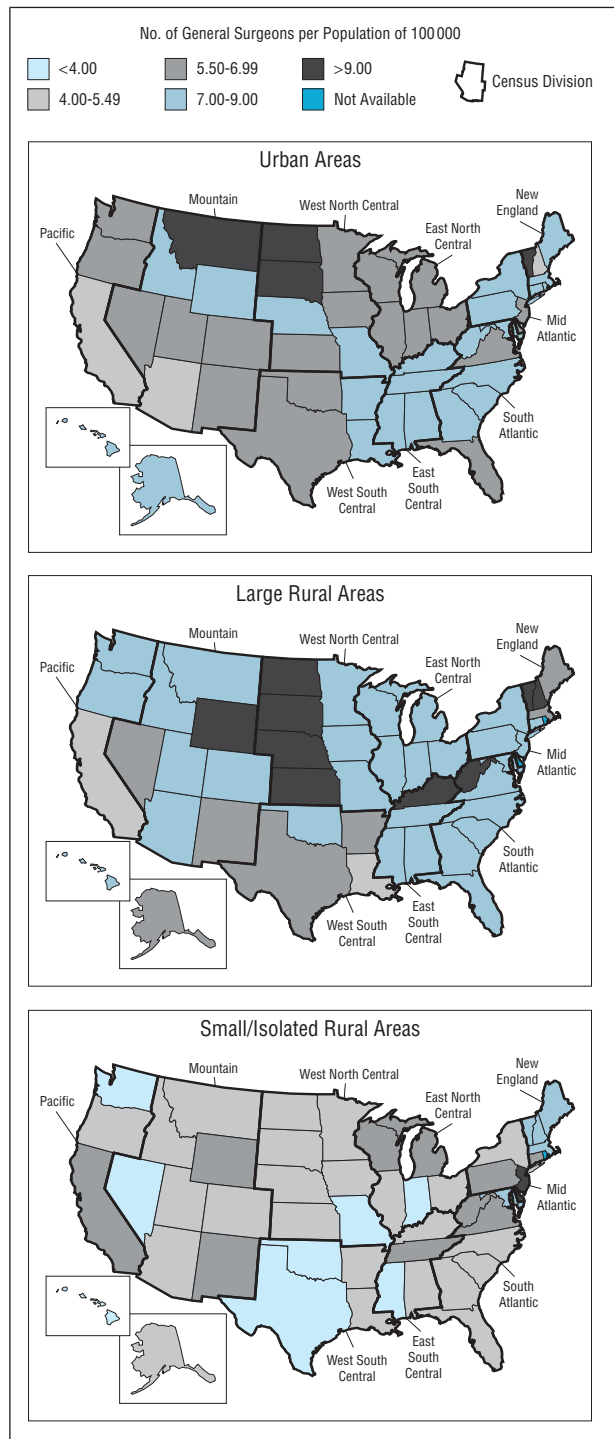
tient access to clinical services, the viability of trauma systems, rural hospital financial viability, and surgical backup for primary care practitioners in rural areas.

There were 17243 general surgeons practicing in the United States in 2001; this is very similar to the 17289 identified from the AMA Masterfile in 1994 using criteria similar to ours<sup>8</sup> and suggests that the general surgical workforce has not kept pace with the rising population. This may be due to a number of factors, including more general surgeons taking early retirement or an increasing tendency for graduating residents to seek fellowship training rather than practicing general surgery. Moreover, our study suggests that the number of general surgeons in the most rural areas of the United States, in particular, will decline further. First, we found that rural general surgeons are older than those in urban areas, suggesting that the relative deficit of general surgeons in more rural areas will only continue to increase. Second, the preference of female surgeons for urban practice suggested by our data may exacerbate the situation in an era when an increasing number of

medical students and thus surgeons are female. Third, we found that general surgeons who are international medical graduates are more likely to be found in smaller rural areas than in urban areas, suggesting that general surgeons who are international medical graduates are filling positions in what are deemed by US graduates to be less attractive practice settings, in this case rural general surgery.

The majority (79.1%, or 13647) of the 17243 clinically active general surgeons in the United States practice in urban areas, with 11.3% (1956) in large rural areas and 9.5% (1636) in small/isolated rural areas. Overall, the 60 million Americans (22.4% of the total population) living in rural areas are served by 20.8% of the nation's general surgeons, suggesting that as a whole rural areas are adequately served by general surgeons. This contrasts markedly with previous studies that estimated that approximately 10% of general surgeons were practicing in rural areas,<sup>17</sup> possibly because of less precise definitions of rurality. However, we did note that there are relatively more general surgeons (per population) in large rural areas compared with urban areas, perhaps reflecting the fact that many of the clinical services performed by general surgeons in large rural areas are undertaken by surgical subspecialists in urban areas. Alternatively, it is possible that in some states (eg, California) managed care organizations have a greater presence in urban areas than in large rural areas, and such organizations tend to manage patients with fewer surgeons. The ratio of general surgeons is far lower in small/isolated rural areas, however, with only 4.67 general surgeons per population of 100 000 in these areas. Within small/isolated rural areas, we noted wide variation across the country, with even fewer surgeons in many states situated in the West North Central, West South Central, Mountain, and East North Central divisions. This suggests that particular small/isolated rural areas in certain states are less attractive than others. This may be the case in areas that lack the required threshold population to support a general surgeon and may also reflect other factors such as lifestyle, practice viability, lack of training, or limited access to clinical facilities in such areas.

The relatively smaller numbers of general surgeons per unit population located in small/isolated rural areas compared with urban and large rural areas beg the question of whether there is a baseline shortage of general surgeons in rural areas at present. There is no single accepted criterion of an adequate general surgeon to population ratio. The Primary Care Health Professional Shortage Areas maps produced by the US Health Resources and Services Administration designate areas with shortages of family physicians, general pediatricians, general internists, and obstetrician/gynecologists—but not general surgeons. In our study, the average number of general surgeons per population of 100 000 in small/isolated rural areas nationwide is certainly lower than 2 SDs below the mean number of surgeons per population of 100 000 in urban and large rural areas in our study. It is also markedly lower than the national average of 7.1 practicing general surgeons per population of 100 000 found by Jonasson and Kwakwa<sup>14</sup> in 1996. It is also be-



**Figure.** Comparison of numbers of general surgeons per population of 100 000 in urban, large rural, and small/isolated rural areas of the United States in 2001.

low the health maintenance organization (HMO) benchmark of 5.1 general surgeons per population of 100 000 cited by Goodman et al<sup>18</sup> in 1996. What exactly constitutes a shortage of general surgeons is beyond the scope of this article, but our data suggest that residents of small/isolated rural areas have less immediate access to general surgical care than do residents of urban and large rural areas.

**Table 3. Ratios of General Surgeons per Population of 100 000 in Urban, Large Rural, and Small/Isolated Rural Areas of All 50 States and the District of Columbia in 2001**

State	Overall	Urban Areas	Large Rural Areas	Small/Isolated Rural Areas
Alabama	6.98	7.42	7.36	4.95
Alaska	6.04	7.01	6.23	4.16
Arizona	5.48	5.40	7.59	3.72
Arkansas	6.69	8.78	6.63	3.98
California	5.21	5.21	5.13	5.50
Colorado	6.22	6.32	7.03	5.49
Connecticut	7.15	7.16	8.30	6.03
Delaware	7.05	6.57	NA	9.02
DC	15.18	15.18	NA	NA
Florida	5.92	5.94	7.92	4.76
Georgia	6.80	7.02	8.09	4.75
Hawaii	6.80	7.11	8.36	1.74
Idaho	6.99	8.24	7.97	3.93
Illinois	6.19	6.28	7.79	4.00
Indiana	5.28	5.54	7.21	2.79
Iowa	6.06	6.72	8.82	4.23
Kansas	6.30	5.77	9.24	4.26
Kentucky	7.03	7.83	10.48	4.44
Louisiana	6.86	7.76	5.30	4.68
Maine	8.21	8.87	6.35	8.17
Maryland	7.74	7.67	7.80	8.95
Massachusetts	7.04	7.00	6.08	8.65
Michigan	5.92	5.58	8.64	6.58
Minnesota	5.47	5.58	8.00	3.81
Mississippi	6.08	8.00	7.75	2.71
Missouri	6.24	7.11	7.82	2.89
Montana	7.49	9.37	8.89	4.76
Nebraska	7.09	8.51	9.21	3.39
Nevada	6.24	6.53	6.89	2.74
New Hampshire	6.26	4.69	11.01	7.08
New Jersey	6.67	6.63	7.14	12.84
New Mexico	6.38	6.65	6.23	5.58
New York	7.49	7.60	8.44	5.42
North Carolina	7.07	7.51	8.31	4.98
North Dakota	8.11	10.93	11.81	3.76
Ohio	6.60	6.83	7.24	3.40
Oklahoma	5.31	5.88	7.21	2.16
Oregon	6.98	6.91	8.79	4.09
Pennsylvania	8.03	8.49	8.15	5.59
Rhode Island	8.32	8.37	NA	NA
South Carolina	7.02	7.79	7.23	4.49
South Dakota	8.51	11.51	12.59	3.36
Tennessee	7.49	8.18	7.28	5.90
Texas	5.35	5.66	5.96	2.27
Utah	5.45	5.57	7.28	3.20
Vermont	9.64	11.28	10.73	8.68
Virginia	6.19	5.98	7.22	6.79
Washington	5.46	5.55	7.03	2.79
West Virginia	8.05	8.57	11.42	5.97
Wisconsin	6.76	6.76	8.13	6.25
Wyoming	7.89	8.37	9.29	6.56
US average	6.40	6.53	7.71	4.67

Abbreviation: NA, not available.

This study has several potential limitations. First, we assumed that a physician's ZIP code listed in the AMA Masterfile was his or her practice address; it is possible, however, that some surgeons may have listed their home address. Second, it should be borne in mind that this study addresses only the supply of general surgeons available to different populations, not the utilization of surgical services. For various reasons, patients from, for ex-

ample, small/remote areas may seek care in large rural or urban areas, regardless of the local availability of care. Third, this study does not take into account any effects of traveling or itinerant general surgeons, ie, those whose ZIP code indicates they work in one (possibly more urbanized) area but who travel on a regular basis to surrounding rural areas to provide consultations and surgical services.<sup>19</sup> Fourth, although the AMA Masterfile is

the most complete nationally available source of information on physicians, the criteria for including general surgeons that we used might exclude surgeons who perform general surgery as part of a subspecialty surgical practice and those who have clinical responsibilities in addition to teaching or research, as well as the clinical services provided by surgical residents, federally employed surgeons, and those who are still clinically active beyond the retirement age that we selected.

Attempts to increase the proportion of general surgeons choosing rural practice will require a multifaceted approach. Selection of students at medical school entry could emphasize those from rural backgrounds, as they are more likely than their urban counterparts to eventually practice in rural areas.<sup>20</sup> Efforts to promote student interest could include developing more student rotations with rural general surgeons.<sup>21</sup> Student interest in general surgery residencies increased in the 2003 National Residency Matching Program match, with 82.7% of positions filled by US seniors (and 99.0% of positions filled overall).<sup>22</sup> Surgical residencies could include rural training tracks with structured periods of rural exposure, more diverse case exposure, or even a rural fellowship.<sup>13,23</sup>

Further research is needed to assess rural surgeons' ongoing requirements to maintain and update their clinical skills and—most importantly—the factors vital to retaining them in rural practice. There may also be opportunities to examine alternatives to the current funding (eg, changing Medicare fee schedules) and organization of surgical services in rural areas (eg, more favorable reimbursement for rural training and practice). In Australia, a regular locum tenens service provided by the regional academic center and flying surgical teams have been used to provide surgical services in isolated areas. Finally, telemedicine has shown promise in the areas of orthopedics and trauma. Once issues of reimbursement and liability have been resolved, telemedicine, along with the nascent field of telesurgery, may contribute to improved surgical care in isolated rural areas.

General surgeons and family practitioners are core components of rural medical care. If rural residents are to achieve health care parity with the urban populace, medical schools and health care policy makers need to address the growing crisis in the rural general surgical workforce.

**Accepted for Publication:** August 10, 2004.

**Correspondence:** Dana Christian Lyngge, MD, Department of Surgery, University of Washington, Box 358280, Seattle, WA 98195-8280 (dlyngge@u.washington.edu).

**Funding/Support:** This study was supported by Cooperative Agreement 5 U27 RH 00235-03 from the US Health Resources and Services Administration, Federal Office of Rural Health Policy, Rockville, Md.

- Williamson HA Jr, Hart LG, Pirani MJ, Rosenblatt RA. Rural hospital inpatient surgical volume: cutting-edge service or operating on the margin? *J Rural Health.* 1994;10:16-25.
- Sariego J. Patterns of surgical practice in a small rural hospital. *J Am Coll Surg.* 1999;189:8-10.
- Ritchie WP Jr, Rhodes RS, Biester TW. Work loads and practice patterns of general surgeons in the United States, 1995-1997: a report from the American Board of Surgery. *Ann Surg.* 1999;230:533-543.
- Rutledge R, Fakhry SM, Baker CC, et al. A population-based study of the association of medical manpower with county trauma death rates in the United States. *Ann Surg.* 1994;219:547-567.
- Bintz M, Cogbill TH, Bacon J. Rural trauma care: role of the general surgeon. *J Trauma.* 1996;41:462-464.
- Krein SL, Christianson JB. *The Composition of Rural Hospital Medical Staffs: The Influence of Hospital Neighbors.* Minneapolis: Rural Health Research Center, Institute for Health Services Research, School of Public Health, University of Minnesota; 1996.
- Kwakwa F, Jonasson O. The general surgery workforce. *Am J Surg.* 1997;173:59-64.
- Jonasson O, Kwakwa F, Sheldon GF. Calculating the workforce in general surgery. *JAMA.* 1995;274:731-734.
- Stevermer JJ, Supattanasiri GJ, Williamson H Jr. A survey of general surgeons in rural Missouri: potential for rapid decrease in work force. *J Rural Health.* 2001;17:59-62.
- Bland KI, Isaacs G. Contemporary trends in student selection of medical specialties: the potential impact on general surgery. *Arch Surg.* 2002;137:259-267.
- Rosenblatt RA, Whitcomb ME, Cullen TJ, Lishner DM, Hart LG. Which medical schools produce rural physicians? *JAMA.* 1992;268:1559-1565.
- Council on Graduate Medical Education. *Tenth Report: Physician Distribution and Health Care Challenges in Rural and Inner-City Areas.* Washington, DC: US Dept of Health and Human Services, Public Health Service, Health Resources and Services Administration; 1998.
- Waddle BJ. Rural surgery: opportunity or minefield. *Arch Surg.* 2000;135:121-125.
- Jonasson O, Kwakwa F. Retirement age and the work force in general surgery. *Ann Surg.* 1996;224:574-582.
- Morrill R, Cromartie J, Hart LG. Metropolitan, urban, and rural commuting areas: toward a better depiction of the United States' settlement system. *Urban Geogr.* 1999;20:727-748.
- Rosner B. *Fundamentals of Biostatistics.* Boston, Mass: Duxbury; 1999.
- Landercasper J, Bintz M, Cogbill TH, et al. Spectrum of general surgery in rural America. *Arch Surg.* 1997;132:494-498.
- Goodman DC, Fisher ES, Bubolz TA, Mohr JE, Poage JF, Wennberg JE. Benchmarking the US physician workforce: an alternative to needs-based or demand-based planning. *JAMA.* 1996;276:1811-1817.
- Kellerman R, Ast T, Dorsch J, Frisch L. Itinerant surgical and medical specialist care in Kansas: report of a survey of rural hospital administrators. *J Rural Health.* 2001;17:127-130.
- Asher EF, Martin LF, Richardson JD, Polk HC Jr. Rural rotations for senior surgical residents: influence on future practice location. *Arch Surg.* 1984;119:1120-1124.
- Evans S, Sarani B. The modern medical school graduate and general surgical training: are they compatible? *Arch Surg.* 2002;137:274-277.
- National Residency Matching Program. Positions offered and filled by US seniors and all applicants, 1999-2003. Available at: [http://www.nrmp.org/res\\_match/tables/table5\\_2003.pdf](http://www.nrmp.org/res_match/tables/table5_2003.pdf). Accessed December 31, 2003.
- Oregon Health Sciences University. OHSU launches first-of-its-kind rural surgery program. Available at: <http://www.ohsu.edu/news/archive/2002/082702rural.html>. Accessed December 31, 2003.