J Neurosurg 102:202–208, 2005

Neurosurgical workforce trends in the United States

Oren N. Gottfried, M.D., Richard L. Rovit, M.D., M.Sc., A. John Popp, M.D., Kristin L. Kraus, M.Sc., Arlene Stolper Simon, M.B.A., and William T. Couldwell, M.D., Ph.D.

Department of Neurosurgery, University of Utah School of Medicine, Salt Lake City, Utah; Department of Neurosurgery, New York Medical College, Valhalla and New York; and Department of Surgery, Albany Medical College, Albany, New York

Object. The purpose of this study was to evaluate the US neurosurgery workforce by reviewing journal recruitment advertisements published during the past 10 years.

Methods. The number of available academic and private neurosurgical staff positions was determined based on recruitment advertisements in the *Journal of Neurosurgery* and *Neurosurgery* for the 10-year period from 1994 to 2003. Advertisements were evaluated for practice venue, subspecialization, and location. The numbers of active neurosurgeons and graduating residents also were reviewed.

The number of advertised neurosurgical positions increased from 141.6 ± 38.2 per year from 1994 through 1998 to 282.4 ± 13.6 per year from 1999 through 2003 (mean ± standard deviation, $p < 0.05$). The mean number of academic positions increased from 50.6 ± 11.1 to 95 ± 17.5 ($p < 0.05$), and the mean number of private positions rose from 91 ± 30.4 to 187.4 ± 6.8 ($p < 0.05$). Subspecialty positions represented a mean of only 15.6 ± 5% per year during the first time period and 18.8 ± 3% per year in the second period ($p = 0.22$), and therefore the majority of positions advertised continued to be those for generalists. The number of practicing neurosurgeons declined after 1998, and by 2002 it was less than it had been in 1991. The numbers of incoming and matriculating residents during the study period were static.

Conclusions. The number of recruitment advertisements for neurosurgeons during the last 5 years has increased significantly, concomitant with a severe decline in the number of active neurosurgeons and a static supply of residents.

Key Words • **neurosurgical education** • **manpower** • **neurosurgery** • **training program**

There has been considerable discussion about whether there are too few or too many neurosurgeons.[2,6,8,25,31–33] In the past, some asserted that an overabundance of neurosurgeons existed, and some even called for cutbacks in training programs.[7,8,23,26,39,43–46] From 1963 to 1973, the number of neurosurgeons in the US increased by 36%,[8] and a report in 1975 revealed that neurosurgical training rates had increased at 6 to 10 times the growth rate for the nation's population.[46] Recently, this perception of an excess number of neurosurgeons has changed.[16,25,28] In a 1997 study undertaken to estimate workforce needs, neurosurgery was one of only four fields (among 21 medical fields evaluated) that did not require downsizing to maintain an ideal physician-to-population ratio.[28] A 2003 survey of neurosurgery residency program directors demonstrated that most thought that the number of practicing neurosurgeons in the US was too low.[25] Thus the commonly held belief that specialist physicians are in oversupply is being challenged.[14,37]

In 1999 Friedlich and coworkers[16] evaluated neurosurgery journal recruitment advertisements to demonstrate changes in the workforce. They found that contrary to earlier reports and a prevailing perception of a decreased demand, the mean number of advertisements for neurosurgeons had increased between the periods from 1985 to 1995 and from 1995 to 1998 (92.6 compared with 102.7 mean advertisements/year, respectively). Friedlich, et al., documented the beginning of a trend of increased demand for neurosurgeons starting in 1996. These findings contrasted with data collected by Seifer and coworkers,[36] who surveyed journal recruitment advertisements for the entire physician workforce and concluded that advertisements for specialized physicians had declined steeply from 1990 to 1995. The authors of this study did not evaluate neurosurgery positions specifically, however.

The review of journal advertisements or the creation of a help-wanted index as an estimate of workforce demand has been used previously as a quantifiable and objective indicator of workforce trends during an extended period of time.[1,2,10,12,13,15,16,18,24,34,36,38] Economists commonly use help-wanted indexes or job listings as a measure of relative supply–demand imbalances in the employment market, and this method has been used in a variety of fields since at least the 1960s.[1,9,10,12,13,15,18,34] Forman and coworkers[15] noted that a review of a previous month's help-wanted indexes is described in the business sections of many national news publications including *The New York Times* and *The Wall Street Journal*.

This method was first applied to an assessment of marketplace demands for physicians in the study by Seifer, et al.,[36] in the *Journal of the American Medical Association*. Since that time it has been used in studies reported in the *Journal of Neurosurgery*,[16] *American Journal of Roentgen-*

ology,[15] *American Journal of Medicine*,[24] and *Radiology*.[38] Forman and colleagues[15] used a help-wanted index to track changes in the radiology job market and concluded that a job market "can be tracked in a coincident manner with the use of a help wanted index," that "changes in the make-up of a field's practice are identified in a well-constructed index," and that "these findings have validity and can be useful as an adjunct to other information for policy and planning purposes." Alternative methods of approximating the job market include surveys and mathematical models. The former are subjective and expensive, often published in a delayed manner, and subject to sampling variability and nonresponse bias, whereas the latter are always based on assumptions about the current market. In contrast, the use of journal recruitment advertisements is a quantifiable, objective, and historically documented measure of available physician positions.[36]

Since the publication of the article by Friedlich and coworkers,[16] neurosurgery has faced many challenges. The current medical liability crisis of increasing costs of malpractice insurance in the US has led many neurosurgeons to exclude high-risk surgeries, focus on spine work, avoid emergency treatment, move practices to locations where the medical liability system is more stable, and retire early.[4,20,30] We examined the sufficiency of the neurosurgical workforce in the US by evaluating journal recruitment advertisements from the last 10 years, thus expanding the research begun by Friedlich and colleagues. We also evaluated the total number of active neurosurgeons to determine whether changes in the numbers of journal recruitment advertisements represented an actual change in demand, and we considered the future supply of neurosurgeons.

Clinical Material and Methods

Advertisements for available neurosurgical positions were collected from all issues of the *Journal of Neurosurgery* and *Neurosurgery* for the 10-year period from 1994 to 2003 (240 issues). There was no change in journal policy regarding methods of acquiring recruitment advertisements or advertisement sales during the period studied. Each advertisement was allocated to the monthly issue in which it first appeared. Those appearing in successive monthly issues of the same journal or in both journals were recorded only once. If an advertisement specified two or more available positions, each position was recorded individually. All staff positions for clinical neurosurgeons in the US were included; fellowship, research, and nonsurgical positions were excluded.

Advertised positions were classified as either academic or private sector. An academic employment opportunity was defined as one advertised by an institution with an Accreditation Council for Graduate Medical Education–approved neurosurgical residency training program. All others were categorized as private-practice opportunities.

Each advertisement was also evaluated based on whether it sought general or subspecialty care. We defined a subspecialty advertisement as one that stated a requirement for fellowship training, subspecialty expertise, or necessary (subspecialty) experience within a specific neurosurgical field. The subspecialty fields included pediatrics, spine, vascular, endovascular, oncology, stereotactic, functional, epilepsy, pain, stereotactic radiosurgery, skull base, and trauma. An advertisement was designated as generalist if it contained no information about subspecialty-specific experience or training. Advertisements that used terms such as "preferred experience in [subspecialty]" or "interests in [subspecialty]" were not included as a subspecialty position because of the possibility that a neurosurgeon without subspecialty experience or training might ultimately occupy the position. In addition, in cases in which advertisements listed a single position available with several acceptable possibilities of subspecialty expertise, the appropriate fractional designation was made. For example, an advertisement for one academic neurosurgeon with necessary training in functional, epilepsy, and pain was allocated as one third of a position per subspecialty.

To supplement our understanding of supply and demand in the neurosurgical workforce, the numbers of active neurosurgeons and graduating residents were acquired from the American Board of Neurological Surgeons. The number of applicants to neurosurgical residencies and the number of residency positions were obtained from the San Francisco Matching program website (www.sfmatch.org).

Values are expressed as the means ± standard deviations. Differences between the more recent 5 years (1999–2003) and the preceding 5 years (1994–1998) were assessed using the nonparametric Mann–Whitney U-test, with significance set at a probability level less than 0.05. All analyses were performed using statistical computer software (statistiXL, version 1.4).

Results

The number of neurosurgical positions advertised in the *Neurosurgery* and *Journal of Neurosurgery* increased from a mean of 141.6 ± 38.2 per year for the 5-year period from 1994 through 1998 to a mean of 282.4 ± 13.6 per year for the 5-year period from 1999 through 2003 ($p < 0.05$). The total number of advertisements for each 5-year period increased from 708 to 1412. Figure 1 demonstrates the increasing trend in the number of positions advertised over the entire period studied. The total number of positions almost tripled from a low of 110 for 1995 to 297 in 2003. The mean number of academic positions per year during the entire study period was 72.8 ± 27.2 compared with 139.2 ± 54.9 for private positions. Furthermore, there were more private than academic positions in all years. The mean number of available academic positions per year increased from 50.6 ± 11.1 for the first 5-year period to 95 ± 17.5 for the second 5-year period ($p < 0.05$), whereas the mean numbers of available private positions per year were 91 ± 30.4 and 187.4 ± 6.8, respectively ($p < 0.05$), for the same periods. Thus, both private and academic opportunities increased roughly twofold during the later time period, which was statistically significant.

The number of advertised positions for subspecialized neurosurgeons also increased during the entire period studied. Figure 2 demonstrates the increase in the number of academic and private subspecialized positions advertised starting in 1998 and peaking in 2001, when 46% of academic positions and 10% of private positions were for subspecialized neurosurgeons. The mean number of subspecialist positions advertised per year from 1994 through 1998 was 21.2 ± 5.9, and from 1999 to 2003 was 53.4 ± 10.2 ($p <$

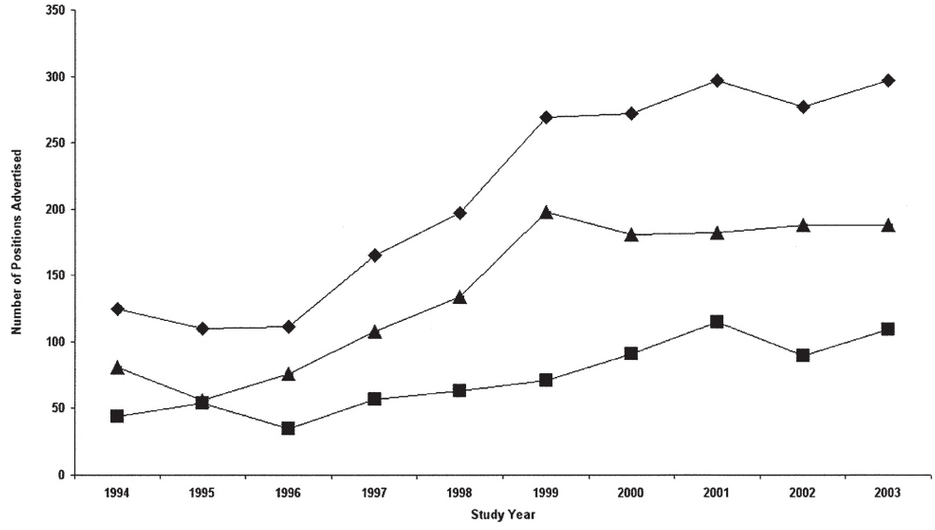

FIG. 1. Graph demonstrating the number of advertised positions for academic *(squares)*, private *(triangles)*, and total *(diamonds)* neurosurgeons from 1994 through 2003.

0.05). The mean number of advertised academic subspecialized positions per year during the two time periods increased from 16.2 ± 5.5 to 38.6 ± 8.9 ($p < 0.05$), that is, 31.8 ± 9% and 40.6 ± 5.4% of the mean total number of academic positions per year for the two time periods, respectively ($p = 0.22$). In comparison, the mean number of private subspecialized positions per year for the two time periods increased from 5 ± 2.3 to 14.8 ± 2.2 ($p < 0.05$), that is, 5.4 ± 1.7% and 8 ± 1.2% of the mean total number of private positions per year for the two time periods, respectively ($p = 0.056$).

The total number of advertised positions for subspecialists increased at the same rate as the overall growth rate for all advertised positions and was statistically significant, but the percentage or proportion of positions accounted for by subspecialties did not increase in a statistically significant manner. The number and percentage of advertisements per year for subspecialists were higher for academic positions compared with those for private ones; the mean percentage of subspecialty positions per year was 36.2 ± 8.4% and 6.7 ± 1.9% for academic and private spots, respectively. Overall, subspecialty positions represented a mean percentage per year of only 17.2 ± 4.3% of all positions, with a mean of 15.6 ± 5% during the period from 1994 through

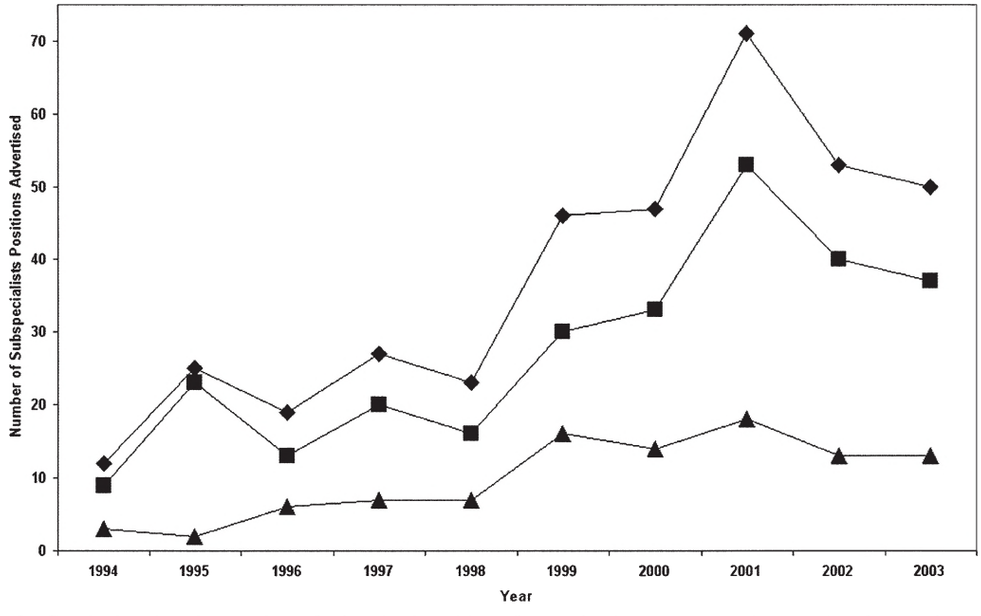

FIG. 2. Graph showing the number of advertised positions for academic *(squares)*, private *(triangles)*, and total *(diamonds)* subspecialized neurosurgeons from 1994 through 2003.

TABLE 1

*Summary of advertisements for neurosurgeons**

	No. of Advertisements																			
	1994		1995		1996		1997		1998		1999		2000		2001		2002		2003	
Specialty	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P
subspecialty																				
spine	2	3	10.5	0	5	4	3.5	4	4.5	5	13	9.5	9.5	8.5	21	12	9	11	17	4
pediatric	2	0	3	2	4	2	7	2	4	2	4	12	8.3	2	9	2	7	1	3	3
endovascular	0	0	0	0	0	0	1	0	0	0	2.5	0	5	0	5	1	7	1	5.5	3.5
vascular	2	0	3.5	0	0	0	2.5	1	0	0	0.5	0	4	0	4.5	0	5	0	2.5	0.5
epilepsy	0	0	0.8	0	1	0	0	0	1.8	0	0	0.5	0.8	0	0.5	0.5	1.7	0	0.6	1.5
functional	0	0	1	0	0.3	0	1	0	2.3	0	0	1	1.3	0.5	1.8	0	2.7	0	2.6	0.5
pain	0	0	0.6	0	0.3	0	0	0	0.8	0	0	0	0	0	0.8	0	1.4	0	0.3	0
stereotactic	0	0	0.6	0	0.3	0	2	0	0	0	0	0.5	0	0.5	1.8	5	0.8	0	2.3	0
oncology	0	0	0	0	0	0	1	0	1.5	0	2	0	1.3	0.5	2	0.5	3.2	0	0	0
trauma	1	0	1	0	1	0	2	0	0	0	0	0	1	1	4	0	1	0	2	0
SRS	0	0	1	0	0	0	0	0	1	0	0	0	1.6	0	0	0	1	0	1	0
skull base	2	0	1	0	1	0	0	0	0	0	0	0.5	0	1	1.5	1.5	0	0	0	0
general	35	78	31	54	22	70	37	101	47	127	41	182	58	167	62	164	49	175	72	175

* A = academic; P = private; SRS = stereotactic radiosurgery.

1998 and a mean of 18.8 ± 3% during the period from 1999 through 2003 ($p = 0.22$); therefore the majority of positions were for generalists. Although the mean number and proportion of advertised subspecialized positions increased during the later time period (1995–2003), it is important to note that after the peak in 2001, they declined.

Among the subspecialties, the highest number of total, private, and academic positions advertised were those for spine followed by pediatrics (Tables 1 and 2). Overall, the spine specialty was associated not only with the most advertisements for a neurosurgical subspecialty but also with the highest growth rate. From 1994 to 1998, 42 spine positions were advertised; from 1999 to 2003, 114 were advertised—an almost threefold increase. The growth rate for spine positions was equivalent between academic and private positions. In academic settings, pediatric, cerebrovascular, functional, and oncological openings more than doubled from 1994 through 1998 to 1999 through 2003. Note that only one academic endovascular position was advertised from 1994 to 1998, whereas 25 were advertised from 1999 to 2003. For private subspecialty advertisements, three fields—spine, pediatrics, and endovascular—accounted for 87.4% of all private subspecialty positions advertised (Table 2). Most of the private subspecialty positions were for spine (61.6%). It is important to note that the percentage of the total number of positions (academic and private) that these subspecialties represented remained low, with spine positions increasing from a mean per year of 6.2 ± 2.5% to 8 ± 1.8% (total 7.1 ± 2.3%, $p = 0.31$) and endovascular positions increasing from a mean per year of 0.1 ± 0.2% to 2.1 ± 0.9% (total 1.1 ± 1.2; $p < 0.05$). No subspecialty other than endovascular in the private or academic setting had a statistically significant increase in proportion during the two time periods.

Eight states—Florida, New York, Illinois, Pennsylvania, Texas, North Carolina, Missouri, and Ohio—of the 10 states with the highest number of job opportunities for private-practice neurosurgical positions in 2002 and 2003 are considered to be in a professional liability insurance crisis, as described by the American Medical Association[30] and the Council of State Neurosurgical Societies.[4]

Data from the American Board of Neurological Surgeons (ML Sanderson, personal communication, 2003) demonstrate that the number of certified practicing neurosurgeons in the US increased and reached a peak in 1998 and then decreased dramatically during the next 4 years (Fig. 3). In fact, the number of practicing neurosurgeons in late 2002 was less than the number in 1991 (3042 compared with 3080, respectively).

The number of neurosurgical residency positions offered through the San Francisco Matching program has remained stable during the past 12 years, and the number of matriculating residents nearly coincides with this number of positions (Fig. 4). A decreasing trend in the number of applicants to the neurosurgical match is apparent.

Discussion

The number of journal-advertised neurosurgery positions for both academic and private practice opportunities doubled from a mean of 141.6 ± 38.2 per year for the period from 1994 to 1998 to a mean of 282.4 ± 13.6 per year for the period from 1999 to 2003 (Fig. 1). Friedlich and coworkers[16] recognized the beginning of this trend toward

TABLE 2

*Distribution of the most common subspecialty advertisements from 1994 to 2003**

	% Positions	
Subspecialty	Academic	Private
spine	34.7	61.6
pediatric	21.7	20.2
endovascular	9.5	5.6
cerebrovascular	8.9	

* Includes subspecialties making up greater than 5% of subspecialty positions advertised.

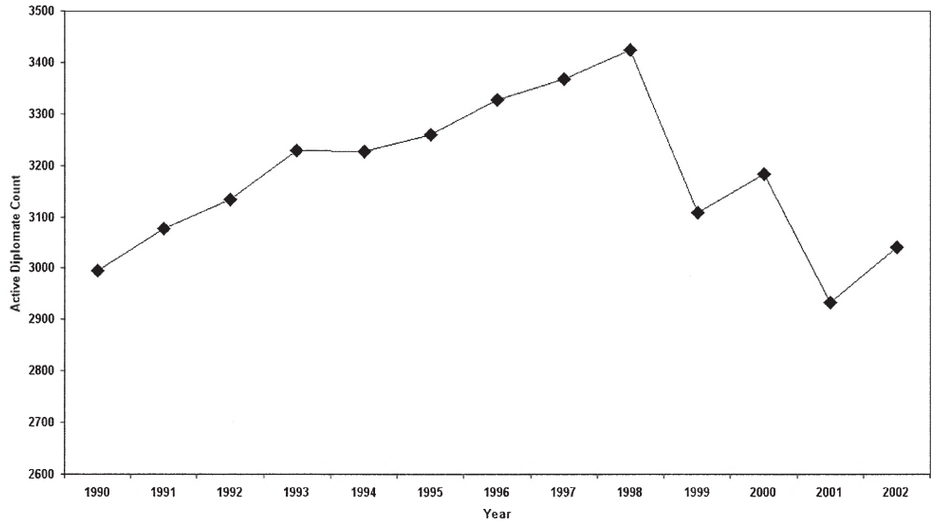

FIG. 3. Graph of data from the American Board of Neurological Surgeons showing the number of certified practicing neurosurgeons in the US. This number increased continuously from 1990 through 1998 and decreased dramatically in the next 4 years.

more available positions when the mean number per year increased from 92.6 (1985–1994) to 102.7 (1995–1998). These authors appreciated "a shift in demand toward subspecialty neurosurgery" when the mean percentage of advertised positions calling for subspecialty expertise displayed a statistically significant increase. In our study, the percentage of advertised subspecialized positions increased only slightly, representing 15.6 ± 5% from 1994 to 1998 and 18.8 ± 3% from 1999 to 2003. Although we observed an increase in the total number of subspecialty positions advertised and a small increase in the percentage of these advertised positions, the shift toward an increased emphasis on subspecialty care described by Friedlich and coworkers was not demonstrated in our study. In fact, after 2001, we observed a new trend in the opposite direction, with decreasing numbers and percentages of subspecialized positions advertised within the field of neurosurgery.

It is significant to note that during the last 5 years, appeals for neurosurgeons have continued to be predominantly those for generalists; 81.2% of all advertisements and 92% of private-practice advertisements were for generalists. The academic setting continues to request subspecialized neurosurgeons at a greater rate than the private sector, as revealed in an earlier study.[16] Although requests for spine surgeons have been advertised more than any other subspecialty, spine accounted for only 8 ± 1.8% of all advertised positions in 1999 to 2003 and 6.2 ± 2.5% in 1994 to 1998, which did not reflect a statistically significant change. In

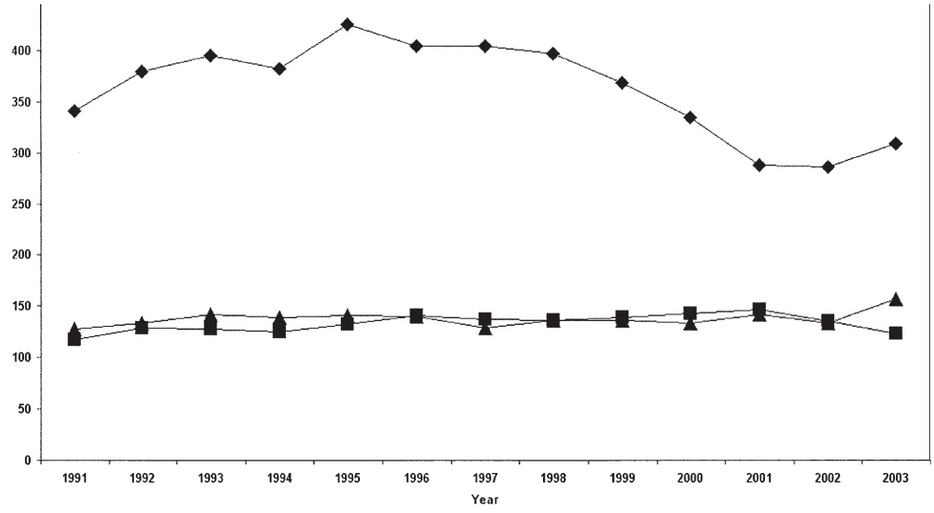

FIG. 4. Graph displaying the number of residency applications *(diamonds)*, the number of neurosurgical residency positions *(triangles)*, and the number of matriculating residents *(squares)* from 1991 through 2003. Although the number of positions matched and the number of residents graduating did not change significantly during the period shown, the number of applicants to the neurosurgical match shows a downward trend.

contrast, Friedlich, et al.,[16] demonstrated a statistically significant increase in the number of private spine positions advertised. They postulated that this increase might be due to an enlarging market share in the field of neurosurgery. In our study, the stable market share of subspecialists together with an approximately 100% increase in the number of neurosurgical positions may reflect an early trend of requesting and hiring generalists to fill the many open positions. It might also suggest that residents are receiving better job training in spine work, for example, and it is not necessary for a specialist to fill the role.

The significant increase in the number of available positions along with a possible end to the trend of hiring subspecialists supports the assertion that the increased number of advertised positions may reflect an actual societal need for neurosurgeons rather than a move to enlarge the market share for the field of neurosurgery or to expand practices. Further supporting the idea that the increased number of available positions reflects an actual need is the fact that 758 board-certified neurosurgeons, representing 25% of the neurosurgical workforce, retired from 1999 to 2001.[4,30] Additionally, the supply of active neurosurgeons in late 2002 was approximately equivalent to that 12 years earlier, whereas the population of the US increased by more than 10% from 1990 to 2000,[41,42] meaning that the number of neurosurgeons is actually failing to keep up with the population. In 2003, 297 available positions needed to be filled, most likely because of increased retirements, and only 124 residents had graduated to fill these positions. The increased retirement rate is likely due in part to the current medical liability crisis, which has exerted strain on practitioners of neurosurgery and has made continued practice in many regions of the country fiscally untenable, as well as to other factors that are creating dissatisfaction with practice.[11,21,30]

Another way to judge whether there is, in fact, an increased need for neurosurgeons is to determine whether the country is receiving adequate neurosurgical care. In this regard, hospitals around the country are reporting difficulties in hiring neurosurgeons and increased neurosurgical job vacancies, particularly in the private sector.[3] Recently, the Massachusetts Medical Society's 2004 Physician Workforce Study[27] revealed neurosurgery as the only field with a critical situation; that is, 43% of staff presidents of community hospitals noted a shortage in neurosurgeons, up from 23% in 2003. Data from this study demonstrated that it took longer to fill a neurosurgical vacancy than one in any other field (30 months), that the applicant pool was inadequate, and that 18% of patients had noted a delay in seeing a neurosurgeon.[27] Another area of concern has been the difficulty in finding a neurosurgeon to cover trauma calls. Recent press accounts reported closures of trauma centers in Pennsylvania, West Virginia, Missouri, and Florida due to shortages of neurosurgeons.[3,5,17,19] Authors of other media reports have described hospitals in jeopardy of losing accreditation status because of an insufficient number of neurosurgeons to cover trauma calls.[22,40]

Data in these reports are supported by evidence from a report by the National Foundation for Trauma Care[29] that indicates that neurosurgeons are crucial participants in trauma care. After trauma surgeons, neurosurgeons represent the specialists with the highest percentage of reimbursements for trauma care, even exceeding those for orthopedic surgeons and anesthesiologists. According to this same report, physician shortages caused by a variety of factors, including malpractice market turmoil and decreased reimbursement, represent one of the major reasons for the closure of trauma centers. The authors noted that difficulties in covering trauma calls are also due to an emphasis among physicians toward subspecialization.[29] The reluctance among subspecialists to cover trauma calls means that trauma care is left to a rapidly shrinking number of physicians. With estimates that 10 to 20% of the nation's 600 regional trauma centers will close within 3 years,[29] it appears quite likely that neurosurgeon shortages are affecting the availability of trauma care in the US.

Neurosurgeon shortages impact the quality of care in areas other than trauma care. In some areas, the demand for neurosurgical care is so high that wait times for appointments can exceed 2 months. In one report, 50% of neurosurgical patients waited more than 8 weeks for an appointment, and 14% waited more than 12 weeks.[35]

Conclusions

To consider our data as indicative of the trend in neurosurgery, it must be assumed that the number of advertisements reflects a constant fraction of the total demand for neurosurgeons. To that end, we have focused on recruitment advertisements in the two major neurosurgical journals. There is no evidence that the other traditional methods of recruitment, including recruitment firms, mailings, or word of mouth, have changed substantially during the last 10 years. The evaluation of journal advertisements has been shown to be an objective and historically documented method of tracking the physician job market. Nonetheless, one limitation is that using journal advertisements alone may underestimate the total number of positions, with a bias toward the later time period because of the increased use of electronic advertising and job searching, which is difficult to quantify.

Our data indicate significant increases in the marketplace demand for neurosurgeons and a continued need for generalist neurosurgeons. Based on our results, however, we cannot predict whether these demands will persist.

Acknowledgment

We thank Dr. J. Wayne Meredith, Chairman of the ACS Trauma Committee, for statistics on trauma care in the US. Preliminary data from this paper appeared in the American Association of Neurological Surgeons Bulletin 12:7, 2004.

References

1. Abraham KG: Help-wanted advertising, job vacancies, and unemployment; comments and discussion, in Brainard WC, Perry GL (eds): **Brooking Papers on Economic Activity.** Washington, DC: Brookings Institute, 1987, Vol 1, pp 207–248
2. Alberstone CD, Benzel EC, Garcia D: Neurosurgery in the marketplace. **AANS Bull Spring 7:**13, 1998
3. Alliance of Specialty Medicine: **Statement of the Alliance of Specialty Medicine before the House Energy and Commerce Health Subcommittee on the Subject of Assessing the Need to Enact Medical Liability Reform: Thursday, February 27, 2003.** pp 1–12 (http://www.specialtydocs.org/liability/docs/AllianceLiabilityTestimonyEC.pdf) [Accessed 1 December 2004]

4. American Association of Neurological Surgeons, Congress of Neurological Surgeons, Council of State Neurosurgical Societies: **Neurosurgery in a State of Crisis: Report on the State of Professional Liability Insurance Rates and the Impact on Neurosurgeons and their Patients.** Washington, DC, 2002 (http://src.senate.gov/pdf/rpt_neuro092502.pdf) [Accessed 1 December 2004]
5. Bavley A: Independence Regional reduces trauma services. **Kansas City Star:** Kansas City, Missouri; November 1, 2003
6. Benzel E: Redefining neurosurgery to meet new market demands. **AANS Bull Spring 7:**15–16, 1998
7. Bergland RM: Neurosurgery may die. **N Engl J Med 288:** 1043–1046, 1973
8. Blackstone EA: Market power and resource misallocation in medicine: the case of neurosurgery. **J Health Polit Policy Law 3:** 345–360, 1978
9. Boschan C: Job openings and help-wanted advertising as a measure of cyclical fluctuations in unfilled demand for labor, in **The Measurement and Interpretation of Job Vacancies.** New York: Columbia University Press, 1966
10. Burch SW, Fabricant RA: A further comment on the behavior of help-wanted advertising. **Rev Econ Stat 50:**278–281, 1968
11. Campbell DA Jr, Sonnad SS, Eckhauser FE, Campbell KK, Greenfield LJ: Burnout among American surgeons. **Surgery 130:** 696–705, 2001
12. Cohen MS, Solow RM: The behavior of help-wanted advertising. **Rev Econ Stat 49:**108–110, 1967
13. Cohen MS, Solow RM: The behavior of help-wanted advertising: a reply. **Rev Econ Stat 52:**442–443, 1970
14. Cooper RA: There's a shortage of specialists: is anyone listening? **Acad Med 77:**761–766, 2002
15. Forman HP, Kamin DS, Covey AM, Sunshine JH: Changes in the market for diagnostic radiologists as measured through a help wanted index. **AJR 174:**933–938, 2000
16. Friedlich DL, Feustel PJ, Popp AJ: Workforce demand for neurosurgeons in the United States of America: a 13-year retrospective study. **J Neurosurg 90:**993–997, 1999
17. Goldstein J, Loyd L: Abington suspends trauma center. **Philadelphia Inquirer:** Philadelphia, Pennsylvania, December 19, 2002
18. Gujarati D: Cyclical behavior of help-wanted index and the unemployment rate. **Rev Econ Stat 51:**482–484, 1969
19. Haner-Dorr N: Orlando Regional requests extension of trauma center closure notice. **Orlando Business Journal:** Orlando, Florida; August 20, 2003
20. Jimenez D: A state in crisis: Missouri. Neurosurgeon offers PLI Survey as a template for others. **AANS Bull Fall 12:**16–17, 2003
21. Jonasson O, Kwakawa F: Retirement age and the work force in general surgery. **Ann Surg 224:**574–582, 1996
22. Kettler B: Neurosurgeon shortage affects broader region. Local hospitals don't have enough specialists to treat patients from neighboring counties. **Mail Tribune:** Jackson County, Oregon, May 18, 2003
23. Kronick R, Goodman DC, Wennberg J, Wagner E: The marketplace in health care reform. The demographic limitations of managed competition. **N Engl J Med 328:**148–152, 1993
24. Kwok YS, Kim C, Bernacki R: Changes in demand for internal medicine specialists and generalists in the 1990s. **Am J Med 115:** 254–255, 2003
25. Lunsford LD, Kassam A, Chang YF: Survey of United States neurosurgical residency program directors. **Neurosurgery 54:** 239–247, 2004
26. Mason HR: Manpower needs by specialty. **JAMA 219:** 1621–1626, 1972
27. Massachusetts Medical Society: **The Massachusetts Medical Society Physician Workforce Study, May 2004.** 2004, pp 1–105 (http://www.massmed.org/pages/workforce04.pdf) [Accessed 1 December 2004]
28. McClendon BJ, Politzer RM, Christian E, Fernandez ES: Downsizing the physician workforce. **Public Health Rep 112:**231–239, 1997
29. National Foundation for Trauma Care: **U.S. Trauma Center Crisis: Lost in the scramble for terror resources, May 2004.** Irvine, CA, 2004 (http://www.traumacare.com/NFTC_CrisisReport_May04.pdf) [Accessed 1 December 2004]
30. Orrico K: Federal medical liability reform: neurosurgeons plan to preserve patients' access to care. **AANS Bull Fall 12:**7, 8, 10, 17; 2003
31. Popp AJ: Neurosurgical workforce: examining the physician supply controversy. **AANS Bull Spring 9:**7–9, 2000
32. Popp AJ: The neurosurgical workforce: market effects, public policy, and professional constraints, in Bean JR (ed): **Neurosurgery in Transition: The Socioeconomic Transformation of Neurological Surgeons, Vol 9: Concepts in Neurosurgery.** Baltimore: Williams & Wilkins, 1998, pp 112–132
33. Popp AJ, Toselli R: Work force requirements for neurosurgery. **Surg Neurol 46:**181–185, 1996
34. Preston NL: **The Help-Wanted Index: Technical Description and Behavioral Trends: A Research Report from the Conference Board's Division on Economic Research.** New York: Conference Board, 1977
35. Saint Louis Regional Health Commission: **Building a Healthier Saint Louis.** Saint Louis, Missouri, 2003 (http://www.stlrhc.org/media/RHC_FullReportCLR.pdf) [Accessed 1 December 2004]
36. Seifer SD, Troupin B, Rubenfeld GD: Changes in marketplace demand for physicians: a study of medical journal recruitment advertisements. **JAMA 276:**695–699, 1996
37. Sheldon GF: Great expectations: the 21st century health workforce. **Am J Surg 185:**35–41, 2003
38. Sunshine JH, Lewis RS, Schepps B, Forman HP: Data from a professional society placement service as a measure of the employment market for physicians. **Radiology 224:**193–198, 2002
39. Tarlov AR: HMO enrollment growth and physicians: the third compartment. **Health Aff (Millwood) 5:**23–35, 1986
40. Trone K: Trauma center lacking surgeons this weekend. **The Desert Sun:** Palm Springs, California; February 21, 2004
41. U.S. Department of Commerce: **Statistical Abstract of the United States, 1990, ed 112.** Washington, DC: Government Printing Office, 1992
42. U.S. Department of Commerce: **Statistical Abstract of the United States, 2000, ed 122.** Washington, DC: Government Printing Office, 2002
43. Watts C: Neurosurgical manpower requirements for 1990: an estimate of the Graduate Medical Education National Advisory Committee. **Neurosurgery 8:**277–279, 1981
44. Weiner JP: Forecasting the effects of health reform on US physician workforce requirement. Evidence from HMO staffing patterns. **JAMA 272:**222–230, 1994
45. Wennberg JE, Goodman DC, Nease RF, Keller RB: Finding equilibrium in U.S. physician supply. **Health Aff (Millwood) 12:** 89–103, 1993
46. Zuidema GD: The SOSSUS report and its impact on neurosurgery. **J Neurosurg 46:**135–144, 1977

Manuscript received March 26, 2004.
Accepted in final form October 7, 2004.
Address reprint requests to: William T. Couldwell, M.D., Ph.D., Department of Neurosurgery, University of Utah, 30 North 1900 East, Suite 3B409, Salt Lake City, Utah 84132. email: william.couldwell@hsc.utah.edu.