Changing Trends in the Use and Costs of Procedures Performed by Neurosurgeons in the United States

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Understanding the changes in procedure use and total cost associated with the care of patients is important to the practice of neurosurgery. This information helps guide policies regarding workforce, training, continuing education, and research. Previous work detailing neurosurgical practice has been limited by focusing on specific procedures (e.g., craniotomy, carotid endarterectomy, etc.) or by using nonpopulation-based analyses or surveys of professional society members (4–6, 8, 9). Such investigations may not accurately capture the change in *overall* practice within the United States or allow for comparison of changes across multiple procedures.

Periodic analysis of health care use and services is vital to understand the changes in supply and demand for specific types of health services, changes in the dollars spent for those services, and potential areas of over/under use or spending. Such analysis is particularly important for neurosurgery because it is a dynamic, technology-driven field, the services provided have a high human impact and often a high cost, and the supply of practitioners is stable and fixed.

This investigation provides population-based estimates and overall trends in discharge rates and hospital charges for inpatient procedures commonly performed by neurosurgeons in the United States. In doing so, it will serve to guide future workforce needs, resource allocation, training and education structures, and research priorities within neurosurgery.

METHODS

All clinical data was collected from the Nationwide Inpatient Sample (NIS) for the years 1997 to 2003 using the HCUPnet interface.[1] The NIS is an all-payer, 20% random sample of US hospitals developed and maintained by the Agency for Healthcare Research and Quality. Diagnostic Related Groups (DRGs) that pertain to inpatient procedures performed by neurosurgeons were used to generate the weighted sample population (estimated N = 6,172,258). The procedures were categorized as craniotomy (DRGs: 1–3, 484, 529, 530), spine procedures (with fusion-specified DRGs: 496–498, 519, 520; without fusion-specified DRGs: 4, 214, 215, 499, 500, 531, 532), extracranial vascular procedures (EVP) (DRG: 5), or other procedures (DRGs: 6–8). Precise DRGs to distinguish spine procedures with and without fusion were not available in 1997; therefore, subanalysis for that year was not performed. Discharges and total hospital charges annually for each procedure grouping were assessed. Population adjustments were made on the basis of US census data, and dollar values were adjusted (to the year 2003) using the consumer price index for hospital-related services.[2,3] Total US hospital discharges were calculated annually to provide estimates of use rates for each procedure compared with overall discharges. The "National Bill" (total charges for all hospitalizations) was calculated annually to provide estimates of charges for each procedure compared with overall charges. Weighted estimates and standard errors were calculated through HCUPnet using SUDAAN software.[7] Weighted estimates were compared using a Z-test calculator. A P level less than 0.05 was considered significant for all analyses.

RESULTS

Overall, hospital discharges for neurosurgical procedures increased from 823,972 in 1997 to 937,020 in 2003 (relative

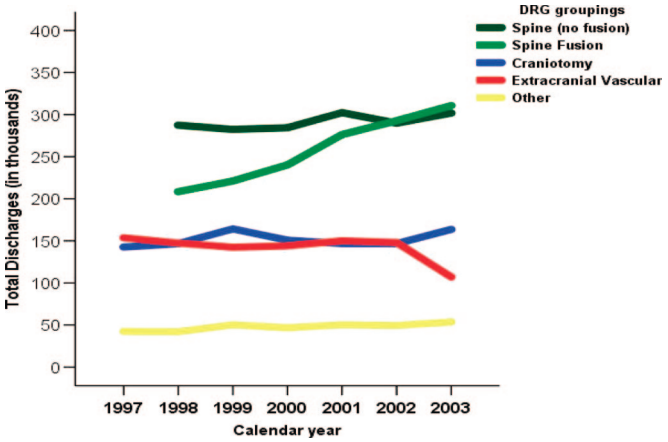

FIGURE 34.1. Discharge rates from US hospitals over time for procedures performed by neurosurgeons. Trends were significant for all spine fusion procedures ($P < 0.001$), EVP ($P < 0.001$), and other procedures ($P = 0.002$). The trends for craniotomy ($P = 0.06$) and spine, no fusion ($P = 0.36$) did not reach statistical significance.

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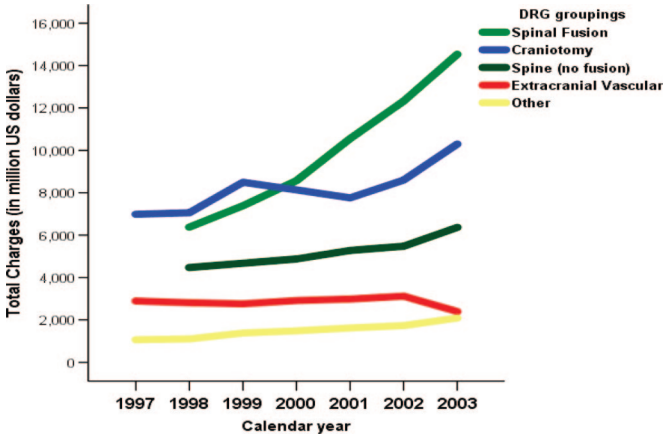

FIGURE 34.2. Total hospital charges in the United States for procedures performed by neurosurgeons. Figures were adjusted to 2003 US dollars. Trends were significant for craniotomy ($P < 0.001$), all spine ($P < 0.001$), EVPs ($P = 0.003$), and other procedures ($P < 0.001$).

increase [RI] = 14%; $P < 0.001$). For all spine procedures, discharges increased from 485,302 to 612,606 (RI = 26%; $P < 0.001$) (*Fig. 34.1*). Of these, 208,483 (42.0%) in 1998 and 310,749 (50.7%) in 2003 were for spine fusion. Discharges for craniotomy increased from 142,622 to 163,669 (RI = 15%) during the time period ($P = 0.06$). A decrease in EVPs ($P < 0.001$) and a modest increase in other procedures ($P = 0.002$) was observed during the time period. The total charges increased from $10.5 billion to $20.8 billion for all spine procedures ($P < 0.001$) and from $7.0 billion to $10.3 billion for craniotomies ($P < 0.001$) (*Fig. 34.2*). The charges associated with EVPs decreased by $0.5 billion ($P = 0.003$) and other procedures increased by $1 billion ($P < 0.001$).

Table 34.1 provides the population-based changes in use for each procedure. Trends were significant for all spine procedures ($P < 0.001$), other ($P = 0.002$), and EVPs ($P < 0.001$). The trend for craniotomy did not reach statistical significance ($P = 0.06$). *Table 34.2* demonstrates the changes in hospital use for each procedure. Spine procedures (particularly those with fusion) increased in terms of share of overall hospital discharges. *Table 34.3* demonstrates the percentage of the overall "National Bill" contributed by each procedure. The combined share for these procedures was 4.03% in 1997 and 4.74% in 2003. Spine procedures increase their share by 0.79%, whereas craniotomy, other, and EVP changed 0.06%, 0.08%, and -0.22%, respectively.

CONCLUSIONS

The findings of this investigation demonstrate the dynamic nature of the contemporary practice of neurosurgery even during a short time period. Spine procedures experi-

TABLE 34.1. Estimated use rate per 100,000 (US population) for procedures performed by neurosurgeons[a]

	Calendar year						
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Craniotomy	52	53	59	54	52	51	56
All spine procedures	178	180	180	186	203	203	211
No fusion	—	104	101	101	106	101	104
Fusion	—	76	79	85	97	102	107
Extracranial vascular procedures	56	53	51	51	53	51	37
Other	16	15	18	17	18	17	18

[a]—, data not available.

TABLE 34.2. Estimated use rate (per 1000 US hospital discharges) for procedures performed by neurosurgeons

	Calendar year						
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Craniotomy	4.1	4.2	4.6	4.1	3.9	3.9	4.3
All spine procedures	14	14.3	14.2	14.4	15.5	15.4	16
No fusion	—	8.3	8.0	7.8	8.1	7.7	7.9
Fusion	—	6.0	6.2	6.6	7.4	7.7	8.1
Extracranial vascular procedures	4.4	4.2	4.0	4.0	4.0	3.9	2.8
Other	1.2	1.2	1.4	1.3	1.4	1.3	1.4

[a]—, data not available.

TABLE 34.3. Percentage of the "National Bill" (all inpatient hospital charges) attributed to procedures performed by neurosurgeons[a]

	Calendar year						
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Craniotomy	1.31	1.30	1.50	1.33	1.21	1.22	1.37
All spine procedures	1.98	2.01	2.14	2.20	2.46	2.52	2.77
No fusion	—	0.83	0.83	0.80	0.82	0.78	0.84
Fusion	—	1.18	1.31	1.40	1.64	1.74	1.93
Extracranial vascular procedures	0.54	0.52	0.49	0.48	0.46	0.44	0.32
Other	0.20	0.20	0.24	0.24	0.25	0.25	0.28

[a]—, data not available.

enced large increases in overall use (both population and hospital adjusted) and charges during this period. Much of that increase was caused by the increasing number of spine fusions performed. Modest increases were found for craniotomy and other procedures. EVPs experienced a decline in both use and charges. These data should be used to guide future workforce, training, and research initiatives within neurosurgery. They also demonstrated the need to continuously monitor the changes of our practice.

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