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Reimbursement patterns for neurosurgery: Analysis of the NERVES survey results from 2011–2016

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ABSTRACT

Objective: In response to rising national health expenditures, the Patient Protection and Affordable Care Act (ACA) was passed in 2010, with major provisions implemented in 2014. Due to increasing concerns about workload and compensation among neurosurgeons, we evaluated trends in neurosurgical reimbursement, productivity and compensation before and after the implementation of the major provisions of the ACA.

Patients and Methods: Results from Neurosurgery Executives' Resource Value and Education Society (NERVES) annual surveys were collected, representing data from 2011 to 2016. Responses from different practice settings across the six years were categorized into groups, and inverse variance-weighted averaging was performed within the frameworks of a one-way ANOVA model with year. Data from 2011 to 2013 and 2014–2016 were analyzed similarly for differences among practice setting and region.

Results: The NERVES survey response rates ranged from 20% to 36%. Median values for compensation decreased by 3.66%, 6.42%, and 10.34% within private, hospital, and academic practices respectively after 2014 although these trends did not reach statistical significance. Median work RVUs had a trend to decrease by 5.67%, 13.08%, and 19.44% within private, hospital, and academic practices respectively after 2014. Academic practices showed statistically significant decreases in annual total RVUs, total gross charges and collections.

Conclusion: These data demonstrate neurosurgical reimbursement and productivity have trended down during a time that increases in productivity and reimbursement were predicted. This phenomenon is most notable in academic practices compared to private or hospital based practices. Prospective analyses of the impact of healthcare policy reform on neurosurgical productivity are urgently needed.

1. Introduction

With the advent of Medicare and Medicaid in the 1960s, the fee-for-service model which had previously defined physician-reimbursement was challenged by the managed-care models dictated by third-party payers [1]. In the 1990s, Hsaio proposed the relative value unit (RVU), a method of factoring resource input cost into physician reimbursements [2–5]. The RVU and fee-for-service model has been changing significantly for the past three decades. In 2010, the Patient Protection and Affordable Care Act (ACA) was enacted with major provisions coming into effect in 2014 [6,7]. The recent legislation has accelerated the shift towards value-based purchasing, bundled payment models, and accountable care organizations (ACOs) [8].

Through all of these changes, national health expenditures have continued to increase, reaching $3.3 trillion and 17.9% of gross domestic product in 2016 [9]. Fee-for-service payment models are being eroded by alternative payment models (APMs) introduced by the CMS Innovation Center and ACOs [8,10–12]. While the fee-for-service model remains the dominant reimbursement model in the US healthcare system, third-party payers are gradually moving towards APMs in order to control costs. In APMs, such as value-based bundled payment models, a single payment is given to providers for care associated with a specific condition or procedure for a predefined period of time. In this model, payers de-incentivize individual productivity and value is added to patient outcomes and complication reduction, thereby reducing drivers of healthcare expenditure by shifting costs exceeding the monetary allotment per patient to hospitals and physicians [8,13]. Many physicians feel that these reimbursement changes have created

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additional bureaucratic burden and have decreased physician salaries.

We aimed to establish the trends in RVUs generated and reimbursement using a nationwide survey of neurosurgeons. The Neurosurgery Executive Resource Value and Education Society (NERVES) was established in 2002 and functions to strengthen neurosurgical practices by providing regulatory information and management strategies to neurosurgery administrators. The annual socioeconomic survey asks a series of questions to practice managers to provide benchmarking data to neurosurgical practices [14]. Given the changes to the US healthcare delivery system, the purpose of this study was to evaluate the NERVES annual socioeconomic survey data and describe how practice setting affects neurosurgeon reimbursement and compensation in the context of the current healthcare climate by comparing reimbursement and productivity before and after the implementation of major provisions of the ACA.

2. Patients and methods

Permission was obtained from the Neurosurgery Executives' Resource Value & Education Society (NERVES) to use the survey results for the purposes of this study. Data was collected from NERVES Socioeconomic survey reports representing surveys administered from 2011 to 2016 [15]. The survey questionnaire was developed by Katz, Sapper & Miller healthcare consulting and accounting firm and members of the NERVES survey committee. With respect to annual RVUs and annual work RVUs the data reported in the NERVES surveys was normalized by the standard of a 1.0 clinical full-time equivalent (FTE) neurosurgeon basis beginning in 2014. All reported nominal dollar amounts were adjusted to 2016 real dollars using GDP deflator indices provided by the Bureau of Economic Analysis, US Department of Commerce.

2.1. Statistical analysis

The goal of our analysis was to obtain a single summary estimate of the survey responses to each question and compare among the estimates from different practice settings over the entire period 2011–2016, and separately for the years before and after 2014.

The survey responses for each practice setting and year pair was modeled via a lognormal distribution, with the log-location parameter being estimated by the natural logarithm of the provided median income, and the log-scale parameter being estimated by the ratio of the provided income standard deviation to the provided mean income. Based on the responses from different practice settings across the six years categorized into Before/After 2014 groups, we performed a one-way ANOVA with practice setting (Private/Hospital/Academic) as the sub-group factor. A usual one-way ANOVA assumes homoscedasticity, i.e., equal variance for each outcome (log median income specific to each practice setting and year), which was not the case in this study (the reported variances differed across practice settings and years). To account for this variability, we considered inverse variance-weighting within the framework of one-way ANOVA [16]. Within this framework, we used F-tests to detect any significant difference among sub-group means and/or the interaction means for each survey question. For survey questions with a significant F-test ($\alpha = 0.05$), we followed up with pairwise comparison of sub-group means via Tukey's honest significant difference (HSD) test at confidence level 95% (NOTE: In the column for mean separation, sub-categories sharing a number (such as '1') are not significantly different. In other words, statistically significant differences within groups (as determined by $p < 0.05$) are denoted by differing Tukey numericals). Lognormal log-location estimates (and 95% confidence intervals) were back-transformed to median estimates. All calculations were done in R version 3.5.1 (R Core Team, 2018), and the packages 'tidyverse' (Wickham, 2017) and 'emmeans' (Lenth, 2018).

Table 1
NERVES Study Sample Sizes and Response Rates.

Data Year	2011	2012	2013	2014	2015	2016
Number of Practices	73	63	98	90	94	96
Total Neurosurgeons	432	415	580	692	794	814
Response Rate (%)	22	20	27	36	36	36

3. Results

The NERVES survey was administered to 243 member practices and additional nonmember practices. The response rate ranged from 20 to 36%. The number of responding practices and number of neurosurgeons represented are shown in Table 1.

Analysis of survey metrics between practice settings (Table 2) demonstrates a statistically significant difference in neurosurgeon annual compensation, with, hospital-employed ($915,112.64) neurosurgeons earning more than those employed in physician-owned practices ($819,369.73), who respectively earn more than those employed in academic practices ($655,868.98) [$p < 0.05$ between subgroups]. Annual collections are higher among physician-owned groups ($1,091,038.19) compared to hospital-employed ($798,945.77) and academic practices ($783,570.06) [$p < 0.05$]. Academic practices have less new patients, annual contractual adjustments and annual bad debt write-off adjustments than their counterparts in physician-owned and hospital-employed practices [$p < 0.05$]. Hospital-employed neurosurgeons reported fewer gross charges per wRVU ($239 vs $286 and $299 for physician-owned and academic groups) [$p < 0.05$] and had the lowest collections per wRVU ($72/wRVU vs $98/wRVU and $85/wRVU compared to physician-owned and academic groups) [$p < 0.05$ vs. physician-owned practices]. However, compensation per wRVU was similar across all three groups.

Analysis of within group differences since the implementation of the major provisions of the ACA (Table 3), represented by data from periods 2011–2013 ("before 2014") and periods 2014–2016 ("after 2014"), demonstrated that median compensation within all groups (physician-owned, hospital-employed and academic practices) showed a trend for decrease after 2014. Among academic practices, there was a 24% decrease in gross charges before 2014 ($2,812,296.51) as compared to after 2014 ($2,149,578.71) [$p < 0.05$] as well as a 20% decrease in collections before 2014 ($874,040.70) compared to after 2014 ($701,846.68) [$p < 0.05$]. Decreases are also suggested in annual collections for private (2.58%) and hospital-based (12.27%) practices before and after 2014, although these analyses did not achieve statistical significance. Hospital-employed neurosurgeons had a reduction in the number of annual new patients after 2014 (294) when compared to before 2014 (460) [$p < 0.05$], a decrease of 36%. The change in the number of new patients before and after 2014 for private (-11.56%) and academic practices (−17.53%) appears to trend downwards but did not achieve statistical significance. There was a 29% decrease in estimated median annual total RVUs before and after 2014 for academic practices from 21,853 to 16,304 [$p < 0.05$]. The remainder of the comparisons were not statistically significant within any practice setting when analyzed before/after 2014 including annual compensation, contractual adjustments, bad debt write-offs, primary surgeries performed, work RVUs, as well as gross charges, collections, or compensation per wRVU.

Subtle decreases are suggested across all practice settings in annual compensation (−3.66%, −6.42%, and −10.27% respectively for private, hospital-based, and academic practices) and work RVUs produced (−5.67%, −13.08%, and −19.44% respectively for private, hospital-based, and academic practices), though these analyses did not achieve statistical significance. Additional decreases are suggested in annual collections for private (−2.58%) and hospital-based (−12.27%) practices before and after 2014.

Table 2
NERVES Survey Questionnaires from 2011 to 2016 by Practice Setting.

Question	Practice Setting	Estimated Median	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Tukey HSD separation (95% level)
Neurosurgery Annual Compensation	*Physicians*	$819,369.73	$765,406.64	$877,137.35	1
	Hospital	$915,112.64	$870,783.96	$961,697.94	2
	Academic	$656,709.79	$615,961.07	$700,154.22	3
Neurosurgeon Annual Gross Charges	*Physicians*	$3,370,724.49	$3,103,797.78	$3,660,606.91	1
	Hospital	$2,674,552.05	$2,463,797.22	$2,903,334.98	2
	Academic	$2,494,792.94	$2,233,322.29	$2,786,875.78	2
Neurosurgeon Annual Collections	*Physicians*	$1,091,038.19	$994,219.69	$1,197,285.01	1
	Hospital	$798,945.77	$729,821.66	$874,616.88	2
	Academic	$783,570.06	$701,390.81	$875,377.92	2
Neurosurgeon Annual Contractual Adjustements	*Physicians*	$1,974,053.73	$1,732,329.53	$2,249,507.42	1
	Hospital	$1,907,605.59	$1,671,631.24	$2,176,891.06	1
	Academic	$1,347,804.37	$1,160,582.64	$1,565,228.16	2
Neurosurgeon Annual Bad Debt Write-Off Adjustments	*Physicians*	$54,839.34	$39,698.46	$75,754.92	1
	Hospital	$56,498.96	$43,426.32	$73,506.87	1
	Academic	$24,412.15	$16,679.73	$35,729.19	2
Neurosurgeon Annual Primary Surgeries Performed	*Physicians*	291.37	261.85	324.21	1
	Hospital	303.76	256.67	359.50	1
	Academic	247.78	212.64	288.75	1
Neurosurgeon Annual New Patients	*Physicians*	430.65	367.16	505.11	1
	Hospital	385.48	322.82	460.29	1
	Academic	281.86	237.25	334.87	2
Neurosurgeon Annual Total RVUs	*Physicians*	21,365.78	18,026.09	25,324.22	1
	Hospital	19,822.27	15,240.15	25,782.07	1
	Academic	16,397.88	13,662.18	19,681.38	1
Neurosurgeon Annual Work RVUs	*Physicians*	11,550.37	10,272.99	12,986.57	1
	Hospital	11,600.12	10,387.80	12,953.91	1
	Academic	8,904.93	7,884.35	10,057.61	2
Neurosurgeon Annual Gross Charges WRVUs	*Physicians*	$285.71	$268.57	$303.95	1
	Hospital	$238.73	$227.20	$250.83	2
	Academic	$298.99	$266.65	$335.26	1
Neurosurgeon Annual Collections per WRVUs	*Physicians*	$98.45	$89.17	$108.71	1
	Hospital	$72.26	$68.05	$76.73	2
	Academic	$85.28	$75.44	$96.41	12
Neurosurgeon Annual Compensation per WRVUs	*Physicians*	$79.06	$73.92	$84.55	1
	Hospital	$80.52	$75.39	$85.99	1
	Academic	$79.04	$66.45	$94.00	1

Physicians (Physician-owned private practices), Hospital (Hospital-employed) Academic (Academic practices). Tukey HSD separation sub-categories sharing a letter (such as '1') are not significantly different at a 95% confidence level. Sub-categories who do not share a letter are statistically significant at $p < 0.05$.

4. Discussion

Changes in healthcare are impacting neurosurgical practice and compensation. Our data suggest that overall neurosurgical work volume and compensation over the past several years have decreased. In terms of annual gross charges, collections, and total RVUs academic practices demonstrate a statistically significant decrease since 2014 despite the normalization of NERVES survey responses for total annual RVU and wRVU by the standard of a 1.0 clinical full-time equivalent (FTE) neurosurgeon basis beginning in 2014 (which would minimize the difference). While not a statistically significant difference, the magnitude of decrease in the median number of annual surgeries performed has been most dramatic in academic practices compared to private practice and hospital employed neurosurgeons.

In the context of macroeconomic changes in the US, these findings are more robust. The US was recovering from the recent financial crisis leading to the great recession. As a result of the recent economic decline, the unemployment rate was near historical highs at the beginning of the study period (9.1%) and down trended to more normal levels by the end of the period (4.7%) [17]. The employment rate, a rate of those under retirement age who are working, increased almost three hundred basis points to 69.6% [18]. Both factors, in addition to the ACA provisions, would expect to lead to an increase in the insured population leading to an increase in patient pool (specifically non-Medicare practices), and improve collections with a reduction in write-offs. However, this effect was not noted. Annual new patients were decreased in the after 2014 group, suggesting no significant increase in patient pool, while the number of primary surgeries were relatively flat with a trend decrease in the annual wRVUs. The relatively unchanged number of primary surgeries being performed is consistent with prior studies modeling these healthcare reforms [19–21]. Since the implementation of the ACA and expansion of Medicaid, changes in payer mix have largely contributed to the steep decline in uncompensated care to hospitals which appears to be reflected in hospital-employed neurosurgeon and academic practices annual contractual and bad debt write-off adjustments whereas in physician-owned groups annual contractual adjustments and bad debt adjustments have increased.

With regards to physician reimbursement, some reports predicted physicians would see wage increases of 15% by 2016 and up to 30% by 2021 with most of that increase noted within the first two years [22]. However, according to the survey data, the real neurosurgeon annual compensation had an overall decline after 2014 while annual compensation per wRVU remained stable. Even though during the same time consumer prices for medical services increased by 20% and real median personal income in the US increased by 9.6% [23], the notable increases were not seen in real annual neurosurgical compensation or compensation by wRVU [23,24].

Despite increase in regulatory burden, most neurosurgical practices have embraced ACA plans. A 2017 survey of neurosurgical practice leaders conducted by the AANS and CNS [25] indicated that 82% of neurosurgeons accepted patients insured under ACA exchange plans, with an additional 12% of neurosurgeons accepting exchange-insured patients in limited number. This is compared to 66% of neurosurgeons accepting Medicaid and an additional 21% accepting a limited number of Medicaid-covered patients, with many reporting they only see new Medicaid patients through trauma or emergency department call.

Table 3
NERVES survey results 2011–2016, within practice setting analysis before and after 2014.

Question	Practice Setting	Year	Estimated Median	↓/↑ after 2014	Percent Change	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Neurosurgery Annual Compensation	*Physicians*	Before 2014	$834,069.96	↓	−3.66%	$751,866.21	$925,261.29
		After 2014	$803,525.65			$720,740.93	$895,819.06
	Hospital	Before 2014	$944,238.93	↓	−6.42%	$875,740.65	$1,018,094.96
		After 2014	$883,627.51			$816,010.40	$956,847.58
	Academic	Before 2014	$711,687.53	↓	−10.27%	$619,322.77	$817,827.41
		After 2014	$638,625.87			$588,392.02	$693,148.43
Neurosurgeon Annual Gross Charges	*Physicians*	Before 2014	$3,321,628.69	↑	3.56%	$2,986,106.88	$3,694,850.04
		After 2014	$3,439,887.19			$3,034,822.98	$3,899,016.19
	Hospital	Before 2014	$2,643,484.56	↑	2.46%	$2,363,174.63	$2,957,043.69
		After 2014	$2,708,428.08			$2,410,965.87	$3,042,590.84
	Academic	Before 2014	$2,812,296.51	↓**	−23.57%	$2,429,632.20	$3,255,230.02
		After 2014	$2,149,578.71			$1,826,113.24	$2,530,340.69
Neurosurgeon Annual Collections	*Physicians*	Before 2014	$1,103,361.12	↓	−2.58%	$977,436.45	$1,245,508.86
		After 2014	$1,074,945.26			$935,081.82	$1,235,728.57
	Hospital	Before 2014	$847,831.00	↓	−12.27%	$751,600.73	$956,381.98
		After 2014	$743,776.26			$651,645.01	$848,933.27
	Academic	Before 2014	$874,040.70	↓**	−19.70%	$749,367.94	$1,019,455.35
		After 2014	$701,846.68			$601,363.95	$819,119.20
Neurosurgeon Annual Contractual Adjustments	*Physicians*	Before 2014	$1,884,721.36	↑	11.13%	$1,511,350.03	$2,350,332.17
		After 2014	$2,094,454.35			$1,631,768.12	$2,688,334.80
	Hospital	Before 2014	$1,983,489.57	↓	−8.94%	$1,593,581.64	$2,468,797.81
		After 2014	$1,806,175.02			$1,393,999.81	$2,340,221.41
	Academic	Before 2014	$1,390,062.10	↓	−7.69%	$1,091,733.33	$1,769,912.65
		After 2014	$1,283,134.13			$945,933.91	$1,740,537.25
Neurosurgeon Annual Bad Debt Write-Off Adjustments	*Physicians*	Before 2014	$51,427.60	↑	20.30%	$33,064.92	$79,988.03
		After 2014	$61,866.58			$33,778.14	$113,312.15
	Hospital	Before 2014	$64,278.04	↓	−31.84%	$44,991.25	$91,832.66
		After 2014	$43,811.24			$26,548.17	$72,299.70
	Academic	Before 2014	$18,004.90	↑	72.81%	$9573.91	$33,860.40
		After 2014	$31,113.51			$17,705.37	$54,675.52
Neurosurgeon Annual Primary Surgeries Performed	*Physicians*	Before 2014	298.04	↓	−4.28%	244.14	363.83
		After 2014	285.28			235.27	345.91
	Hospital	Before 2014	298.54	↑	2.28%	189.47	470.40
		After 2014	305.35			237.99	391.79
	Academic	Before 2014	259.61	↓	−11.81%	202.12	333.44
		After 2014	228.96			165.29	317.17
Neurosurgeon Annual New Patients	*Physicians*	Before 2014	458.62	↓	−11.56%	377.99	556.46
		After 2014	405.62			335.90	489.81
	Hospital	Before 2014	460.04	↓**	−36.12%	379.29	557.98
		After 2014	293.89			231.40	373.26
	Academic	Before 2014	307.44	↓	−17.53%	252.51	374.33
		After 2014	253.55			204.03	315.10
Neurosurgeon Annual Total RVUs	*Physicians*	Before 2014	22,007.64	↓	−6.05%	18,713.14	25,882.15
		After 2014	20,675.80			17,429.90	24,526.17
	Hospital	Before 2014	*	–		*	*
		After 2014	21,446.76			17,748.81	25,915.17
	Academic	Before 2014	18,625.38	↓**	−28.76%	15,874.69	21,852.70
		After 2014	13,268.04			10,797.32	16,304.11
Neurosurgeon Annual Work RVUs	*Physicians*	Before 2014	11,915.66	↓	−5.67%	9,922.22	14,309.61
		After 2014	11,239.60			9,469.72	13,340.28
	Hospital	Before 2014	12,414.57	↓	−13.08%	10,536.27	14,627.70
		After 2014	10,790.97			9,109.97	12,782.16
	Academic	Before 2014	9,657.50	↓	−19.44%	8,193.59	11,382.96
		After 2014	7,779.73			6,292.81	9,617.98

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Table 3 (*continued*)

Question	Practice Setting	Year	Estimated Median	↓/↑ after 2014	Percent Change	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Neurosurgeon Annual Gross Charges WRVUs	*Physicians*	Before 2014	$283.21	↑	2.72%	$257.72	$311.23
		After 2014	$290.92			$254.14	$333.02
	Hospital	Before 2014	$236.89	↑	1.74%	$217.97	$257.45
		After 2014	$241.01			$219.73	$264.36
	Academic	Before 2014	$317.21	↓	− 12.81%	$262.35	$383.53
		After 2014	$276.58			$222.43	$343.92
Neurosurgeon Annual Collections per WRVUs	*Physicians*	Before 2014	$98.82	↓	− 1.17%	$85.37	$114.38
		After 2014	$97.66			$78.54	$121.43
	Hospital	Before 2014	$74.72	↓	− 8.65%	$68.10	$81.97
		After 2014	$68.26			$60.49	$77.04
	Academic	Before 2014	$84.63	↑	1.58%	$68.63	$104.37
		After 2014	$85.97			$69.29	$106.68
Neurosurgeon Annual Compensation per WRVUs	*Physicians*	Before 2014	$81.30	↓	− 7.08%	$73.02	$90.52
		After 2014	$75.54			$65.86	$86.63
	Hospital	Before 2014	$79.80	↑	2.33%	$71.79	$88.70
		After 2014	$81.66			$71.49	$93.27
	Academic	Before 2014	$74.01	↑	10.26%	$50.52	$108.43
		After 2014	$81.60			$62.53	$106.49

*Insufficient data to perform analysis.

** $p < 0.05$.

Physicians (Physician-owned private practices), Hospital (Hospital-employed) Academic (Academic practices).

Approximately 77% of respondents in the same survey reported having to regularly comply with cumbersome prior authorization procedures, frequently resulting in administrative hassle and delays in care. Continuity of care is often disrupted by frequent changes in plans and network inclusion. These results suggest that despite improved healthcare coverage there still remain significant administrative burdens for patients and providers [25].

This is an evaluation of survey data and therefore has inherent limitations. First, this study is limited similarly to the challenges faced by the authors of the original NERVES questionnaire, such as bias pertaining to the respondent group and in the accuracy and uniformity in which participants reported data. In addition, the data reported here is limited by a lack of availability to the raw survey data and is subject to any biases or errors involved in the processing of the primary data source. Given the nature of the NERVES questionnaire and the survey administration, these would likely have minimal influence over the trends report here. Another limitation faced by this study is the general paucity in breadth and depth of available economic data on this subject, limiting the scope and impact of the data analysis performed. In particular, the limited detail of data available through the NERVES survey coupled with scarcity of economic data through other sources leads to challenges attempting to further analyze trends within individual subgroups. Lastly, poor response rates limit the ability to find statistically significant differences. For example, in 2012 there were 3689 board-certified neurosurgeons working for over 5700 hospitals [26]. During the same data year, 415 of all polled neurosurgeons representing 63 practices responded to the NERVES survey.

Furthermore, the data does not incorporate reductions for co-surgeons or multiple procedure payment reduction. There is no correction for the distribution of different practice settings within each geographical region, nor variances in response rates between practice settings. There is also no statistically perfect way to account for changes in neurosurgeon managerial practices in preparation for the major provisions of the ACA. In addition, we concede that analysis of survey data subgroups of before and after 2014 is a coarse way to characterize the effects of multifaceted and wide-reaching healthcare reform legislature.

Overall, neurosurgeons have seen a trend for reduced RVUs and compensation during a time that the wage increases would have been expected in the context of concurrent macroeconomic factors. Several factors contribute to this finding. Prospective analyses of practice patterns in healthcare delivery are important to continue to influence policy making that impacts physicians and patients. Directions for further research would include more detailed analysis of economic data within practice setting and with consideration to geographic region. In order to accomplish such detailed analysis, a broader pool of available data would be essential. A change of culture regarding reporting of economic and productivity data, particularly from non-academic practices, is imperative for successful analysis of the productivity and economic trends in the context of a changing healthcare climate.

5. Conclusion

Due to profound differences in culture, business models, and motivations in different practice settings, the effects of changing payment structure will vary based on practice setting. Based on the NERVES survey data the ACA does not appear to have had drastic changes on neurosurgical practices, but a subtle trend suggesting decline has emerged. This study calls for in depth evaluation of these trends using yearly survey data to allow neurosurgeons to monitor their practices as health policy continues to evolve.

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