Does intraoperative neurophysiologic monitoring matter in noncomplex spine surgeries?

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ABSTRACT

Objectives: To determine associations between intraoperative neurophysiologic monitoring (IOM) for spinal decompressions and simple fusions with neurologic complications, length of stay, and hospitalization charges.

Methods: Adult discharges in the Nationwide/National Inpatient Sample (NIS) (2007–2012) with spinal decompressions and simple spinal fusions were included. Revision surgeries, instrumentations, complicated approaches, and tumor- and trauma-related surgeries were excluded. Extracted data included patient demographics, medical comorbidities, primary spinal surgery type, and hospital characteristics. Bivariate and multiple regression analyses using NIS survey design variables correlated IOM use with neurologic complications, hospital charges, and length of stay.

Results: IOM was reported in 4.9% of an estimated 1.1 million discharges in the weighted sample. Discharges reporting IOM were more often privately insured (61% vs 57%, $p < 0.001$) and had slightly more comorbidities (25% vs 24% with 3+ comorbidities, $p = 0.01$). Spinal fusions more often reported IOM than decompressions. The IOM group had fewer neurologic complications (0.8% vs 1.4% of controls) with no difference in length of stay (3.0 days for each group), but increased hospital charges (39% greater). Multiple regression adjustment showed significant associations of IOM with fewer neurologic complications (odds ratio 0.60, 95% confidence interval [CI] 0.47, 0.76, $p < 0.001$), while the estimated percentage of hospital charges was sizably diminished from the unadjusted analysis (IOM effect +9%, 95% CI +4%, +13%, $p < 0.001$), and length of stay was reduced (IOM effect −0.26 days, 95% CI −0.42, −0.11, $p < 0.001$).

Conclusions: IOM was associated with better clinical outcomes and some increased hospital charges among discharges of simple spinal fusions and laminectomies in a large, multiyear, nationally representative dataset. *Neurology*® 2015;85:2151–2158

GLOSSARY

CCS = Clinical Classification Software; **CI** = confidence interval; **CPT** = Current Procedure Terminology; ***ICD-9-CM*** = *International Classification of Diseases–9–clinical modification*; **IOM** = intraoperative neurophysiologic monitoring; **NIS** = Nationwide Inpatient Sample or National Inpatient Sample; **OR** = odds ratio; **SRS** = Scoliosis Research Society.

Spinal decompressions and fusions are among the most widely performed and costly surgeries in the United States,[1] carrying a small but real chance of neural injury,[2–5] with profound consequences for patient quality of life and health care costs.[6] Intraoperative neurophysiologic monitoring (IOM) can detect impending neurologic compromise, alerting the operating team to take action to avoid injury. The availability of IOM in the United States is reported to be high,[7] but the actual rate of IOM usage in spinal surgeries is largely unknown, and the decision to use IOM generally rests with the surgeon.[8]

The effectiveness of IOM has recently been challenged by empirical evaluations using retrospective case series and observational studies.[9–12] Several of these focus on surgeries where the

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perceived risk of postoperative deficits is small, concluding that IOM adds cost with no difference in clinical outcomes. These reports amplify the uncertainty of IOM effectiveness for spinal surgeries.

In this analysis, we assess the utilization of IOM in spinal decompressions and simple fusions in a large nationally representative dataset and test the hypothesis that these surgeries have better outcomes when performed with IOM.

METHODS

Data source. We examined cross-sectional inpatient discharge data from the Nationwide Inpatient Sample (2007–2011),[13] redesigned as the National Inpatient Sample for 2012[14] (NIS), the largest all-payer dataset of inpatient hospitalizations in the United States, comprising a 20% stratified sample of nonfederal community hospitals, with over 8 million discharges from over 1,000 hospitals in 46 states for 2012. Pooling of data over multiple years for analysis of trend has been provided through data design variables and instruction by the Healthcare Utilization Project of the Agency for Healthcare Research and Quality.[15,16] The sample period started with introduction of *ICD-9-CM* code for IOM on October 1, 2007,[17] ending December 31, 2012.

Standard protocol approvals, registrations, and patient consents. The University of Washington Institutional Review Board designated the NIS as a de-identified publicly available dataset and associated research projects do not require ethics approval or review. The study was carried out in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)[18] guidelines for observational studies.

Search algorithm and inclusion/exclusion criteria. We searched the NIS 2007–2012 datasets for adult inpatient discharges containing single-level Clinical Classification Software (CCS)[19] grouper procedure coding spinal decompressions (CCS = 3) and spinal fusions (CCS = 158). We searched for IOM (*ICD-9-CM* 00.94) among *ICD-9* coded procedures. We excluded revisions, surgeries with instrumentation and prosthetic discs, anterior and dorsolateral approach lumbar fusions, atlanto-axial fusions, posterior cervical fusions, fusions involving more than 3 vertebrae, and fusions involving combined anterior and posterior approaches. We also excluded discharges involving trauma or neoplasms. The selection process is detailed in figure e-1 on the *Neurology*® Web site at Neurology.org.

Data extraction, outcomes of interest, and model specification. Variables were determined by Andersen and Newman[20] criteria of enabling, predisposing, and need factors of health care utilization. Age, sex, race, 3rd-party payer status, zip code–related income, comorbidities, year and quarter of discharge, primary surgery subtype (discectomy, laminectomy, anterior cervical fusion, or thoracolumbar fusion), number of coded spinal surgical procedures, number of nonsurgical procedures (excluding IOM), total hospital charges, hospital annual discharge volume, hospital teaching status, hospital geographic region, and urban vs rural hospital status were abstracted as independent variables. Comorbidity scoring was calculated using the Elixhauser et al.[21] method, parsed into 4 dummy categories (0, 1, 2, 3, or more).[22] Discharge years were treated as categorical variables. Hospital discharge volume was a continuous measure, while other hospital-specific variables were categorical terms.

We were interested in 1 clinical and 2 nonclinical outcomes. The clinical outcome was the presence of *ICD-9* diagnostic coding for neurologic complications resulting from any services or procedures (*ICD-9* 997.0, 997.00, 997.01, 997.02, 997.09) in the reported discharge diagnoses. Nonclinical outcomes were the duration and the total charges of hospitalization.

Statistical analysis. Analyses utilized the NIS complex sample design (probability weights, stratification, and clustering) for accurate national-level estimates. Differences in totals, proportions, or means of reported variables among the exposure groups were evaluated through 2-sample t test and Pearson χ^2.[23] IOM and relevant spine surgeries were assessed for annual change in the sample and at the hospital level. Bivariate (dependent and treatment variable only) and multiple regression analyses were performed for association of IOM with the clinical and nonclinical outcomes. Multiple regressions included patient demographics, primary surgery subtype, comorbidities, and hospital variables. Logistic regression modeled IOM and neurologic complications, reporting odds ratios (ORs) and 95% confidence intervals (CIs). Hospital charges were inflated to 2012 dollars using the Consumer Price Index for medical expenditures,[24] then evaluated using a generalized linear model (gamma family) with log link for best fit. Attributable charges were reported as percentage of overall charges. Length of stay was evaluated with Poisson regression, reporting marginal effects in days. Observations with missing data were analyzed for bias and excluded if randomly distributed between treatment groups or outcomes. Significance was set at $p \leq 0.05$. All statistical testing was performed using STATA 12.1 (StataCorp, College Park, TX).

Subgroup analysis: Primary spine surgery subtypes. Descriptive statistics regarding rates of IOM use and neurologic complications, hospital charges, and length of stay were performed for association of the primary surgery subtypes of discectomy, laminectomy, cervical fusion, or thoracolumbar fusion. Inferential analyses were not performed by subgroup, owing to the anticipated reduction in sample size from the main analysis.

Sensitivity analyses. To address the availability of IOM, we limited the sample to discharges from hospitals reporting at least one IOM procedure in the same calendar year. We repeated the bivariate and multiple regression analyses for the clinical and nonclinical outcomes.

RESULTS

Study sample. An estimated 1.1 million discharges (234,067 unweighted observations) met inclusion criteria for the study period with 4.9% reported usage of IOM. Missing data accounted for <2% of observations for all covariates except race, where 12% of data in the original sample were missing. There were no missing data on primary surgery or clinical comorbidities. Between IOM and non-IOM surgeries, there was no difference in subject age or sex. IOM recipients were slightly more likely to be nonwhite, have private insurance, and come from the highest income quartile. Simple fusions were more common in monitored than unmonitored surgeries. Regional variation in IOM reporting was reflected in higher IOM prevalence in the Western geographic region (38% of total). IOM was not more likely to be performed at teaching hospitals. See table 1 for details.

Table 1 Sample characteristics by IOM status

Characteristics	No IOM	IOM	*p* Value
Discharges			
No. (unweighted)	223,200	10,867	NA
No. (estimated)	1,070,917	52,708	NA
Patient demographics			
Mean age, y	57.3	56.7	0.07
Female, %	48	48	0.96
Race, %[a]			
White	83	80	<0.001
Black	7	8	
Other	10	12	
Primary insurance, %[a]			
Public	43	39	<0.001
Private	57	61	
Income quartile (by zip code), %[a]			
1st (bottom)	23	17	<0.001
2nd	26	21	
3rd	26	27	
4th (top)	26	35	
No. coded procedures			
Surgical spine	1.9	2.2	<0.001
Nonspine surgery[b]	0.7	1.2	<0.001
Primary spine surgery, %[a]			
Anterior cervical fusion	18	28	<0.001
Posterior TL fusion	9	19	
Discectomies	34	23	
Laminectomy	39	30	
Comorbid conditions, %[a,c]			
0	29	27	0.01
1	29	28	
2	21	22	
3 or more	21	23	
Hospital characteristics, %			
Geographic region, %[a]			
Northeast	21	12	<0.001
Midwest	16	22	
South	42	28	
West	22	38	
Other			
Teaching hospital, %	55	49	0.13
Annual discharges	19,662	15,663	0.002
Urban setting, %	96	97	0.04

Abbreviations: IOM = intraoperative neurophysiologic monitoring; NA = not applicable; TL = thoracolumbar.
Reported p values are from Student t test (for reported means) or χ^2 test (for individual proportions or nonoverlapping groups of proportions).
[a] Reported proportions are for characteristics within the subcategory and treatment group.
[b] Not including IOM.
[c] Based on Elixhauser et al. method of comorbidity estimation in inpatient setting.

Table 2 Estimated annual totals and reported rates of IOM and decompressions and simple fusions

Year	Discharges with decompressions and simple fusions	Discharges with decompressions and simple fusions with IOM	Overall IOM rate for noncomplex spine surgeries, %	Hospitals[a] reporting IOM in decompressions and simple fusions	IOM rate for hospitals reporting IOM in noncomplex spine surgeries, %
2007[b]	42,589	372	0.90	129	2.20
2008	198,500	3,338	1.70	292	3.90
2009	184,381	6,927	3.80	482	7.10
2010	210,333	8,625	4.10	682	7.00
2011	250,137	16,622	6.60	843	10.10
2012	237,685	16,825	7.10	622	14.10
Annual Δ% 2008-2012	6.90	50.80	40.60	23.00	33.90

Abbreviation: IOM = intraoperative neurophysiologic monitoring.
[a] Weighted by Nationwide Inpatient Sample/National Inpatient Sample hospital weights to reflect national numbers.
[b] For discharges beginning October 1, 2007.

Yearly IOM reporting. IOM reporting grew at an annual rate of 50.8% for the full years of 2008–2012, while annual discharge estimates reporting simple fusions and laminectomies grew only 6.9% per year. Hospitals reporting IOM use in simple fusions and laminectomies increased from 292 in 2008 to 622 in 2012, an increase of 23% per year. The rate of IOM reporting in simple fusions and laminectomies in these hospitals was nearly twice the total yearly average (14.1% vs 7.1%) (table 2).

Outcomes. Neurologic complications were reported in 1.4% of unmonitored surgeries and 0.8% of monitored surgeries. Following multiple logistic regression, the adjusted OR for neurologic complications was 0.60 (95% CI 0.46, 0.76, $p < 0.001$). Estimated hospitalization charges were 39% greater with IOM ($62,999 vs $45,266), falling to a 9% increase (95% CI 4%, 13%, $p < 0.001$) after multiple regression adjustment. Length of stay was no different in the 2 groups (3.0 days for both), but a small marginal decrease (0.26 days, 95% CI 0.11, 0.42, $p < 0.001$) attributable to IOM was observed after multiple regression (tables 3 and 4).

Subgroup analysis. Descriptive analyses of the outcomes of 4 subgroups by primary surgery subtype were generally consistent with the main analysis. Laminectomies had the highest neurologic complication rate, with the largest reduction in complications for IOM usage (2.7% vs 1.7%), while anterior cervical fusions had the smallest complication rate (0.2% vs 0.15% for IOM and no IOM groups, respectively). Length of stay was largely unchanged by IOM status and sample-weighted unadjusted costs were greater for IOM in all groups (table 5).

Sensitivity analysis. When limiting the sample to discharges in hospitals reporting any IOM for simple fusions and laminectomies in the same calendar year, the number of discharges in the non-IOM group was reduced by 38% from the main analysis. Inferential analyses from this sample were consistent with the main analysis, showing significant reduction in neurologic complications, increased total charges, and reduced length of stay in the IOM group, which were robust to multiple regression (table e-1).

Table 3 Sample-weighted clinical and nonclinical outcomes by IOM status

	Neurologic complications, %	Total hospitalization charges	Length of stay, d
No IOM	1.4	$45,266	3.0
IOM	0.8	$62,999	3.0

Abbreviation: IOM = intraoperative neurophysiologic monitoring.

DISCUSSION In a large, nationally representative and publicly available dataset, IOM usage was associated with significantly fewer neurologic complications in spinal laminectomies and fusions, results that were robust to multiple regression adjustment. Total hospital charges for monitored patients were greater, albeit the magnitude of difference in charges was substantially reduced following multiple regression adjustment. The adjusted marginal effect of IOM on length of stay was a reduction in stay. The sensitivity analysis, limiting the sample only to hospitals that perform IOM, did not substantially alter the associations between IOM and neurologic complications, hospital charges, and length of stay from the main analysis.

This analysis provides a counterpoint to a recent study of the Truven Marketscan database[10] (hereafter referred to as "the Marketscan study"), which looked at single-level surgeries, excluding surgeries with greater risks. We also excluded more complex surgeries and surgeries that carried larger presumptive risks,

Table 4 Bivariate and multiple regression-adjusted sample-weighted associations of IOM with neurologic complications, percentage of total hospital charges, and length of stay (marginal effect, in days)

	Neurologic complications, logistic regression	Total hospital charges, GLM, log-transformed	Length of stay, Poisson, marginal effect
Bivariate			
β_{IOM}	OR 0.56	+39%	dy/dx = −0.02 days
95% CI	0.44, 0.72	31%, 48%	−0.19, +0.16
***p* Value**	<0.001	<0.001	0.86
Multiple regression			
β_{IOM}	OR 0.60	+9%	dy/dx = −0.26 days
95% CI	0.47, 0.76	4%, 13%	−0.42, −0.11
***p* Value**	<0.001	<0.001	<0.001

Abbreviations: βIOM = coefficient representing effect of IOM and marginal effect (dy/dx) of IOM on days of length of stay; CI = confidence interval; GLM = generalized linear model; IOM = intraoperative neurophysiologic monitoring; OR = odds ratio.

leaving decompressions and simple fusions. Our article differs from the Marketscan study in the dataset used, which is episodic and not longitudinal, therefore the unit of analysis is discharges, not patients followed over time. The NIS reports procedures using *ICD-9-CM* procedure codes instead of Current Procedure Terminology (CPT) coding, so identification of the sample population is somewhat different in our analysis as well. Further distinctions from the Marketscan study are detailed below.

Our first major finding is that reporting of IOM occurs in a minority of laminectomies and simple spinal fusions. In our sample, fewer than 5% of surgeries reported IOM use. Monitored surgeries were more often privately insured, had 3 or more comorbidities, were fusion surgeries, and occurred on the West coast than unmonitored surgeries. IOM reporting increased annually by over 50% per year, suggesting that this may have been related to the relative newness of the code for IOM (introduced FY 2008) and some IOM services may have gone unreported. The number of monitored surgeries did not increase markedly in 2012, although this may be related to changes in sampling techniques in the NIS relative to previous years.[15] The rate of reported IOM increased to nearly 10% in the sensitivity analysis, which limited the sample to only surgeries at hospitals reporting IOM. This latter figure is closer to the 12% IOM usage in the Marketscan study, although far below the 65% rate in the Scoliosis Research Society (SRS) data,[9] and contrasts with a 2007 survey of US spinal surgeons,[7] where 95% of respondents reported access to electrophysiologic monitoring in the operating room.

Our second major finding is that IOM is associated with better clinical outcomes. The NIS does not indicate whether diagnoses existed prior to admission. We did not include poorly reported *ICD-9* codes for nerve root or spinal cord injury (occurring 20 and 229 times, respectively, in a published analysis of over 440,000 spine cases in the NIS from 2007 to 2011[25]) as these could not definitively be determined to have occurred during the admission. Therefore, we focused on *ICD-9* coding for neurologic complications, reported in prior large administrative claims studies of iatrogenesis from spinal surgeries. The extent and severity of neurologic complications cannot be ascertained from the data. The rate of neurologic complications seen here is consistent with previous reports,[4,26] including the SRS study, which found the incidence of new neurologic deficits at 1.1%,[9] albeit higher than described in the Marketscan study, which focused on perceived low-risk surgeries where neurologic complication rates were less than 1%. In our sample, neurologic complications were reported nearly twice as often (1.4% vs 0.8%) in the unmonitored group than in those with IOM, an effect that retained significance after adjustment. In subgroup analysis, the rate of neurologic complications was greater in the unmonitored group for all primary surgery subtypes save anterior cervical fusions, which reported a very low rate (<0.2%), compounding uncertainty for this subgroup. Laminectomies had the highest rate and the widest discrepancy between IOM and non-IOM neurologic complications (2.7% vs 1.7%), suggesting that monitoring may have the largest benefit for these procedures.

Table 5 Subgroup analysis: Estimated treatment group sample sizes, clinical and nonclinical outcomes by primary surgery subtype

	Weighted sample (estimated n)		Neurologic complications, %		Mean total charges, $		Mean LOS, d	
Primary surgery	No IOM	IOM	No IOM	IOM	No IOM	IOM	No IOM	IOM
Anterior cervical fusions	197,966	14,764	0.15	0.20	54,828	61,035	2.19	2.03
Thoracolumbar fusions	99,574	10,224	0.77	0.49	86,439	98,454	3.78	4.05
Discectomies	359,798	11,916	0.62	0.45	33,149	47,909	2.26	2.31
Laminectomies	414,527	15,771	2.70	1.72	47,964	61,672	3.91	3.75

Abbreviations: IOM = intraoperative neurophysiologic monitoring; LOS = length of stay.
Results are sample-weighted using Nationwide Inpatient Sample/National Inpatient Sample discharge weights, but not otherwise adjusted.

Compared to prior analyses, we show lower neurologic complications for monitored surgeries. The SRS analysis of a registry requiring surgeons to submit cases to gain society membership may have suffered from selection and recall biases and also was a different population (scoliosis corrections). The Marketscan study, having a similar population of surgeries, elected to use a different analytic method, propensity score matching, to achieve pseudorandomization of the treatment[27] (IOM). This methodology elected to evaluate the latent tendency to select IOM by factors such as associated bone morphogenic protein use, ignoring year of surgery (2006–2010) and prior IOM usage. While we pooled our results adjusted from primary surgery subtype to obtain an overall estimate of IOM efficacy, the Marketscan study restricted inferential analysis within subgroups, parsing sample sizes and increasing uncertainty, which was further compounded by excluding the majority of untreated subjects through matching. Like our analysis, among the Marketscan study's subgroups, IOM benefit was greatest in laminectomies (0 neurologic complications for monitored surgeries compared to 1.18% in unmonitored surgeries), and the lowest neurologic complications were seen in anterior cervical fusions ($<$0.2%).

Our third major finding is that while total hospital charges are greater with IOM use, length of stay may be improved. We posit that the increased usage of IOM in more costly fusion surgeries may account for the greater unadjusted charges and mask reductions in unadjusted length of stay. In this study, adjusting for primary surgical procedure, demographics, comorbidities, and hospital factors reduced the mean percentage of charges attributable to IOM from 39% to 9% of total charges, which remained significant. These do not appear to be a function of length of stay, which was significantly reduced in the monitored groups after adjustment (0.3 days). An approximately 10% reduction in length of stay is desirable for both surgeons, for whom longer stays are associated with greater iatrogenic complications,[28] and for cost-conscious 3rd-party payers. Our findings on hospital charges are in line with the result of differences in allowed payments reported in the Marketscan study, which range from 6% to 24% greater in the IOM group after matching. We differ in indexing fiscal outcomes on a particular year (2012), and including calendar year in outcome adjustment models. Moreover, differences in total hospital charges and allowed payments do not account for complexities in fixed and variable labor and equipment costs and may reflect a host of other services not captured in multivariable adjustment. Postmatching length of stay was also less in the monitoring group in the Marketscan study for 3 of 4 surgery types (anterior cervical fusion, lumbar fusion, and lumbar discectomy).

Although we focused on comparatively low-risk surgeries, the clinical impact of IOM suggested by our analysis is substantial. Here, the main clinical outcome of IOM use, a reduction in neurologic complications by nearly half, is important even when the risk is less than 2%. In a cost-consequences simulation model,[29] the likelihood of preventing a neurologic complication was calculated as the baseline risk of neurologic complication for the surgery $\times$ diagnostic sensitivity of IOM $\times$ probability of prevention of neurologic complication given an IOM alert. Our results are consistent with that model's outcome of a 49% reduction in relative risk with IOM. Given an absolute risk reduction of 1.4%–0.8% = 0.6%, 167 cases would need to be monitored to spare one neurologic complication. Although hospital charges appear to be greater in monitored surgeries, the actual cost of IOM should be set against a lifetime of lost wages and health care costs from neurologic complications (including spinal cord injury) of upwards of a million or more dollars.[6] In a separate published cost-benefit analysis,[6] IOM was cost-neutral even when the baseline risk is as low as 0.3%, far lower than the overall risk of surgeries in this sample. When disability and postoperative quality of life are factored into the equation, IOM may be invaluable. This effect is magnified when one realizes the hundreds of thousands of surgical cases performed annually and the tiny minority that are currently monitored.

There are a number of limitations to this analysis. Sample sizes are enormous, and can overemphasize minor differences in the data.[30] We rely on accurate coding of spinal surgeries, IOM procedures, and clinical conditions. Surgical complications in administrative claims may be inaccurately reported, leading both to underreporting and overreporting compared to prospectively collected registry data.[31] The NIS does not use CPT coding, which could also delineate modalities (evoked potentials and EMG) used during IOM. We cannot ascertain the level of expertise of the monitoring professional, which could range from a surgeon using an automated EMG device[32] to a board-certified, fellowship-trained neurologist, nor whether the monitoring physician was in the operating room or stationed off-site.[33] The relatively low rate of IOM reporting in the main analysis is also potentially problematic. However, as the act of reporting the *ICD-9-CM* IOM code is probably not related to the clinical or nonclinical outcomes of interest, the assumption of the authors is that IOM reported here represents a random sampling of discharges with IOM, where some unreported IOM is present in the unmonitored group. The code would be unlikely to be reported erroneously, where nonreporting is much more likely. This would have the effect of biasing the results toward the null, so the true effect of IOM may be greater in magnitude than that depicted here. Moreover, the sensitivity analysis shows that the main effects of IOM hold true even when removing surgical cases from hospitals that never report IOM. Finally, the associations seen here cannot be interpreted to be causal in this retrospective analysis of cross-sectional data.

In spite of these limitations, our study demonstrates that IOM is associated with improved outcomes for spinal surgeries in a large, nationally representative dataset. Certainly, more research is needed to confirm these findings. Still, the sample size needed for a traditional randomized clinical trial may be cost-prohibitive,[34] and ethical issues have been raised regarding randomized controlled trials in IOM.[35,36] We suggest that the next important step would be the identification of longitudinal changes to neurologic status and differential effects of baseline IOM modalities with on-site oversight by neurophysiologists, with remote oversight, and surgeon-directed automated EMG in a large, granular dataset. Ultimately, a prospective collection of longitudinal data in a registry format would help overcome reporting biases for both identification of monitored patients and accurate determination of outcomes. The results would be helpful in decisions to encourage or discourage the use of IOM through coverage and reimbursement decisions from public and private payers.

Comment: Neurophysiologic intraoperative monitoring in "low-risk" spine surgeries

Neurophysiologic intraoperative monitoring (IOM) is used during surgeries in which there is risk of injury to the nervous system. Many neurophysiologic modalities, including EEG, EMG, nerve conduction, and brainstem auditory evoked potentials, somatosensory evoked potentials (SEP), and motor evoked potentials (MEP), are routinely used for IOM. A recent guideline on IOM noted that SEP and MEP monitoring in spinal surgeries is effective in predicting an increased risk of neurologic complications.[1] However, there remains concern that IOM is overused, not necessary, and adds to expense of surgery.[2]

Ney et al.[3] used the Nationwide Inpatient Sample, a very large dataset of hospitalization in the United States, to evaluate the value of IOM in relatively "low-risk" spinal decompressions and simple fusion surgeries. They found that IOM was performed on 4.9% of approximately 1.1 million patients. The IOM group had fewer neurologic complications (0.8% vs 1.4%) than the group that was not monitored. The reduction in complications did not translate to a reduction in costs or length of stay. Rather, the cost was 39% greater in the IOM group (9% after multiple regression adjustment).

This study provides important evidence for the value of IOM in even so-called low-risk surgeries. It is important to appreciate that only 4.9% of such surgeries utilized IOM. As such, there are potentially many more neurologic complications that can be avoided. In this study, the modalities used during IOM and the experience of the monitoring teams were not assessed. Thus, whereas the value of IOM is evident, the type of monitoring that should be performed is not. The authors were unable to demonstrate a reduction in the cost of care with IOM, which should follow a reduction in complications. Regardless, fewer neurologic complications are always preferred.

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AUTHOR CONTRIBUTIONS

Dr. Ney: study concept and design, acquisition of data, analysis and interpretation, critical revision of the manuscript for important intellectual content. Dr. Ney had full access to the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Dr. van der Goes: acquisition of data, analysis and interpretation, analysis and interpretation, analysis and interpretation. Dr. Nuwer: study concept and design, analysis and interpretation, critical revision of the manuscript for important intellectual content, study supervision.

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