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Estimating Intraoperative Neurophysiological Monitoring Rates for Anterior Cervical Discectomy and Fusion: Are Diagnostic or Procedural Codes Accurate?

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ABSTRACT

Background: The utility of intraoperative neurophysiological monitoring (IONM) is well established for some spine surgeries (eg, intramedullary tumor resection, scoliosis deformity correction), but its benefit for most degenerative spine surgery, including anterior cervical discectomy and fusion (ACDF), remains debated. National datasets provide "big data" approaches to study the impact of IONM on spine surgery outcomes; however, if administrative coding in these datasets misrepresents actual IONM usage, conclusions will be unreliable. The objective of this study was to compare estimated rates (administrative coding) to actual rates (chart review) of IONM for ACDF at our institution and extrapolate findings to estimated rates from 2 national datasets.

Methods: Patients were included from 3 administrative coding databases: the authors' single institution database, the Nationwide Inpatient Sample (NIS), and the National Surgical Quality Improvement Program (NSQIP). Estimated and actual institutional rates of IONM during ACDF were determined by administrative codes (International Classification of Diseases [ICD] or Current Procedural Terminology [CPT]) and chart review, respectively. National rates of IONM during ACDF were estimated using the NIS and NSQIP datasets.

Results: Estimated institutional rates of IONM for ACDF were much higher with CPT than ICD coding (73.2% vs 16.5% in 2019). CPT coding for IONM better approximated actual IONM usage at our institution (74.6% in 2019). Estimated IONM utilization rates for ACDF in national datasets varied widely: 0.76% in CPT-based NSQIP and 18.4% in ICD-based NIS.

Conclusions: ICD coding underestimated IONM usage during ACDF at our institution, whereas CPT coding was more accurate. Unfortunately, the CPT-based NSQIP is nearly devoid of IONM codes, as it has not been a collection focus of that surgical registry. ICD-based datasets, such as the NIS, likely fail to accurately capture IONM usage. Multicenter and/or national datasets with accurate IONM utilization data are needed to inform surgeons, insurers, and guideline authors on whether IONM has benefit for various spine surgery types.

Level of Evidence: 4.

Clinical Relevance: Currently available national databases based on administrative codes do not accurately reflect IONM usage.

Testing and Regulatory Affairs

Keywords: intraoperative neurophysiological monitoring, ICD-9, ICD-10, CPT, administrative coding, anterior cervical discectomy and fusion

INTRODUCTION

Intraoperative neurophysiologic monitoring (IONM) accurately predicts spinal cord injury during spine surgery.[1] Evidence for improved neurological outcomes from use of IONM has only been well demonstrated in spinal deformity surgery for scoliosis[2] and intramedullary spinal cord tumor resection.[3] IONM is considered standard of care for spinal deformity correction surgery by the Scoliosis Research Society.[4] The benefits of IONM for decompression and fusion of degenerative spine pathologies, such as anterior cervical discectomy and fusion (ACDF), are less clear.[5,6]

Randomized clinical trials for IONM do not exist and are not likely to as they would be considered to lack clinical equipoise.[7] Prospective registries for IONM also do not exist, which has led many investigators to utilize national datasets, such as the Nationwide Inpatient Sample (NIS), to answer questions about IONM effectiveness in spine surgery.[5,6,8–11] Concerns have been raised that IONM utilization is likely underrepresented in the NIS.[8,12] Inclusion of a large number of monitored surgeries in the non-IONM group could invalidate conclusions regarding the impact of IONM by such studies. To our knowledge, there have been no studies comparing the accuracy of administrative codes in identifying surgeries with IONM to a "gold standard" like chart review.

We sought to determine the accuracy of International Classification of Diseases (ICD) procedure codes and Current Procedural Terminology (CPT) codes in identifying IONM during ACDF at our institution for 2 different time epochs. We also examined IONM rates during ACDF using the ICD-based NIS and the CPT-based National Surgical Quality Improvement Program (NSQIP). We hypothesized that ICD coding would underestimate actual rates of IONM use but that CPT coding would be more accurate given its use for billing and reimbursement.

Table 1. ICD-9, ICD-10, and CPT procedure codes for ACDF and IONM.

Procedure	ICD-9	ICD-10		CPT
ACDF	81.02	0RG1070	0RG13K0	22551
		0RG10J0	0RG10A0	22554
		0RG10K0	0RG1470	
		0RG1370	0RG14J0	
		0RG13J0	0RG14K0	
IONM	00.94	4A1004G	4A1134G	95941
		4A1034G	4A11729	95940
		4A1074G	4A1172B	G0453
		4A1084G	4A1174G	95920
		4A10X2Z	4A11829	
		4A10X4G	4A1182B	
		4A11029	4A1184G	
		4A1102B	4A11X29	
		4A1104G	4A11X2B	
		4A11329	4A11X4G	
		4A1132B		

Abbreviations: ACDF, anterior cervical discectomy and fusion; CPT, Current Procedural Terminology; ICD-10, International Classification of Diseases, 10th Revision; IONM, intraoperative neurophysiological monitoring.

METHODS

Data Sources

Rates of IONM for patients undergoing ACDF were estimated using 3 separate sources: our institutional database, the NIS, and the NSQIP. The Healthcare Cost and Utilization Project NIS is an all-payer inpatient database that contains data for more than 7 million inpatient stays each year.[13] The American College of Surgeons NSQIP receives data from >500 hospitals in the United States and contains actively abstracted demographics, comorbidities, intraoperative, and 30-day postoperative parameters (eg, complications, readmissions, and reoperations).[14] The NIS relies on ICD procedure codes and has 15 codes associated with each hospitalization, whereas the NSQIP relies on CPT codes inputted by the participating institutions. This study was approved by our institutional review board (ID No. 15–006838). Patient informed consent was not required for this study given its retrospective nature, deidentified datasets, and reporting of aggregated results.

Institutional IONM Rates in ACDF

Institutional review board approval was obtained prior to the study. Four queries were performed to estimate the institutional rates of IONM for patients undergoing ACDF using administrative coding. Two separate time epochs were examined: 1 January 2009 to 31 December 2013 and 1 January 2019 to 31 December 2019. The ICD-9 procedure code 81.02 was used to determine patients undergoing ACDF between 2009 and 2013. These patient-date combinations were then screened for IONM using ICD-9 procedure code 00.94, similar to the methodology used by others.[5,6,8–11] The same time epoch was then screened using CPT codes 22,551 and 22,554 to determine patients undergoing ACDF. These patient-date combinations were then screened for IONM using CPT codes 95941, 95940, G0453, and 95920. Similar search strategies were used for the 2019 epoch. However, ICD-10 codes replaced ICD-9 on 1 October 2015, so the ICD-10 codes in Table 1 were used to determine ACDF and IONM procedures. The same CPT codes used for the 2009–2013 query were applied to the 2019 epoch. After obtaining patient lists with procedure dates using the strategies above, actual rates of IONM were validated by querying the reporting tool used to write and send IONM reports to the electronic health record (separate from the institutional database). Reports with the same date as the ACDF ICD or CPT code were used to confirm IONM for each case. If a patient's ACDF and IONM report dates did not match, it was assumed that the IONM report was for a different surgery type.

Chart Review of Institutional IONM Cases

To provide further validation regarding the actual utilization of IONM for ACDF, electronic health records of patients identified as having an ACDF by CPT codes at our institution during 2019 were retrospectively reviewed. The operative report and IONM report were reviewed to determine with certainty whether IONM was used for monitoring an ACDF.

National IONM Rates in ACDF

Search strategies like those used on the institutional dataset were used on the NIS and NSQIP datasets. One of the same epochs (1 January 2009 to 31 December 2013) was examined in the NIS using the same ICD-9

Table 2. Estimatedhan CPT coding, and the discrepancy from actual I rates of institutional IONM usage for ACDFs.

				IONM Usage	
Dates	**ACDF Coding**	**IONM Coding**	**ACDFs (*n*)**	**Coding**	**IONM Report**
2009–2013	ICD-9	ICD-9	679	103 (15.2%)	231 (34.0%)
2009–2013	CPT	CPT	715	251 (35.1%)	257 (35.9%)
2019	ICD-10	ICD-10	79	13 (16.5%)	52 (65.8%)
2019	CPT	CPT	213	156 (73.2%)	156 (73.2%)

Abbreviations: ACDF, anterior cervical discectomy and fusion; CPT, Current Procedural Terminology; ICD, International Classification of Diseases; IONM, intraoperative neurophysiological monitoring.

codes. All 15 procedure code columns were screened for the ACDF code. Then, either the first 5 procedure code columns or all columns were screened for an IONM code. This process was repeated for a separate time epoch (1 January 2014 to 30 September 2015). The NSQIP dataset was queried using the same CPT codes for ACDF and IONM that were used on the institutional dataset but from the epoch of 1 January 2014 to 31 December 2017 (most recent data accessible to the authors).

Analysis of Procedure Code Order From NIS

To further investigate the utilization of IONM codes in administrative databases and its impact on research studies, the frequency of IONM appearance in each of the 15 procedure code columns was determined from the 17,606 hospitalizations where both ACDF and IONM ICD-9 codes were present.

RESULTS

Institutional IONM Rates

According to ICD-9 procedure codes, 674 patients underwent 679 ACDF procedures between 2009 and 2013 (Table 2) and 103 procedures (15.2%) had utilized IONM. However, cross-referencing these same ACDFs with an IONM report database revealed that 231 (34.0%) procedures used IONM on the same date as the ACDF ICD-9 code. By comparison, CPT coding estimated that 707 patients underwent 715 ACDF procedures during the same period with 251 procedures (35.1%) using IONM. Cross-referencing the CPT-identified ACDFs with the IONM report database identified 6 additional ACDFs where IONM was used beyond what was identified CPT coding (35.9%).

According to ICD-10 procedure codes, 79 patients underwent 79 ACDF procedures in 2019, and only 13 procedures (16.5%) used IONM. However, cross-referencing with the IONM report database revealed that 52 (65.8%) of the 79 ACDFs used IONM. By comparison, CPT coding estimated that 213 patients underwent 213 ACDF procedures in 2019 with 156 (73.2%) ACDFs using IONM. The same rate was seen when CPT-identified ACDFs were cross-referenced with the IONM report database. Detailed chart review confirmed that 159 had an IONM report referring to an ACDF, but the 3 additional monitored ACDFs found had date mismatches between the ACDF and IONM CPT codes. Either the CPT code or the signing of the IONM report occurred on the day after surgery in all 3 instances.

National IONM Rates From NIS and NSQIP

All 15 ICD-9 procedure code columns in NIS were queried for ACDF codes, revealing a total of 152,735 hospitalizations between 2009 and 2013 during which an ACDF surgery occurred (Table 3). Searching only the first 5 columns for the IONM code detected IONM use in 10,934 (7.2%) of these hospitalizations. The estimated IONM use in this cohort increased to 17,606 (11.5%) when all 15 columns were screened for IONM. A similar increase was seen with the later epoch (2014 to 30 September 2015) where the estimated IONM rate during ACDF went from 10.9% up to 18.4% when the additional procedure code columns were included. There were 43,262 ACDFs identified by CPT codes in the NSQIP database from 2014 to 2017. Among those, only 327 (0.76%) had IONM CPT codes.

Analysis of Procedure Code Order From NIS

The IONM usage estimate for ACDFs in the NIS increased almost 2-fold when all 15 ICD-9 procedure code columns were queried as compared to just the first 5 (see previous section). The Figure illustrates what priority the IONM code had in the NIS database query from 2009 to 2013. It was found at least once in all 15 columns but was most commonly in the fourth, fifth, or sixth column.

DISCUSSION

All 3 sources (institutional, NIS, and NSQIP) used in this study are versions of "big data," and all were created for

Table 3. Estimated rates of national IONM usage for ACDFs.

Source	Dates	ACDF Coding	IONM Coding	Hospitalizations	IONM Usage
NIS	2009–2013	ICD-9[15]	ICD-9[5]	152.735	10,934 (7.2%)
NIS	2009–2013	ICD-9[15]	ICD-9[15]	152,735	17,606 (11.5%)
NIS	2014 to 30 September 2015	ICD-9[15]	ICD-9[5]	50,601	5,538 (10.9%)
NIS	2014 to 30 September 2015	ICD-9[15]	ICD-9[15]	50,601	9,296 (18.4%)
National Surgical Quality Improvement Program	2014–2017	CPT	CPT	43,262	327 (0.76%)

Abbreviations: ACDF, anterior cervical discectomy and fusion; CPT, Current Procedural Terminology; ICD-9, International Classification of Diseases, 9th Revision; IONM, intraoperative neurophysiological monitoring; NIS, Nationwide Inpatient Sample.
Note: IONM use in the NIS database was assessed using either the first 5 procedure code columns (designated as [5]) or all 15 columns (designated as [15]).

purposes other than specifically answering the question of how often IONM is used for ACDFs. It should not be unexpected that these datasets are imperfect at approximating actual rates of monitored ACDFs. We showed that estimated IONM rates in ACDF vary widely based on methodology. CPT coding (used for billing) appears to be superior to ICD coding for capturing ACDFs and IONM usage within our institutional dataset, irrespective of epoch or ICD version. Unfortunately, the CPT-based NSQIP appears to underestimate IONM rates in ACDF, essentially eliminating a reliable CPT-based national dataset for studying IONM.

ICD coding estimated lower IONM usage in ACDF than CPT coding, and the discrepancy from actual IONM usage was also greater for ICD than CPT. This direct comparison between ICD and CPT coding was only available and thus only performed on the single institution cohort, which limits the generalizability. ICD estimation of IONM rates in ACDF was only modestly higher at our institution than in the NIS dataset (15.2% vs 11.5%). This could imply that IONM rates in ACDF are slightly higher at our institution than nationally. We realize that the rate of IONM use in ACDFs at our institution may not reflect national practices,

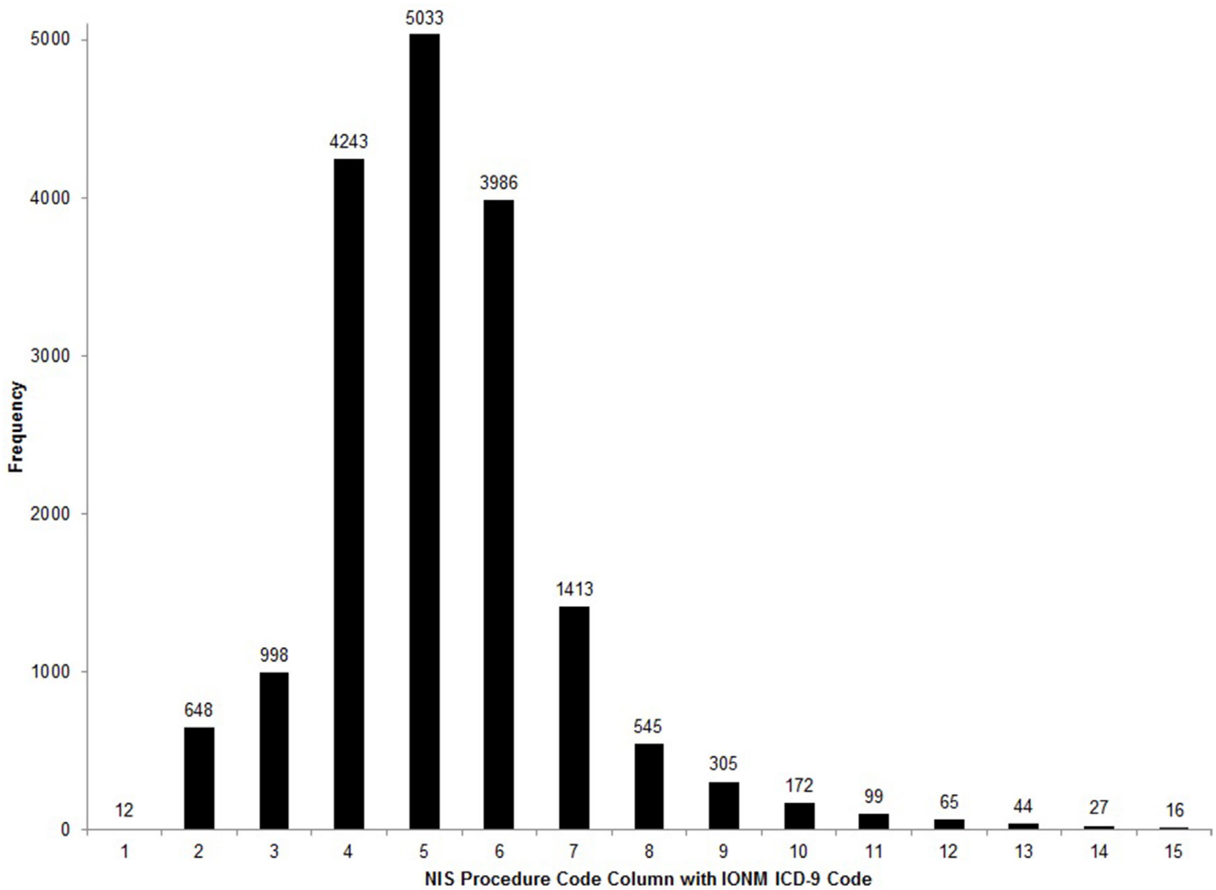

Figure. Distribution of which out of 15 International Classification of Diseases-9 (ICD-9) columns the intraoperative neurophysiological monitoring (IONM) code (*N* = 17,606) was in among anterior cervical discectomy and fusion hospitalizations from 2009 to 2013 (*N* = 152,735) included in the Nationwide Inpatient Sample database.

but we do not believe that ICD coding at our institution is substantially different compared to the NIS to a degree that would lead to systematic difference. It is possible that the inferior detection of IONM by ICD coding compared to CPT in our institutional data can be generalized to the many institutions contributing data to the NIS. George et al suspected that their rate of IONM utilization of 18% for pediatric scoliosis deformity correction from the NIS was underreported[8] based on a report from the Scoliosis Research Society indicating that 65% of these surgeries receive IONM.[15] Another NIS study of ACDF acknowledged that the NIS does not contain accurate information on IONM utilization.[16]

If the NIS is used to study IONM usage with the understanding and full disclosure that it fails to capture IONM utilization accurately, all ICD procedure code columns should be examined for IONM. Badhiwala et al examined only the first 5 of 15 ICD code columns in the NIS, which further exacerbates any underestimation of IONM that relying on an ICD-based dataset imposes.[5] In our analysis of the 2009–2013 epoch, increasing the ICD query for IONM to all 15 available columns increased the number of ACDF surgeries using IONM from 10,934 to 17,606 (a 61% increase), which reflects a nontrivial increased rate of IONM usage in ACDF from 7.2% to 11.5%. An even larger discrepancy in the estimated IONM utilization rate during ACDFs resulted in the later epoch from 2014 to 31 September 2015 (10.9%–18.4%).

In a letter to the editor addressing the Badhiwala et al study, Wilent et al[12] suggested that the rate of monitoring 7% of ACDFs is lower than the general practice in the United States, referencing a survey among spine surgeons that showed an IONM utilization rate between 61% and 66% for ACDF.[17] In response, Badhiwala et al stated that their findings are consistent with the literature and their (Canadian) practice, adding the concern regarding the representativeness of the sample size of the survey study (n = 46). While the small sample size in the survey study might have led to an overestimation of the actual monitoring rates, the findings from institutional neuromonitoring reports in our study were consistent with the survey study,[17] showing 65.8% and 73.2% as the rates of IONM for the year 2019. However, when the same search and validation methods were repeated for 2009–2013, rates were found to be 34.0% and 35.9%. These findings highlight the likely increase in utilization trends for IONM, which has been suggested by others[9,10,18] and accounts for this difference to some extent. More importantly, our findings also suggest that the actual national estimate should fall somewhere between those 2 rates (~7% and ~70%).

As mentioned by Badhiwala et al, the rate of IONM usage in ACDF obtained in their study (6.8%)[12] is more similar to other national databases such the PearlDiver Patient Record Database (17.1%)[19] than it is to the survey of surgeons (61%–66%).[17] One major difference between the NIS and PearlDiver databases is that the latter uses both ICD and CPT codes, which might have contributed to the higher percentage of monitored ACDFs seen in the PearlDiver database. However, the PearlDiver study[19] likely also missed many monitored ACDFs due to the omission of 4-limb somatosensory evoked potential and motor evoked potential CPT codes (95938 and 95939), which are what would typically be used in the majority of IONM for ACDF. They did not use the IONM oversight codes that we did but instead used IONM modality codes only. This concept is supported by the findings of the present study, where queries using CPT codes generated much higher rates than the ICD procedure codes.

Another potential confounder is that Badhiwala et al are Canadian authors who mentioned that the rate obtained from the NIS was consistent with their practice.[12] A survey study conducted among Canadian spine surgeons in 2010 demonstrated rates of monitoring modalities ranging from 7% to 11% for cervical discectomy and from 7% to 19% for cervical or thoracic instrumentation.[20] As a result, it would not be ideal to make an assumption regarding the validity of ICD-based query in NIS given the conceivable dissimilarity to Canadian IONM practices. The medicolegal as well as cost containment environments in Canadian medicine differ significantly from the United States, and experiences in Canada cannot necessarily be extrapolated to the United States.

ICD-based "big data" studies on IONM effectiveness pulling data from the NIS have drawn conclusions both for and against the benefit of IONM in spine surgery. Badhiwala et al[5] concluded that IONM did not reduce neurological complication rates following ACDF whereas Ney et al[6] concluded that IONM was associated with better clinical outcomes for simple spine fusion and laminectomies. The present study does not settle the issue of whether IONM is beneficial or not during degenerative spine surgery such as ACDF. Our institutional data support what other authors have suspected[6,8,12,16]—ICD codes in the NIS are not likely capturing the true utilization rate of IONM during spine surgery. Readers should bear this in mind with NIS studies on the utility of IONM, irrespective of their conclusions.

CONCLUSION

Estimated rates of IONM for ACDF in our single institution cohort based on administrative coding were vastly different depending on the methodology used (range 15.2%–73.2%) with some methods capturing half to less than a third of actual rates. CPT coding with date matching very closely approximated or matched the actual rate of IONM. NSQIP and NIS estimated rates vary from 0.76% to 18.4%. This study casts doubt on the reliance on administrative coding, especially ICD, alone to accurately capture actual rates and trends of IONM in ACDF. Whether IONM improves outcomes in degenerative spine surgery cannot be reliably examined with any currently available datasets, including the current study. This is especially relevant as certain policy makers or payers may assume national database studies to accurately reflect clinical practice. We further emphasize the need for better multicenter and national datasets with accurate capture of IONM utilization.

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