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Practice patterns for intraoperative neurophysiologic monitoring

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ABSTRACT

Objective: The professional practice of intraoperative monitoring (IOM) has evolved over the past 30 years. This report describes the field's current state and how site of service affects practice.

Methods: A survey queried American Academy of Neurology IOM neurologist members about their IOM volume, case type, duration, numbers of simultaneous cases, and location of the monitoring physician.

Results: Physicians located locally typically monitored fewer cases annually and simultaneously compared to physicians who monitored from remote locations. Physicians at remote locations monitored proportionally more spine procedures, whereas physicians who monitored locally monitored more intracranial procedures and a greater variety of cases.

Conclusions: The remote monitoring practice model is different from local models in annual volume, simultaneous cases, work per case, and types of cases. *Neurology*® 2013;80:1–5

GLOSSARY

AAN = American Academy of Neurology; **IOM** = intraoperative monitoring; **OR** = operating room.

The professional practice of intraoperative neurophysiologic monitoring (IOM) has evolved over 3 decades. Initially the IOM professional personally supervised every case in the operating room (OR). By 1990, physicians learned to supervise 2–3 adjacent ORs, much like an anesthesiology attending supervising 2–3 residents. In that model, the IOM physician supervised technologists. By 1995, remote telemonitoring allowed an IOM professional to supervise an OR from some distance away. Usually supervision was conducted from a nearby central station to which each room's monitoring data were relayed by a dedicated wire or Internet connection. When needed, the IOM physician could walk down the hall to an OR. More recently, community groups extended telemonitoring to far distant sites. A remote telemonitoring professional might be hundreds of miles away.

Several surveys have assessed the number of neurologists who perform IOM or whether they monitor in the OR suite.[1–8] More detailed questions have not been addressed. How many cases are monitored simultaneously? Do they monitor locally at their own hospital, or do they monitor from distant remote sites? What kinds of cases are monitored? A recent survey's results are presented here and compared to some past results.

We posed hypotheses that 1) physicians who monitor remotely supervise more cases annually than physicians who monitor from on-site; 2) physicians who monitor remotely supervise more cases simultaneously than physicians who monitor from on-site; 3) cases supervised remotely are more likely to be performed for cervical and lumbar spinal column surgery; and 4) cases supervised locally are more likely to involve intracranial procedures.

METHODS

The American Academy of Neurology (AAN) emailed US physician members a one-question survey: "Do you perform intraoperative monitoring in your practice?" This 2010 survey instrument requested a simple yes–no email reply. Recipients excluded residents, fellows, retired members, nonphysicians, and non-US members.

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Every respondent who answered yes to the first survey was emailed a subsequent 6-question survey. The questions were as follows:

1. What percentage of your total time in practice is spent providing IOM services?
2. Please estimate the number of IOM cases you have monitored in the past year.
3. Please enter numbers that reflect the percentage of time you monitor simultaneous cases.
4. Where do you typically perform intraoperative monitoring services?
5. What kinds of cases and monitoring do you perform by portion of time?
6. How long do your monitoring cases typically last?

The responses were compiled. The response rate to the initial survey was compared to the 2009 AAN Practice Survey response rates.[7] A biomathematician used a Wilcoxon rank sum test to evaluate statistically the hypotheses.

We defined remote site of service as online and unable to go into the OR personally, e.g., many miles away. Nearby site of service was online and near enough to go into the OR if needed during the case. In-OR site of service was for services carried out personally in the OR. Local site of service was a combination of nearby and in OR.

For the number of simultaneous cases and case duration, the data first were averaged within an individual respondent before determining the median and 75th percentile. For example, for a physician who reported that half of his cases were monitored one at a time and the other half were monitored two at a time, the physician's average number of simultaneous cases was calculated to be 1.5. This procedure resulted in median and 75th percentile values that included fractions.

Numbers of IOM cases nationally were calculated using data taken from the Medicare Part B database, data for which are publically available through the American Medical Association's RBRVS (Resource-Based Relative Value Scale) Data Manager database.[9] Current Procedural Terminology code 95920 was used to identify IOM cases. The 2009 AAN member survey results[7] were used to extrapolate from the Part B database to all carriers. The typical duration of monitoring cases was determined using the distribution of responses to survey question 6.

RESULTS In the initial single-question survey, 3,575 members responded. The response rate of 29.8% was somewhat less than the 41.3% response rate for the 2009 AAN member survey. Among the 3,575 respondents, 503 (15%) replied that they did perform IOM in their practice.

Table 1 Numbers, duration, and portion of spine cases per intraoperative monitoring neurologist, comparing local and remote intraoperative monitoring practice sites of service

	Local		Remote	
	Median	75th %ile	Median	75th %ile
No. cases annually	50	200	550	1,750
No. cases simultaneously	1.0	1.8	2.2	3.9
Case duration, h	3.2	4.1	3.3	3.8
% Cases lumbar discectomy/fusion	5	25	40	45
% Cases cervical spine	10	30	25	33

Among the 503 who identified themselves as performing IOM, 163 (32%) responded to the second, 6-question survey instrument. These physicians spent a median of 10% of their practice time performing IOM (25th percentile 5% of their practice time; 75th percentile 40%). Ten of the 163 respondents spent 100% of their practice time on IOM.

We assessed the respondents' sites of service. Among 163 respondents, 141 (86%) performed monitoring typically locally. Among those, 61 (37%) performed monitoring typically personally in the OR. Another 106 (65%) performed monitoring typically nearby, where they were able to enter the OR if needed. Among the local groups, 26 respondents endorsed both in-OR and nearby patterns as typical in their practices. Therefore percentages add to greater than 100. A total of 38 (23%) respondents performed monitoring typically online from a remote site. Among those remote monitoring physicians, 21 (15%) endorsed only the remote option. The remaining 17 endorsed both remote and local sites of service. To more clearly distinguish the local from the remote practice models, we focused our further data analysis on those who endorsed one or the other and excluded the 17 who endorsed both remote and local sites of services.

Table 1 shows the number of cases monitored annually, number of simultaneous cases, duration of cases, portion of cases that were lumbar discectomy and fusion, and portion that were cervical spine procedures. These are broken out by whether the monitoring physician used a local or remote IOM practice site of service. Local practices perform fewer cases annually: median annual local cases 50, remote cases 550 ($p < 0.001$). T1

Work per case was compared to the site of service. Remote practices monitored more cases simultaneously: median 1.0 local, 2.2 remote cases ($p < 0.001$). For local site of service monitoring 1.0 case at a time, a full 60 minutes of attention was given to each patient per hour of monitoring service. For remote site of service monitoring simultaneously 2.2 cases, the physician would have allocated 27 minutes of attention to each individual patient per hour of monitoring service. Also, at the 75th percentile a difference of more than a factor of 2 was seen depending on the physician's site of service.

Overall, 21,883 cases were reportedly performed annually by physicians who reported practicing only locally. A total of 18,995 cases were reportedly performed annually by physicians who reported practicing only remotely. Whereas the remote practice is only a small portion of IOM physicians, they accounted for nearly half of the monitored cases. Table 1 data confirm the considerably higher case volumes for remote monitoring practices.

The distribution of case types is shown in table 2. Some differences were seen depending on the site of T2

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Table 2 Types of surgery in which intraoperative monitoring was used

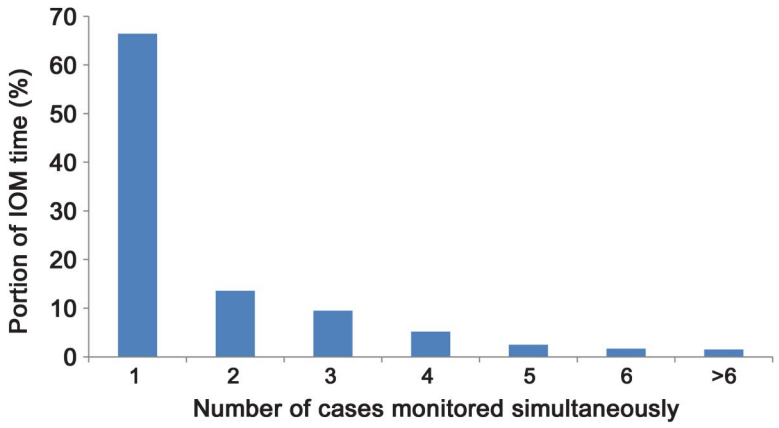
Type of surgery	Percentage
Carotid	13.5
Intracranial aneurysms, AVM	3.2
Intracranial tumors	6.2
Epilepsy resections	6.4
Movement disorders	9.4
Intracranial CN decompression, CPA tumors	3.8
Cervical spine	19.1
Thoracic spine	8.8
Aorta, cardiac	0.9
Lumbar discectomy, fusion	20.5
Tethered cord, rhizotomy	2.6
Peripheral nerve, plexus, arm, leg	2.5
Middle ear, mastoid, parotid, thyroid	2.1
Other	1.2

Abbreviations: AVM = arterial venous malformation; CN = cranial nerve; CPA = cerebellopontine angle.

service. Remote monitoring practices had a much greater portion of spine cases (table 1). Lumbar spine cases constituted a median of 5% of local practice cases and 40% of remote cases. Cervical and lumbar spine cases together were a larger portion of cases for remote than for local practices: median 70% of remote, 25% of local cases ($p < 0.001$). Conversely, intracranial cases were performed more commonly by local practices: median 20% of local, 5% of remote cases ($p < 0.01$).

F1 Typically a physician monitors one case at a time. Figure 1 shows the distribution of number of simultaneous cases monitored. About 90% of the time, the physician monitors 3 or fewer cases simultaneously. Physicians who monitor locally typically monitor 3 or fewer cases, whereas some physicians who monitor cases from remote sites are more likely to monitor larger numbers of simultaneous cases. Table 1 shows that distinction.

Figure 1 Number of cases monitored simultaneously



IOM = intraoperative monitoring.

The combined observations of numbers plus types of cases show that physicians who reported a remote practice tend to monitor a larger number of cases overall and simultaneously, and those practices had a much larger portion of spine surgery, especially lumbar spine surgery. In contrast, physicians who reported local practice patterns tend to monitor fewer cases overall and simultaneously, and those practices had a greater variety of cases and the more complex intracranial procedures.

The volume of IOM cases nationally annually can be estimated from the Medicare Part B database. In the AAN member demographic surveys, traditional Medicare represents about 25% of neurologists' practices. By assuming that fraction applies to all IOM, one can multiply the Medicare Part B data by 4 to estimate the number of cases across all carriers. IOM procedures usually are coded with Current Procedural Terminology code 95920. The total annual number of 95920-coded procedures is reported in the Medicare Part B database. That code is used once per hour of monitoring. To estimate the number of cases, one adjusts by the duration of cases, which was reported in the current survey. After converting the Part B hourly data on code 95920 to case volume figures and converting to estimated national case volume across all carriers, figure 2 shows the increase in the volume of cases over time. F2

DISCUSSION

The data here were collected from an AAN member survey in 2 stages. The survey response rates were 30% and 32%. Surveys with less than 60% return are generally considered to be weak evidence. The performance of IOM in practice data reported here are consistent with numbers and trends obtained over nearly 2 decades, which helps to substantiate the validity for the rates reported here.

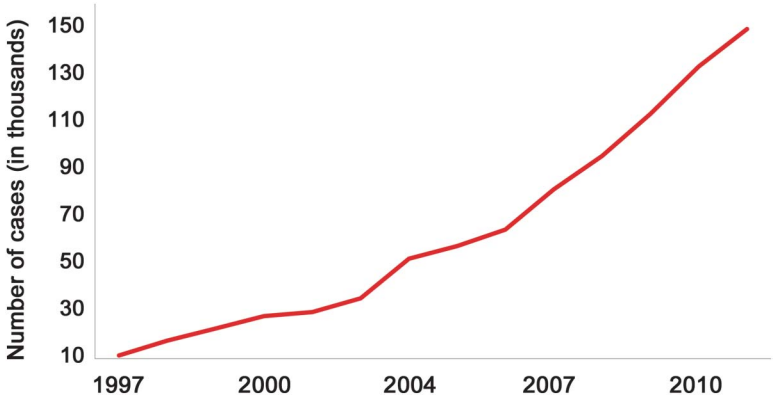
The 2009 AAN member survey reported that 8.5% of neurologists perform IOM in their practice. The portion of members providing IOM has dropped in the past dozen years. This trend is shown in table 3. T3 While the number of full-time practicing US neurologists increased by 17% over a decade,[3,7] the number of neurologists providing IOM declined from approximately 2,000 to 1,300. Physical medicine physicians and others also perform this procedure.

At the same time, the volume of IOM continues to climb. Figure 2 shows a 15-fold increase in IOM case volume over 13 years. Much of that increased volume has occurred with the advent of and growth in popularity of the remote monitoring practice.

Advantages and disadvantages of the remote monitoring practice have been debated in recent years.

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Figure 2 Growth in volume of intraoperative monitoring cases from 1997 to 2010, as extrapolated to all carriers from the Medicare Part B full year annual national data



Arguably the ability to communicate is hampered when no face-to-face option is available during difficult clinical circumstances. Ability to solve problems is limited by an inability to check technical and many clinical details remotely. Access to medical records and patient radiologic imaging also is limited for remote monitoring for many community hospitals. Internet connections may fail. At the same time, remote monitoring made IOM available to many hospitals that did not have the volume of work to justify an IOM specialist on site. For properly selected cases, some IOM is far better than no IOM because IOM can reduce major neurologic deficits by 60%.[10–12]

The greatest growth appears to be for lumbar surgery. Minimally invasive lumbar surgery and pedicle screw procedures are relatively new procedures, and commonly use monitoring. This is in addition to monitoring during more traditional lumbar decompression and fusion procedures. Along with offering IOM at hospitals that did not previously have the service, these changes in available services have contributed to the increases in volume.

This field is becoming more organized into a subspecialty discipline.[13] To encourage IOM, training in IOM is available now as a recognized clinical major pathway within Accreditation Council for Graduate Medical Education–accredited Clinical Neurophysiology fellowship programs. The freestanding board in the field of central neurophysiology, the American Board of Clinical Neurophysiology, now offers a subspecialty certification in IOM. Regional and national educational programs are given several times each year by several societies in this field. The American Board of Registration of Electroencephalographic Technologists offers a technologists' certification in intraoperative neuromonitoring and an accreditation program for hospital IOM laboratory clinical services.

Overall, these data show several trends. IOM is growing in volume. The subset of neurologists performing IOM in their practices is becoming somewhat smaller and more specialized over time. The discipline seems to have 2 or 3 different practice patterns: monitoring in the OR, monitoring nearby and able to enter the OR when needed, and remote monitoring at a distance. The remote practice pattern is performed by a smaller number of neurologists, with higher volumes of cases annually and simultaneously. The remote cases tend to be simpler spine cases, whereas the local (in-OR and nearby) cases tend to be more complex cases including a greater portion of intracranial procedures. These are sufficiently distinct to represent different practice types with their own advantages and disadvantages, and their own distinct work performed per case.

Table 3 American Academy of Neurology member survey results: Percent of neurologist respondents who performed intraoperative monitoring in their practice in the past 12 months[a]

1991–1992	1993–1994	1997	1998	2000	2004	2009
12.5	13.7	14.5	14.5	11.1	9.8	8.5

[a] Source: American Academy of Neurology Practice surveys.[1–7]

AUTHOR CONTRIBUTIONS

Dr. Nuwer was involved in study concept and design, data analysis and interpretation, and principal preparation of the manuscript. Dr. Cohen was involved in study concept and design, data analysis and interpretation, and manuscript revision. Ms. Shepard was involved in study concept and design, data acquisition, and analysis and interpretation, and reviewed the manuscript.

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DISCLOSURE

M. Nuwer estimates that 35% of his effort is spent on intraoperative monitoring. He uses all 3 practice models discussed here. In the past 2 years, he has given expert testimony in 3 cases. He receives grant support from the NIH and Epilepsy Foundation. He serves on the board of Corticare, as a local medical director for SleepMed, on the editorial board of *Journal of Clinical Neurophysiology*, as an honorary consulting editor of *Clinical Neurophysiology*, and receives royalties from Cambridge University Press. B. Cohen does not perform intraoperative monitoring. He receives compensation for work with HHS in the Vaccine Compensation Program. K. Shepard is a staff member of the American Academy of Neurology and reports no conflicts of interest. Go to Neurology.org for full disclosures.

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