

Contemporary Opinions on Intraoperative Facial Nerve Monitoring

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Abstract

Objective. To examine the current trend in intraoperative facial nerve monitoring (IOFNM) training, performance, and reimbursement by subspecialists.

Study Design. Cross-sectional survey of the American Neurotology Society, American Otological Society, American Society of Pediatric Otolaryngology, and program directors of otolaryngology–head and neck surgery programs accredited by the Accreditation Council on Graduate Medical Education.

Setting. American Academy of Otolaryngology–Head and Neck Surgery Intraoperative Nerve Monitoring Task Force.

Subjects and Methods. The task force developed 2 surveys, which were implemented through SurveyMonkey.com: (1) a 10-question survey sent to 1506 members of the societies listed to determine IOFNM practice and reimbursement patterns and (2) a 10-question survey sent to the 107 accredited US otolaryngology residency program directors to examine the state of resident training on facial nerve monitoring.

Results. Response rates were 18% for practicing physicians and 15% for residency program directors. The majority agreed that IOFNM was indicated for most otologic and neurotologic procedures. In addition to facial nerve monitoring, facial nerve stimulation was used in complex skull base and temporal bone procedures. When queried about reimbursement by Medicare, only 4.4% of surgeons responded that they received reimbursement. Program directors indicated universal exposure of residents to IOFNM, with 61% of programs giving residents formal training.

Conclusions. IOFNM is widely used among otologists and neurotologists in the United States. The majority of residents receive formal training, and all residents are exposed to the setup, use, monitoring, and troubleshooting of the device. Reimbursement for IOFNM is reported by a paucity of those surveyed.

Keywords

acoustic neuroma, aural atresia, chronic ear surgery, cochlear implantation, facial nerve monitor, facial nerve stimulator, mastoidectomy, otolaryngology resident education, reimbursement, skull base surgery, stapedectomy, SurveyMonkey.com, tympanoplasty

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Intraoperative facial nerve monitoring (IOFNM) is an important adjunct to otologic and lateral skull base surgery, and its use and significance continue to evolve. Facial paralysis is a potentially devastating complication of any temporal bone procedure and can result in extensive cosmetic, functional, financial, and psychological consequences. Iatrogenic facial paralysis following otologic surgery is second to hearing loss as the most common reason for litigation.^{1,2} In a review of cases from 2 large legal databases, verdicts in favor of the plaintiffs were awarded an average of \$1,131,189.² While injury to the facial nerve is a recognized complication, preservation of facial nerve integrity and function is a primary goal of modern otologic/neurotologic surgery.

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IOFNM was shown to improve facial nerve outcomes with skull base surgery.³⁻¹¹ Its routine use in otologic cases has been more controversial, despite the relatively high risk of facial nerve injury for primary (0.6% and 3.7%)^{12,13} and revision (4%-10%) cases.^{14,15} IOFNM monitors have been commercially available for >20 years. Although initially criticized as being an expensive luxury and not a substitute for anatomic training and surgical knowledge of the facial nerve,¹⁶ IOFNM was found to be cost-effective for all patients undergoing middle ear or mastoid surgery.¹⁷ IOFNM is a valuable tool (1) to assist in the localization of the nerve when it is congenitally aberrant or distorted by disease or previous surgery and (2) to identify occult dehiscences of, aid dissection and disease removal from, and confirm the integrity of the facial nerve. Although difficult to quantify, IOFNM also plays a significant role in the training of residents in ear surgery.¹⁸ Otolaryngology residency programs have incorporated IOFNM into their curricula and trained residents to set up, troubleshoot, utilize, and interpret facial nerve monitors for temporal bone procedures.

Surveys of practicing otologists and neurotologists over the last 23 years^{16,19,20} reveal a growing trend among otolaryngologists to utilize IOFNM in chronic ear surgery. These prior surveys focused on the availability of IOFNM and the respondents' opinion with regard to standard of care in otologic surgery. None examined the specific training for IOFNM, the exact details of when or how the procedure is performed, or the reimbursement for the procedure. There have been significant changes in reimbursement in health care in the United States, and some cases are now monitored by nonsurgical staff or remote monitoring companies. We undertook this study to examine the current trends in IOFNM training, performance, and reimbursement by subspecialty surgeons.

Methods and Materials

The Executive Committee of the Board of Directors of the American Academy of Otolaryngology—Head and Neck Surgery (AAO-HNS) directed the formation of a task force to evaluate intraoperative nerve monitoring. The task force strictly limited its initial efforts on the implementation, education, use of, and reimbursement for facial nerve monitoring, as the literature on the benefits of facial nerve monitoring is robust, consisting of >500 articles over the last 40 years. This study was granted exemption from Institutional Review Board review (Georgetown 2018-0019).

The task force created 2 surveys, which were implemented from April 18 to June 5, 2016, through SurveyMonkey.com:

- A 10-question survey was sent to 1506 members of the American Neurotology Society, American Otological Society, and American Society of Pediatric Otolaryngology via the AAO-HNS member database to determine the current use of and reimbursement for IOFNM. These groups were chosen to focus the

Table 1. Training, Certification, and Practice Mix of AOS, ANS, and ASPO Members Responding to the Survey.

Question	Responses	
	n	%
Fellowship trained in otology?		
Yes	174	64.2
No	97	35.8
N/A	2	
Fellowship trained in neurotology?		
Yes	172	63.5
No	99	36.5
N/A	2	
Training in intraoperative facial nerve monitoring?		86.1
Yes	235	9.2
No	25	4.8
Not sure	13	
Board certification in neurotology?		
Yes	117	
No	152	43.5
N/A	4	56.5
Percentage of practice that is otology/neurotology?		
<25	57	20.9
25-50	24	8.8
51-75	24	8.8
76-100	168	61.5

Abbreviations: ANS, American Neurotology Society; AOS, American Otological Society; ASPO, American Society of Pediatric Otolaryngology; N/A, skipped question.

survey on physicians with high-volume otologic practices.

- A 10-question survey was sent to the 120 accredited US otolaryngology residency program directors to examine the state of resident training on facial nerve monitoring.

Results

Practitioner Survey

Responses were obtained from 273 practitioners (18.1%; **Table 1**). The majority had completed fellowship training in otology/neurotology, with 44% having obtained an American Board of Otolaryngology Certificate of Added Qualification in neurotology. Forty-eight percent (48%) of respondents primarily practiced otology/neurotology. Almost 90% of practicing surgeons reported that they had received training on IOFNM. The source and type of training for IOFNM varied widely among these practitioners. Training in residency (71.4%) and fellowship (69.0%) greatly exceeded training from surgical support and equipment representatives (27.5%), continuing medical education (20.4%), and a proctor, mentor, or other surgeon (17.6%).

Table 2. Indications for IOFNM.

Procedure	Responses, n (%)			
	Total	Yes ^a	No	Unsure
Atresia surgery	267	257 (96.3)	2	8
Acoustic neuroma surgery	262	255 (97.3)	0	7
Revision chronic ear surgery with mastoidectomy	268	251 (93.7)	3	14
Skull base surgery	260	243 (93.5)	3	14
Chronic ear cases involving mastoid	265	236 (89.1)	13	16
Cochlear implantation	266	230 (86.5)	12	24
Revision chronic ear surgery without mastoidectomy	262	177 (67.6)	48	37
Tympanoplasty/canalplasty	259	119 (45.9)	108	32
Stapedectomy	261	98 (37.5)	123	40

Abbreviation: IOFNM, intraoperative facial nerve monitoring.

^aAgreement that IOFNM is indicated.

Table 3. Responses to the Question “What Procedures Do You Perform IOFNM?”^a

Procedure	Responding Yes	
	n	%
Revision chronic ear surgery with mastoidectomy	252	92.3
Chronic ear cases involving mastoid	246	90.1
Cochlear implantation	205	75.1
Atresia surgery	192	70.3
Revision chronic ear surgery without mastoidectomy	188	68.9
Acoustic neuroma surgery	176	64.5
Skull base surgery	173	63.4
Tympanoplasty/canalplasty	152	55.7
Stapes surgery	110	40.3
Other	42	15.4
None	8	2.9

Abbreviation: IOFNM, intraoperative facial nerve monitoring.

^aRespondents, N = 273. Percentages might be more reflective of a surgeon's case mix than how often one uses IOFNM for each case.

Surgeons were asked to endorse or deny if IOFNM is indicated for a particular procedure (**Table 2**). The majority of respondents confirmed that IOFNM was indicated for most otologic and neurotologic procedures except for tympanoplasty/canalplasty without mastoidectomy and stapedectomy/stapedotomy. Among these practitioners, usage of IOFNM varied depending on the type of surgical case (**Table 3**). A majority of surgeons use IOFNM for almost all surgical procedures. The frequency of IOFNM usage fell <50% only for stapedectomy/stapedotomy. These percentages might be more representative of a particular surgeon's practice than how often IOFNM is actually used, and this finding might explain why the use of IOFNM for acoustic neuroma surgery is only 64%.

The use of a facial nerve stimulator during otologic and neurotologic procedures is summarized in **Table 4**. Facial

nerve stimulation was most frequently used during acoustic neuroma surgery, skull base surgery, and chronic ear surgery. Facial nerve stimulation was used infrequently for cochlear implantation, revision chronic ear surgery without mastoidectomy, tympanoplasty/canalplasty, and stapes surgery.

Placing electrodes and verifying the integrity of the nerve monitor varied among practitioners. Most practitioners (61.1%) preferred to perform these tasks themselves, while this responsibility was delegated to a monitoring service (18.1%), a resident (15.2%), an audiologist (4.1%), or a nurse (1.5%) in a minority of cases. The task of observing and heeding the facial nerve monitor during the case was handled overwhelmingly by the primary surgeon (85.5%), followed by another monitor in the room (**Table 5**). A fraction of surgeons relied on an audiologist, remote monitoring systems, or a nurse to follow the IOFNM.

Surgeons reported billing for IOFNM in less than half of cases (**Table 6**). While 85% of surgeons perform facial nerve monitoring themselves, 64% responded that they either “never” submit a bill or “do not bill for this procedure.” When queried about reimbursement for IOFNM by Medicare, only 4.4% surgeons responded that they received reimbursement. The remainder of practitioners responded with “no” (36.8%) or “N/A” (58.8%; ie, skipped question). When queried about reimbursement for IOFNM by private insurance companies, only 20.2% responded positively. The remaining 79.9% responded with either “no” or “N/A.”

Program Director Survey

Responses were obtained from 18 (15%) program directors. These directors indicated universal exposure of residents to intraoperative nerve monitoring during surgery for otologic/neurotologic cases and head and neck/endocrine cases. Eighty-three percent of programs train residents to troubleshoot IOFNM. Sixty-one percent of programs provide formal training on IOFNM, consisting of hands-on training (84.6%), direct observation in the operating room (69.2%), self-directed learning (46.2%), and didactic lectures

Table 4. Frequency of Facial Nerve Stimulator Usage.^a

Procedure	Total ^b	Responders Using Nerve Stimulator, n (%)			
		Never	<25%	25%-50%	>50%
Acoustic neuroma surgery	186	15	3	0	168 (90.3)
Skull base surgery	189	13	9	12	155 (82.0)
Revision chronic ear surgery with mastoidectomy	260	41	87	19	113 (43.5)
Chronic ear cases involving mastoid	259	50	86	12	111 (42.9)
Atresia surgery	207	36	48	20	103 (49.8)
Cochlear implantation	219	52	68	6	93 (42.5)
Revision chronic ear surgery without mastoidectomy	244	72	81	18	73 (29.9)
Tympanoplasty/canalplasty	228	107	57	10	54 (23.7)
Stapedectomy	214	128	40	3	43 (20.1)

^aPractitioners were asked to rate the percentage of cases where a facial nerve stimulator was used.

^bThe total number of responses for an item (ie, not all respondents answered each item).

Table 5. Observing the Facial Nerve Monitor.

Who	Responses ^a	
	n	%
Surgeon	230	85.5
Monitoring service in the room	71	26.4
Audiologist	21	7.8
Remote monitoring service	10	3.7
Nurse	8	3.0

^aMore than 1 choice permitted.

(15.4%). Formal documentation of training and documentation of resident competency is recorded in 83.3% of programs. This survey revealed that 77.8% of program directors were not aware that intraoperative nerve monitoring is considered a competency of the American Board of Otolaryngology.

Discussion

IOFNM has become a mainstay of otologic and neurotologic surgery. IOFNM continues to evolve since its beginnings in the late 1970s and the patenting of the Prass probe in 1990.²¹ Since its first development for acoustic neuroma surgery,^{22,23} intraoperative monitoring has helped surgeons identify and preserve the facial nerve during surgical treatment for a range of temporal bone pathologies. IOFNM was shown to improve facial nerve outcomes in many otologic and neurotologic procedures, including acoustic neuroma surgery,^{24,25} skull base surgery,²⁶ cochlear implantation,²⁷ chronic ear surgery,²⁸ cholesteatoma,²⁹ and atresia surgery.³⁰ This survey shows the high acceptance rate of this technology among respondents performing otologic and neurotologic surgery.

Two previous surveys of US practice patterns of IOFNM were performed with a random sample of board-certified AAO-HNS members and therefore polled primarily general

Table 6. Frequency of Submitting Bill for IOFNM.

Frequency	Responses	
	n	%
Always	51	19.0
Sometimes/partially	35	13.1
Never	113	42.2
I do not know	9	3.4
I do not bill for this procedure	60	22.4

Abbreviation: IOFNM, intraoperative facial nerve monitoring.

otolaryngologists. Only 10% of respondents reported their primary area of interest as otology in the earlier survey,¹⁹ and only 31% of respondents were fellowship trained in otology/neurotology in the later study.²⁰ In these 2 earlier studies, less than half of respondents (32% and 49%, respectively) thought that IOFNM should be used as the standard of care in chronic ear surgery. Although informative, these surveys likely did not reflect the opinions of surgeons who limit their practice to otologic surgery. While limited in scope, they did show a trend of increasing adoption of IOFNM for chronic ear surgery as compared with the narrow questionnaire regarding standard of care in 1994,¹⁶ which showed only a 4% rate for routine IOFNM by the American Neurotology Society and American Otological Society member respondents at the time. As “standard of care” is a legal definition that varies from state to state and country to country, our task force purposely did not attempt to collect data on the respondents’ opinions on standard of care but aimed to survey current training, practices, procedures, and reimbursement related to IOFNM.

Critics of IOFNM have stressed the cost burden of the procedure to hospitals and health care systems as unnecessary, and a comment in the 1994 survey deserves quotation: “The real test to this question would be answered if each surgeon had to pay for VII monitoring personally—then

what cases would be monitored?"¹⁶ The answer to this question is seen in present practice, where surgeons are using monitoring but not getting paid for it. In other words, surgeons still perform this task even if not reimbursed.

The devastation of iatrogenic facial nerve injury to the patient and the burden of its treatment and recompense by the surgeon, hospital, and health care system are so significant that use of IOFNM for chronic ear surgery was found to be cost-effective with a model even when it included the use of a monitoring audiologist.¹⁷ The cost of IOFNM is undoubtedly driven higher when nonsurgeon monitoring is billed to insurance companies and health care systems. This study shows the wide use of IOFNM by subspecialty surgeons for chronic ear surgery despite the lack of reimbursement to at least 80% of surgeons who are, for the most part, doing their own monitoring. When one considers setup and troubleshooting time, intraoperative care, and attention of IOFNM, most surgeons are indeed paying somewhat personally for this procedure, yet its use continues to expand over time.

Facial nerve monitors are designed for use by the surgeon with acoustic and visual alerts that can be easily interpreted during surgery. Medicare, the largest third-party payer in the United States, pays for intraoperative nerve monitoring when performed by (1) a physician not performing the surgical procedure, (2) an audiologist trained and certified in electrophysiologic monitoring, (3) a physical therapist trained and certified in electrophysiologic monitoring, or (4) a neurophysiologist, neurologist, or physiatrist, but not the operating surgeon (Current Procedural Terminology code 95940). Furthermore, Medicare allows reimbursement for remote monitoring (Current Procedural Terminology code 95941, Healthcare Common Procedure Coding System code G0453)³¹ by a physician, usually a neurophysiologist, who can be outside the hospital and relay information back to the surgeon. This situation has multiple elements that can impede the transmission of information, including communication delay, communication failure, lack of waveform, and lack of attention. For optimum performance, IOFNM needs to be instantaneous. The only way to achieve this instantaneity is by auditory signal from the nerve monitor and by perception of the operating surgeon without a middle party. This is analogous to collision sensors on a car in which the audible tone becomes more rapid the closer the car comes to an obstacle; this immediate feedback allows the driver to avoid a collision. It is preposterous to consider that collision avoidance would work best when someone other than the driver monitors the alarm. It is even more absurd to consider that someone in a secure remote location would need to call the driver to warn of an impending collision.

Some third-party payers consider IOFNM medically necessary for certain procedures, such as surgery for acoustic neuroma, cholesteatoma, facial nerve neuroma, and vestibular neurectomy, but not for cochlear implantation, tympanoplasty, and tympanomastoidectomy, claiming that the value for these indications has not been established.³² The results

of the survey indicate that most practitioners are not submitting bills for IOFNM and that those who do submit a bill are not getting paid; therefore, knowledge in the process of billing and collecting for these services is lacking. Reimbursement for IOFNM is performed in some US markets, perhaps related to local physicians' education, experience in billing, and willingness to appeal their claims for their services. The Centers for Medicare and Medicaid Services and third-party payers currently not paying for IOFNM should reconsider paying the surgeons reasonable fees for performing this important procedure, as they are universally trained, are the most competent and adept to perform this service, and carry the ultimate responsibility for facial nerve integrity.

This survey omitted several important factors that might have an impact on its conclusions, such as age of respondent, years in practice, practice setting (academic or private practice), or case mix. The major shortcoming of this study is its low response rate. We did not send email reminders or offer incentives to reply.³³ Response rates of web surveys have been decreasing over the last 10 years.³⁴ A low response rate might introduce a nonresponse bias; however, such bias is not always linked to the response rate.^{35,36} In fact, the relationship between the nonresponse rate and nonresponse bias is weak.³⁷ The low response rate in our study is consistent with other emailed survey-based studies, and the cost of paper- or interviewer-based surveys is significant, while not improving response rate. The most recent survey on the topic was performed by mail and SurveyMonkey.com with no statistically significant differences between the mailed and electronic responses.²⁰ We did not include a category for nonavailability for IOFNM, assuming ubiquitous access in this health care environment. Although the percentage on nonuse of IOFNM is low for all procedures other than stapedectomy and tympanoplasty/canalplasty, lack of access to equipment and no choice/preference could still be a consideration in some settings.

Conclusion

IOFNM is widely used among otologists and neurotologists in the United States for procedures beyond tympanoplasty and stapes surgery. Otolaryngology residents are given exposure on the setup, use, monitoring, and troubleshooting of the device, and their competency is evaluated. Reimbursement for IOFNM is reported by only a paucity of those surveyed. Current reimbursement guidance for a separate individual, either in the room or in a remote location, is cost-ineffective and potentially hazardous in terms of loss of feedback immediacy. There is a need for reassessment of policies to enable financially viable provision of the highest quality of care during otologic and neurotologic surgical procedures.

Author Contributions

Paul W. Gidley, study design, data analysis, writing manuscript, final approval, accountable for all aspects; **Jennifer Maw**, study design, data analysis, writing manuscript, final approval, accountable for all aspects; **Bruce Gantz**, study design, editing manuscript,

final approval, accountable for all aspects; **David Kaylie**, study design, editing manuscript, final approval, accountable for all aspects; **Paul Lambert**, study design, editing manuscript, final approval, accountable for all aspects; **Sonya Malekzadeh**, study design, editing manuscript, final approval, accountable for all aspects; **Sujana S. Chandrasekhar**, study design, editing manuscript, final approval, accountable for all aspects.

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References

1. Wiet R, Schuring A. The legal aspects of surgical facial nerve injury. *Ear Nose Throat J*. 1996;75:737-738.
2. Ruhl DS, Hong SS, Littlefield PD. Lessons learned in otologic surgery: 30 years of malpractice cases in the United States. *Otol Neurotol*. 2013;34:1173-1179.
3. Silverstein H, Rosenberg SI, Flanzer J, Seidman MD. Intraoperative facial nerve monitoring in acoustic neuroma surgery. *Am J Otol*. 1993;14:524-532.
4. Silverstein H, Smouha EE, Jones R. Routine intraoperative facial nerve monitoring during otologic surgery. *Am J Otol*. 1988;9:269-275.
5. Silverstein H, Willcox TO Jr, Rosenberg SI, Seidman MD. Prediction of facial nerve function following acoustic neuroma resection using intraoperative facial nerve stimulation. *Laryngoscope*. 1994;104:539-544.
6. Kartush JM. Electroneurography and intraoperative facial nerve monitoring in contemporary neurotology. *Otolaryngol Head Neck Surg*. 1989;101:496-503.
7. Kartush JM. Intra-operative monitoring in acoustic neuroma surgery. *Neurol Res*. 1998;20:593-596.
8. Kartush JM, Larouere MJ, Graham MD, Bouchard KR, Audet BV. Intraoperative cranial nerve monitoring during posterior skull base surgery. *Skull Base Surg*. 1991;1:85-92.
9. Kartush JM, Lundy LB. Facial nerve outcome in acoustic neuroma surgery. *Otolaryngol Clin North Am*. 1992;25:623-647.
10. Kircher ML, Kartush JM. Pitfalls in intraoperative nerve monitoring during vestibular schwannoma surgery. *Neurosurg Focus*. 2012;33:E5.
11. Porter RG, LaRouere MJ, Kartush JM, Bojrab DI, Pieper DR. Improved facial nerve outcomes using an evolving treatment method for large acoustic neuromas. *Otol Neurotol*. 2013;34:304-310.
12. Schuring AG. Iatrogenic facial nerve injury. *Otol Neurotol*. 1988;9:432-433.
13. Nilssen E, Wormald P. Facial nerve palsy in mastoid surgery. *J Laryngol Otol*. 1997;111:113-116.
14. Wiet RJ. Iatrogenic facial paralysis. *Otolaryngol Clin North Am*. 1982;15:773-780.
15. Dew LA, Shelton C. Iatrogenic facial nerve injury: prevalence and predisposing factors. *Ear Nose Throat J*. 1996;75:724-729.
16. Roland PS, Meyerhoff WL. Intraoperative electrophysiological monitoring of the facial nerve: is it standard of practice? *Am J Otolaryngol*. 1994;15:267-270.
17. Wilson L, Lin E, Lalwani A. Cost-effectiveness of intraoperative facial nerve monitoring in middle ear or mastoid surgery. *Laryngoscope*. 2003;113:1736-1745.
18. Noss RS, Lalwani AK, Yingling CD. Facial nerve monitoring in middle ear and mastoid surgery. *Laryngoscope*. 2001;111:831-836.
19. Greenberg JS, Manolidis S, Stewart MG, Kahn JB. Facial nerve monitoring in chronic ear surgery: US practice patterns. *Otolaryngol Head Neck Surg*. 2002;126:108-114.
20. Hu J, Fleck TR, Xu J, Hsu JV, Xu HX. Contemporary changes with the use of facial nerve monitoring in chronic ear surgery. *Otolaryngol Head Neck Surg*. 2014;151:473-477.
21. Prass RL. Electrical stimulus probe. *Google Patents*; 1990.
22. Delgado TE, Bucheit WA, Rosenholtz HR, Chrissian S. Intraoperative monitoring of facial muscle evoked responses obtained by intracranial stimulation of the facial nerve: a more accurate technique for facial nerve dissection. *Neurosurgery*. 1979;4:418-421.
23. Sugita K, Kobayashi S. Technical and instrumental improvements in the surgical treatment of acoustic neurinomas. *J Neurosurg*. 1982;57:747-752.
24. Sampath P, Holliday MJ, Brem H, Niparko JK, Long DM. Facial nerve injury in acoustic neuroma (vestibular schwannoma) surgery: etiology and prevention. *J Neurosurg*. 1997;87:60-66.
25. Lalwani AK, Butt FY-S, Jackler RK, Pitts LH, Yingling CD. Facial nerve outcome after acoustic neuroma surgery: a study from the era of cranial nerve monitoring. *Otolaryngol Head Neck Surg*. 1994;111:561-570.
26. Leonetti JP, Brackmann DE, Prass RL. Improved preservation of facial nerve function in the infratemporal approach to the skull base. *Otolaryngol Head Neck Surg*. 1989;101:74-78.
27. Hsieh HS, Wu CM, Zhuo MY, Yang CH, Hwang CF. Intraoperative facial nerve monitoring during cochlear implant surgery: an observational study. *Medicine*. 2015;94:e456.
28. Heman-Ackah SE, Gupta S, Lalwani AK. Is facial nerve integrity monitoring of value in chronic ear surgery? *Laryngoscope*. 2013;123:2-3.
29. Selesnick SH, Lynn-Macrae AG. The incidence of facial nerve dehiscence at surgery for cholesteatoma. *Otol Neurotol*. 2001;22:129-132.
30. Meiteles LZ, Linstrom CJ. Facial nerve monitoring in surgery for congenital auricular atresia. *Laryngoscope*. 1993;103:406-415.
31. Centers for Medicare and Medicaid Services. Billing Medicare for remote intraoperative neurophysiology monitoring in CY 2013. <https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeeSched/Downloads/FAQ-Remote-IONM.pdf>. Published 2013. Accessed February 8, 2018
32. Vudiniabola S, Pirone C, Williamson J, Goss AN. Hyperbaric oxygen in the therapeutic management of osteoradionecrosis of the facial bones. *Int J Oral Maxillofac Surg*. 2000;29:435-438.

33. Phillips AW, Friedman BT, Utrankar A, Ta AQ, Reddy ST, Durning SJ. Surveys of health professions trainees: prevalence, response rates, and predictive factors to guide researchers. *Acad Med.* 2017;92:222-228.
34. Van Mol C. Improving web survey efficiency: the impact of an extra reminder and reminder content on web survey response. *Int J Soc Res Methodol.* 2017;20:317-327.
35. Groves RM, Peytcheva E. The impact of nonresponse rates on nonresponse bias: a meta-analysis. *Public Opin Q.* 2008;72:167-189.
36. Groves RM. Nonresponse rates and nonresponse bias in household surveys. *Public Opin Q.* 2006;70:646-675.
37. Brick JM, Tourangeau R. Responsive survey designs for reducing nonresponse bias. *J Off Stat.* 2017;33:735-752.