**AMERICAN CLINICAL NEUROPHYSIOLOGY SOCIETY**
Continuing Medical Education Committee
Professional Practice Gap Analysis
*Revised September 2017*

**Sources of Data**

- AAN Member reports 2004, 2009, 2010
- AAN Core Curricula in Clinical Neurophysiology
- American Board of Clinical Neurophysiology Candidate Exam Handout
- American Board of Electrodiagnostic Medicine Candidate Exam Booklet
- American Board of Psychiatry and Neurology Initial Exam Content Outline
- American Board of Psychiatry and Neurology Certification Statistics
- ACNS CME Committee Meetings 2014 - 2018
- ACNS Program Committee Meeting 2014 - 2018
- ACNS Course Committee Meeting 2014 - 2018
- ACNS CME Survey 2012
- ACNS Annual Meeting and Courses evaluation forms 2013 - 2018
- ACNS Fall Course evaluation forms 2013 - 2018
- Review of journal articles in *Journal of Clinical Neurophysiology*, *Clinical Neurophysiology*, and *Neurology*
- Results of ACNS In-Service Exam scores 2013 - 2018

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**Gap #1 - Emerging Areas of Practice**

Several emerging areas of clinical neurophysiology have significant practice gaps in which the opportunities for training and mentoring fall short of the need for experienced and trained neurologists. Intraoperative monitoring, intensive care unit EEG monitoring ,Video and Quantitative EEG and invasive evaluation for epilepsy surgery with Stereo EEG are growing areas of clinical neurophysiology with few practicing neurologists having adequate training in these techniques. Adult and pediatric physicians as well as neurodiagnostic technologists with competence in these areas are in great demand. Without additional specialized training, neurologists will not be competent to conduct these types of monitoring. Identification of this practice gap has been made in several ways:

**Summary of Data**

1. **Surveys of United States neurologists**
   In 2009, the American Academy of Neurology (AAN) surveyed 21,772 members, including 11,963 practicing US AAN neurologists (Neurologists 2009: AAN Member Demographic and Practice Characteristics). The Practice Profile Form (PPF) was sent to a 20% random sample (2,380). The response rates were 56% for the census and 41% for the PPF. The percent of respondents performing intraoperative monitoring was 8.5, with a median number of procedures per month of two. This area of practice is therefore much smaller than other areas of clinical neurophysiology (see general clinical neurophysiology below). The small number of studies performed monthly suggests that it is difficult for practicing neurologists to gain and maintain sufficient expertise in intraoperative monitoring by clinical practice alone. Continuous EEG monitoring in the intensive care unit was performed by 16.3% of respondents, with a median number of procedures per week of two. Again, this number is insufficient to gain and maintain appropriate expertise in this complex neurophysiologic technique. In fact, when reviewing demographic data on ACNS meeting attendance roughly 50% of participants in the 30-50 year age range indicate a desire to learn neurophysiology technical knowledge by attending these meetings.

2. **Availability and scope of training programs in clinical neurophysiology**
   Training in these new areas is not available or limited in most neurology residencies. Clinical neurophysiology fellowship training programs provide 6 or more months of didactic and clinical experience in the major areas of clinical neurophysiology (electroencephalography, electromyography and nerve conduction studies, or polysomnography and assessment of disorders of sleep), but typically less clinical experience in other areas, such as intraoperative monitoring and analysis and evoked potential studies. Clinical neurophysiology fellowship training programs have updated curricula to include training in intraoperative monitoring, but this is usually only didactic education rather than practical experience. Only a few clinical

neurophysiology fellowships offer a full 6 months of experience in intraoperative monitoring. EEG and video-EEG monitoring in the intensive care unit setting are new areas of clinical neurophysiology which have not yet been formally incorporated into clinical neurophysiology training programs.

3. **Development of a competency in Intraoperative Monitoring through the American Board of Clinical Neurophysiology Exam. Since this is a recent creation, currently only few neurologists have been certified by this examination.**
   A new track in EEG Monitoring in the ICU is being developed by the Board.

4. **Examination scores in the Intraoperative Monitoring sections of the American Board of Clinical Neurophysiology Exam and the American Clinical Neurophysiology In-Service Exam have been consistently lower than those in more established areas of clinical neurophysiology.**
   From 2013- 2018 data the percent correct responses in the intraoperative monitoring section of the In-Service exam are 34-47%, compared to 53-85% in other areas of clinical neurophysiology. This gap in knowledge is present in all examinees: current clinical neurophysiology fellows, graduates of clinical neurophysiology training programs, and neurologists in practice.

5. **Number of downloads of guidelines for intraoperative monitoring from the ACNS web site.**
   Guidelines have been published in the recent past for both intraoperative monitoring and continuous EEG monitoring in the ICU and are consistently downloaded for review and supportive data. Members indicate that the guidelines should continue to be a primary focus of the ACNS.

6. **Recent publications in the *Journal of Clinical Neurophysiology* and tracking of the number of publications on these topics downloaded from the journal web site.**
   Recent publications in *Epilepsia* show that several larger epilepsy centers in the United States perform 2/3 of their invasive recordings for epilepsy surgery using Stereo EEG rather than the traditional approach with subdural electrodes.

7. **Participants in ACNS educational programs, have consistently indicated on evaluations requests for programs in Neurophysiologic intraoperative monitoring, ICU EEG monitoring, continuous EEG and quantitative EEG through courses, workshops and symposia.**
   These requests have resulted in the development of courses in these topics at the ACNS meetings with excellent attendance.

**Gap #1 Analysis**

Gaps in knowledge, competence, and performance in NEW clinical neurophysiology procedures, such as neurophysiological intraoperative monitoring (NIOM), the use of EEG in the intensive care unit (ICU EEG monitoring) and invasive exploration for epilepsy surgery using Stereo EEG (Stereo EEG).

**Best Practice:** Clinical neurophysiologists should understand the pathophysiology of normal and abnormal patterns in NIOM, ICU EEG, continuous and Video EEG and Stereo EEG (knowledge), accurately perform and interpret studies (competence), and apply the results of these studies to timely and accurate diagnosis and treatment of patients at risk for neurologic deterioration in the operating room and intensive care unit (performance) or evaluated for epilepsy surgery as their best option for seizure freedom. Updated ACNS guidelines in NIOM and ICU EEG highlight the technical and clinical aspects of these new procedures. An invited review on the principles and clinical practice of Stereo EEG for the Journal of Clinical Neurophysiology has been published in December 2016 and several articles have been published on Stereo EEG in the *Epilepsia* in recent years.

**Current Practice:** Review of surveys of learners, the medical literature, and recent guidelines indicate that NIOM and ICU EEG are underutilized and often misinterpreted, likely due in large part to the shortage of clinical neurophysiologists who have been trained in NIOM, ICU EEG and Stereo EEG. Most CN training programs have little didactic or practical training in these emerging areas of CN. Because these areas are new procedures, clinical neurophysiologists who completed training more than several years ago have little or no exposure to these techniques and those in practice seek training on advanced techniques.

**Resulting Gaps:** Practitioners performing clinical neurophysiology procedures have inadequate knowledge of the pathophysiology of normal and abnormal patterns in NIOM, ICU EEG and Stereo EEG, often do not possess the technical skills to accurately perform and interpret studies (competence), and are uncertain how to apply the results of these studies to the diagnosis and treatment of patients at risk for neurologic deterioration in the operating room and intensive care unit (performance). Gaps are present both for practitioners new to ICU EEG, NIOM and Stereo EEG, as well as those currently performing NIOM and ICU EEG and invasive exploration of epilepsy surgery because of rapid evolution of these techniques.

**Gap #2 - General Practice of Clinical Neurophysiology**

Clinical neurophysiology procedures are performed by a large proportion of practicing US neurologists, many of whom have little or no formal training in clinical neurophysiology. Many clinical neurophysiology procedures (e.g. evoked potentials, invasive EEG, advanced EMG procedures) are performed at low volume at many centers and a forum for review and hands-on interpretation are essential to improve and maintain competence in these areas.

**Summary of Data**

Review of national neurology practice surveys indicate that clinical neurophysiology procedures are performed by a large proportion of practicing US neurologists. Many of these practitioners have little or no formal training (e.g. fellowship) in clinical neurophysiology. Many clinical neurophysiology procedures (e.g. evoked potentials, invasive EEG) are performed at low volume at most centers and a forum for review and hands-on interpretation is essential to improve and maintain competence in these areas. Several specific topics where there are significant gaps between current practice and ideal practice were identified via review of the literature, review of clinical neurophysiology fellowship curricula, discussions with experts in clinical neurophysiology, and surveys of ACNS members and Annual Meeting attendees.

The gap in acquisition and maintenance of expertise in clinical neurophysiology techniques was identified in several ways:

1. **Surveys of United States neurologists.**
   In 2009, the American Academy of Neurology (AAN) surveyed 21,772 members, including 11,963 practicing US AAN neurologists (Neurologists 2009: AAN Member Demographic and Practice Characteristics). The Practice Profile Form (PPF) was sent to a 20% random sample (2,380). The response rates were 56% for the census and 41% for the PPF. From the main survery, practice focus was EEG 32.6%, EMG 8.2%, Epilepsy 39.4%, and Neuromuscular disorders 25.7%.

| Procedure | Percent of respondents who perform/interpret the procedure during the last 12 months | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1991-92 (n=1,371) | 1993-94 (n=1,235) | 1997 (n=1,064) | 1998 (n=1,230) | 2000 (n=832) | 2004 (n=947) | 2010 (n=897) |
| **Electrodiagnostic Services:** | | | | | | | |
| Electroencephalography (EEG) | 68.0 | 68.0 | 69.8 | 65.0 | 59.9 | 61.4 | 56.9 |
| Electromyography (EMG/NCS) [a] | 54.6 | 55.1 | 58.1 | 55.8 | 49.4 | 54.4 | 54.1 |
| Evoked Potentials (EP) | 43.5 | 44.2 | 46.1 | 43.7 | 34.3 | 32.5 | 25.6 |
| Intraoperative Monitoring | 12.5 | 13.7 | 14.5 | 14.5 | 11.1 | 9.8 | 8.5 |
| Sleep Studies | 12.5 | 11.2 | 14.7 | 12.0 | 10.2 | 12.0 | 14.0 |
| Video EEG Monitoring | NA[b] | NA | NA | NA | NA | NA | 17.9 |
| Continuous EEG (cEEG) | NA | NA | NA | NA | NA | NA | 16.3 |

| Procedure | For those who perform the procedure, median number performed per month | | | | | |
|---|---|---|---|---|---|---|
| | 1993-94 | 1997 | 1998 | 2000 | 2004 | 2010 |
| **Electrodiagnostic Services:** | | | | | | |
| Electroencephalography (EEG) | 20 | 20 | 20 | 20 | 20 | 20 |
| Electromyography (EMG/NCS) [a] | 20 | 25 | 25 | 25 | 25 | 20 |
| Evoked Potentials (EP) | 5 | 5 | 5 | 4 | 4 | 2 |
| Intraoperative Monitoring | 2 | 3 | 4 | 1 | 3 | 2 |
| Sleep Studies | 5 | 5 | 10 | 5 | 15 | 11 |
| Video EEG Monitoring | NA | NA | NA | NA | NA | 2 |
| Continuous EEG (cEEG) | NA | NA | NA | NA | NA | 2 |

2. **Availability and scope of training programs in clinical neurophysiology.**
   The amount of training received by neurology residents in clinical neurophysiology is quite variable. EEG and EMG training are provided in 75% of neurology residency programs, ranging from 1-5 months. One quarter of neurology residency programs have no requirement for formal training in clinical neurophysiology. Fellowship training in clinical neurophysiology is available as a 5th year of subspecialization. Fellows have six or more months of didactic and clinical experience in the major areas of clinical neurophysiology (electroencephalography, electromyography and nerve conduction studies, polysomnography and assessment of disorders of sleep, or intraoperative neurophysiologic monitoring), and didactic training in other areas of clinical neurophysiology. Typically concentration occurs in 1 or 2 of these subspecialized areas leaving significant gaps in other areas of clinical neurophysiology even after fellowship training is completed.

3. **Board certification statistics.**
   As of 2014 there were 14,674 U.S neurologists were members of AAN and 4.8% indicated Clinical Neurophysiology as a subspecialty. Fewer than 20% of neurologists according to ABPN have certification in Clinical Neurophysiology although a greater number indicate they perform Clinical Neurophysiology procedures. This suggests a knowledge gap is likely between the current knowledge and the need for appropriate clinical practice of neurophysiologic procedures.

4. **The merger of ACNS with AACN necessitated the addition of content from the peripheral neurology area.**
   Members of the combined Society consist of three groups: those trained primarily in central neurophysiology; those trained primarily in peripheral neurophysiology; and those who were cross-trained or have otherwise gained competence in both areas. It should also be noted that the American Board of Psychiatry and Neurology Subspecialty exam for Clinical Neurophysiology incorporates both central and peripheral neurophysiology, but until the merger with AACN, there had not been a viable single group attempting to provide education in both areas.

5. **Survey responses of meeting attendees confirm that attendees identified these areas described as their own practice gaps**.

**Gap #2 Analysis**

EEG

- Basic EEG:
  - Identification of normal variants
  - Identification of artifacts
  - Clinical correlation
  - Update in technology
- Pediatric EEG:
  a. Neonatal EEG

  Example Gap
  - **Best Practice:** Seizures in neonates are rapidly identified and treated. Clinical neurophysiologists are skilled in neonatal EEG interpretation
  - **Current Practice:** Neonatal seizures are commonly underdiagnosed or misdiagnosed resulting in delays in treatment and poor outcomes.
  - **Resulting Gap:** Inadequate knowledge of risk factors for neonatal seizures, and inadequate competence in performing neonatal EEG and quantitative EEG analysis. Inadequate team approach to patient treatment, incorporating clinical neurophysiologists and neonatologists.
  - **Educational Need:** Didactic lectures and discussion groups on neonatal seizures, quantitative EEG techniques, and new neonatal EEG guidelines.

Digital EEG processing:

- Quantitative EEG
    - Ischemia detection
    - Seizure detection
- Trends for use in the intensive care unit

Example Gap

- **Best Practice:** Seizures in critically ill adults and pediatric patients are rapidly and reliably identified with the addition of quantitative EEG analysis in conjunction with raw EEG analysis. Additional uses include sedation monitoring in critically ill patients and in uncovering unusual patterns of status and nonstatus epilepticus.
- **Current Practice:** Quantitative EEG is used infrequently and there is a lack of standardization of quantitative EEG practices.
- **Resulting Gap:** Inadequate knowledge of information represented by quantitative EEG trends, interpretation of quantitative EEG trend changes, recognition of seizure activity on quantitative EEG, recognition of artifacts on quantitative EEG trends and utilization/manipulation of quantitative EEG software.
- **Educational Need:** Symposia and workshops on quantitative EEG trend basics and utilization of quantitative EEG for seizure detection.

Example Gap

**Best Practice:** Impending cerebral ischemia and vasospasm in patients with subarachnoid hemorrhage is detected in a timely fashion and reliably with quantitative EEG trend analysis.

- **Current Practice:** Quantitative EEG is rarely used for ischemia and vasospasm detection and there is a lack of standardization of quantitative EEG practices for this application.
- **Resulting Gap:** Inadequate knowledge of information represented by quantitative EEG trends, recognition of ischemia/vasospasm on quantitative EEG, recognition of artifacts on quantitative EEG trends and utilization/manipulation of quantitative EEG software.
- **Educational Need:** Symposia and workshops on quantitative EEG trend basics and utilization of quantitative EEG for ischemia/vasospasm detection.

Source localization:

- EEG source localization
- Source co-registration with neuroimaging

Example Gap

- **Best Practice:** Patients with intractable epilepsy undergo efficient and accurate pre-surgical evaluation.
- **Current Practice:** Many potential surgical candidates do not undergo epilepsy surgery evaluation because their seizures are considered to be poorly localized.
- **Resulting Gap:** Inadequate knowledge of methods of seizure localization, and inadequate competence in source localization and co-registration techniques.
- **Educational Need:** Symposia and workshops on source location, co-registration, and clinical applications of above.

Magnetoencephalography

- Clinical indications
- New guidelines
- Role in surgical epilepsy
- Combined EEG-MEG source localization and imaging

Example Gap

- **Best Practice:** Standardization/Optimization of Clinical MEG - MEG was developed as a research tool for neurophysiological assessment and localization of normal brain function.
- **Current Practice:** Clinical MEG Centers soon developed individually without the aid of consensus practice guidelines and protocols.
- **Resulting Gap:** Inadequate knowledge and inadequate competency for clinical MEG recording and interpretation.
- **Educational Need:** Commonly accepted standards for clinical MEG recording and analysis, including how to set up a MEG laboratory, recommended personnel, standards for report writing, etc.

Broad band EEG

- Ultrafast and ultraslow EEG
- Stereo EEG: Pediatric and Adult uses and Differentiation of Seizure types

Functional Brain Mapping and Brain Machine Interface

- Neurophysiology of Brain Function
- Brain Mapping to guide surgical resection
- Emerging technologies

Video-EEG monitoring

- Invasive EEG
- New/next generation seizure detection algorithms

Example Gap

- **Best Practice:** Patients with intractable epilepsy are identified as potential surgical candidates early in their disease course, and undergo presurgical evaluation.
- **Current Practice:** Many potential surgical candidates are not identified at all or are identified only after many years of intractable epilepsy.
- **Resulting Gap:** Inadequate competence in recognizing potential surgical candidates, and in performing presurgical video-EEG monitoring. Inadequate incorporation of results of video-EEG monitoring into patient treatment plans.
- **Educational Need:** Workshops on video-EEG and invasive EEG

Ambulatory EEG

- Indication for EEG and Video EEG home recordings
- Quality Standards
- Guidelines

Intraoperative Neurophysiologic Monitoring:

- SEP Monitoring
- MEPs Monitoring

Example Gap

- **Best Practice:**
  Guidelines and Standard of Care - Evidence-based guideline update: intraoperative spinal monitoring with somatosensory and transcranial electrical motor evoked potentials: report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology and the American Clinical Neurophysiology Society.
  *Reference: Nuwer MR[1], Emerson RG, Galloway G, Legatt AD, Lopez J, Minahan R, Yamada T, Goodin DS, Armon C, Chaudhry V, Gronseth GS, Harden CL;Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology; American Clinical Neurophysiology Society.*

  Guidelines for SEPs monitoring (ACNS website) - Established alarm criteria selection of appropriate nerves; Use of near field and far field potentials, and peripheral potentials
- **Current Practice:**
  - One of the most established neuromonitoring procedures usually performed in combination with MEPs performed routinely at most institutions offering spine monitoring
  - MEPs are monitored (together with SSEPs) in most of the institutions that offer spinal cord monitoring
  - MEPs not commonly used for root monitoring
  - MEPS interpretation based on consistency and temporal correlation to surgical manipulations
  - Few institutions perform D waves or spinal cord mapping
- **Resulting Gap:**
  - Training in troubleshooting/interpretation
  - In understanding how different mechanisms of injury are reflected in MEP changes
  - Limitation in the use of MEPs for root monitoring
  - Presence of few institutions use or train in D wave and spinal cord mapping
  - Workshops/case presentations of MEPs monitoring and associated mechanisms of injury
  - Understanding alarm criteria variability with mechanism of injury
  - Use of D waves and spinal cord mapping
- **Educational Need**: Better understanding of the dipoles, far field/near field potentials

- Sensory-Motor Mapping

  Example Gap
  - **Best Practice:**
    - Able to perform central sulcus (CS) localization, motor mapping awake and under general anesthesia, using both Penfield and multipulse train technique
    - Able to continuously monitor the motor pathways
    - Able to perform subcortical mapping
    - Monitor ECoG for after discharges (AD), assess depth of anesthesia, delineate lesion
  - **Current Practice:**
    - CS localization via phase reversal technique
    - Use of Penfield method to motor map in awake craniotomies only (experts are coming from EEG/Epilepsy field); do not perform continuous motor monitoring or subcortical mapping: Pro: do use ECoG to monitor for Ads
    - Use of multipulse train technique to motor map under general anesthesia but not used to look at the ECoG (experts coming from the EMG field)
  - **Resulting Gap**:
    - In understanding the underuse of ECoG
    - In understanding the underuse of CS localization
    - In understanding the underuse of continuous motor monitoring
    - In understanding that mapping at a high current density->higher risk of triggering seizures
  - **Educational Need:**
    - Increase training in ECoG mapping
    - Enhance and increase training in awake and asleep motor mapping
    - Provide training in multipulse train technique as the most efficient technique for mapping pyramidal neurons under general anesthesia
    - Provide training in the use of continuous motor monitoring in association with subcortical mapping

- Brainstem Mapping

  Example Gap
  - **Best practice:**
    - Monitor and map all motor nerves/their nuclei (free and triggered EMG)
    - BAEP following ACNS guidelines
    - SEP and MEP monitoring
    - Corticobulbar tracts (corticobulbar MEPs)
  - **Current practice:**
    - BAEPs monitoring
    - Cranial nerve monitoring and mapping
    - SEP and MEP monitoring
  - ***Resulting gap:**
    - Infrequent monitoring of a variety of CNs
    - Very infrequent mapping of CNs or CN nuclei
  - **Educational needs:**
    - Workshop training via video simulations of CN monitoring and mapping
    - Increase training for corticobulbar MEP monitoring

- PERIPHERAL NERVE MONITORING/MAPPING

  Example Gap
  - **Best practice:** Multimodality technique: SEPs for root avulsion; Nerve action potentials (NAP) and triggered EMG for assessment of nerve functional integrity and lesion location; tcMEPs from all myotomes
  - **Current Practice:**
    - SEPs for root avulsion;
    - Triggered EMG or twitches to assess functional nerve integrity

  **Resulting Gap:**
    - NAP monitoring/inching technique is rarely applied
    - Inaccurate assessment of nerve integrity

**Educational Needs:** Workshops in NAP recordings/inching technique to increase reliability of our clinical correlates

LANGUAGE & PARIETAL MAPPING

*Best Practice:
- Uses pre and intra-operatively
- Perform adequate language/parietal baseline testing
- Use Penfield method
- Use EcoG for after discharges (Ads) monitoring

*Current Practice:
- Similar
- Perhaps not very specialized testing
- +/- use of ECoG for ADs monitoring

*Resulting Gap:
- Minimal

*Educational Needs:
- Review appropriate battery of tasks in relation to clinical need
- Emphasize importance of ADs monitoring

Endovascular NIOM: including monitoring during carotid surgeries and in cases of vascular anomalies and embolization

Selective Dorsal Rhizotomy predominately pediatric cases of CP; other adult cases less common use

Pelvic Floor monitoring: Preservation of Bladder and Bowel function

Advanced EMG techniques ambulatory setting
- Single fiber EMG
- Motor unit number estimate techniques
- Neuromuscular ultrasound ultrasound
  - Compressive neuropathies
  - Muscle disorders

GENERAL NEEDS

- Increase available ACNS Guidelines
- Promote multimodality approach to NIOM

CHALLENGES

- Diverse groups of providers/facilities
- NIOM poses challenges in outcomes research
  - Guidelines and Standards for NIOM

Multimodality approach
Increase number of NIOM fellowship training programs
Increase number of courses/workshops at subspecialty meetings

**Epilepsy Surgery**
**Gap Analysis**

- Best Practice:

  Epilepsy surgery is now widely accepted as part of the standard intervention when epilepsy becomes refractory to medication.(1) As part of ACNS scope which mainly dealing with clinical neurophysiology investigations, the best practice will discuss only the part of presurgical epilepsy evaluations in term of what, when and how investigation(s) be implemented in presurgical as well as the phase-2 (intracranial EEGs) evaluations as the best practice in epilepsy surgery. From reviewing current literatures, there are no evidence-based data in epilepsy surgery, especially the investigation work-up paradigm or algorithm in extratemporal or pediatric epilepsy surgery. (2) The available epilepsy surgery guidelines are from ILAE in pediatric epilepsy surgery (3, 4) are derived from experts' opinion, not evidence based guidelines.

Based on expert opinions, the presurgical investigations in epilepsy surgery would include

- Longterm video EEG
- High resolution MRI
- Ictal SPECT
- MEG
- PET
- Dense-array EEGs or 3D-EEGs

In term of phase-II evaluations, there is no clear evidence to support or against which is the best clinical approach obtaining ICEEG (Subdural vs SEEGs).

- Current Practice: Can be divided into 2 aspects
  - When to refer

The referral to epilepsy center in clinical practice is still somewhat below the real need. As demonstrated by recent paper, epilepsy surgery trends in the U.S. is below the real need of the patient polpulation.(5) This means the current practice of epilepsy surgery referral remains under utilized.

  - Presurgical Investigations

Currently, everyone would agree to obtain the first two of the above lists of six presurgical investigations (Longterm video-EEG and High resolution MRI). However, beyond these two investigations the choice of presurgical investigations are varies among epilepsy centers. These depend on facitly availability, insurance reimbursement, feasibilty in obtaining the test, etc

  - Surgical Investigations

The phase-II (invasive/intracranial or ICEEG) is also varies among centers but mainly either SEEGs or subdural recordings

- **Resulting Gap:**

Inadequate of evidence based data in the field of epilepsy surgery results in no clear consensus practice guidelines in presurgical work up. This also results reluctant to reimburse some of the presurgical investigation with an excuse of absence practice guidelines, or investigational or experimental testing for epilepsy surgery

- **Need:**

Best practice guidelines of epilepsy surgery is needed. It could help general neurologists understand more about epilepsy surgery and increase more referral. It also might help the reimbursement of some useful presurgical investigations which is still underutilization. A course in evidence based medicine in epilepsy surgery could help clinician and researcher fill the need gap and the missing data.

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Sleep:

Neurophysiology of Sleep Disorders

- Use of new scoring system, implications for patient care
- Sleep in Neurologic Disorders (Epilepsy, Stroke, etc.)
- Sleep and Coma

Example Gap

- Best Practice: Sleep evaluations should conform to recently published guidelines for polysomnography.
- Current Practice: Many practitioners are not familiar with new guidelines.
- Resulting Gap: Inadequate knowledge of optimal polysomnography techniques, inadequate competence in PSG techniques, and inadequate ability to incorporate guidelines into clinical practice.
- Need: Review of new sleep guidelines. Tools to incorporate new guidelines into sleep lab management.

Peripheral Neurophysiology:

- Pediatric EMG
- Critical illness related neurophysiology
- Muscle ultrasound
- Electroneurodiagnostics of the pelvic floor

Example Gap

- Best Practice: Critical illness neuropathy and myopathy are rapidly identified and treated.
- Current Practice: Critical illness neuropathy and myopathy are often not recognized, and prolong the need for ICU care.
- Resulting Gap: Inadequate knowledge of risk factors for critical illness neuropathy and myopathy, and inadequate competence in performing EMG and nerve conduction studies in critically ill patients.
- Need: Didactic lectures and hands-on workshops on critical illness neuropathy and myopathy.

Other areas of Clinical Neurophysiology

- Neurophysiology of Brain and Peripheral Nervous System Stimulation:
  Indication, safety, role in diagnosis and therapy
  - Transcranial Magnetic Stimulation
  - Deep Brain Stimulation
  - Responsive Neurostimulation

- Autonomic Nervous System
  - Neurophysiologic Testing
  - Role of the autonomic nervous system in Sudden Unexpected Death in Epilepsy (SUDEP)

- Neurophysiology in Psychiatry
  - Transcranial magnetic stimulation
  - Quantitative EEG
  - Deep brain stimulation
  - Non-epileptic seizures
  - Evoked Potentials in Traumatic Brain Injury Research

- Practice Management in Clinical Neurophysiology
    - Healthcare models
    - Self-assessment
    - Patient safety and quality improvement
    - Billing and Coding
    - Educational techniques

- Neurophysiology of Movement Disorders
    - Spasticity
    - Use of botulinum toxin
    - Diagnosis and pathophysiology of non-epileptic seizures

- Neurophysiology of Trauma and Recovery
    - Neuroplasticity
    - Regenerative and rehabilitative strategies
    - Neurophysiology of Consciousness
    - Neurophysiology of sports injury and sports medicine
    - Neurophysiology of Cooling after Cardiac Arrest

- Neurophysiologic Mechanisms of Disease
    - Neurophysiologic Biomarkers
    - Channelopathies

Clinical Research Methodology

Challenges:

- Challenges to outcomes research
- Variability of practice among providers
- Lack of objective quality measures
- Low volume trained providers
- Gaps between best and current practice
-

Partnerships with other organizations:

Provide methods to increase training in subspecialty areas of clinical neurophysiology

Collaborative meetings with International Congress of Clinical Neurophysiology to broaden collaboration and training

Collaborative efforts on several guidelines with other organizations

American Association of Neuromuscular & Electrodiagnostic Medicine (AANEM)
American Epilepsy Society (AES)
Child Neurology Society (CNS)
American Academy of Neurology (AAN)

History of Clinical Neurophysiology

Significance in documenting history of the field

Understanding history of subspecialty developments