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Policy Effective Date	**07/15/2024**
Policy End Date	**12/31/2025**

Ambulatory or Video Electroencephalogram (EEG) Monitoring, Including Digital Analysis of Electroencephalogram

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Related Policies (if applicable)
None

Disclaimer

Carefully check state regulations and/or the member contract.
Each benefit plan, summary plan description or contract defines which services are covered, which services are excluded, and which services are subject to dollar caps or other limitations, conditions or exclusions. Members and their providers have the responsibility for consulting the member's benefit plan, summary plan description or contract to determine if there are any exclusions or other benefit limitations applicable to this service or supply. **If there is a discrepancy between a Medical Policy and a member's benefit plan, summary plan description or contract, the benefit plan, summary plan description or contract will govern.**

Legislative Mandates

EXCEPTION: For Illinois only: Illinois Public Act 103-0458 [Insurance Code 215 ILCS 5/356z.61] (HB3809 Impaired Children) states all group or individual fully insured PPO, HMO, POS plans amended, delivered, issued, or renewed on or after January 1, 2025 shall provide coverage for therapy, diagnostic testing, and equipment necessary to increase quality of life for children who have been clinically or genetically diagnosed with any disease, syndrome, or disorder that includes low tone neuromuscular impairment, neurological impairment, or cognitive impairment.

Coverage

This medical policy has become inactive as of the end date above. There is no current active version and this policy is not to be used for current claims adjudication or business purposes.

Ambulatory Electroencephalogram (AEEG) Monitoring

AEEG monitoring **may be considered medically necessary** when used:

- To diagnose a seizure disorder when the clinical history or examination is suggestive of epilepsy, but routine EEG is non-diagnostic;
- To classify seizure type in individuals with epilepsy after a routine electroencephalogram (EEG) is non-diagnostic and classification will be used to select drug therapy;
- In conjunction with ambulatory electrocardiogram (ECG) recordings for seizures suspected to be of cardiogenic origin (i.e., cardiac arrhythmias, transient ischemic attacks, etc.) not diagnosed by conventional studies;
- To determine classification and quantification of seizures in a patient who experiences frequent absence or petit mal seizures;
- To determine characterization (lateralization, localization, distribution) of EEG abnormalities, both ictal (i.e., seizure, stroke, headache) and interictal (period between seizures), associated with seizure disorders in the evaluation of patients with intractable epilepsy for surgical evaluation; or
- To monitor neonates with hypoxic-ischemic encephalopathy (HIE) who are being treated with therapeutic hypothermia (TH).

AEEG monitoring **is considered not medically necessary** when used in the following circumstances:

- Study of neonates who do not meet the criteria above, or unattended non-cooperative patients;
- Localization of seizure focus/foci when the seizure symptoms and/or other EEG recordings indicate the presence of bilateral foci or rapid generalization; or
- For final evaluation of patients who are being considered as candidates for resective surgery when the medically necessary criteria listed above have not been met.

NOTE 1: In most circumstances extended AEEG monitoring (i.e., longer than 72 hours) is not necessary, as AEEG is generally diagnostic within the first 24 to 72 hours.

Video Electroencephalogram (VEEG) Monitoring

VEEG monitoring **may be considered medically necessary:**

- To diagnose seizure type and epilepsy syndrome in individuals who present diagnostic difficulties following clinical assessment and standard EEG;
- For identification and localization of a seizure focus on individuals with intractable epilepsy who are being considered for surgery;
- To monitor neonates with HIE who are being treated with TH; or
- To document provocation of seizures after medication withdrawal for the purpose of making medication adjustments or otherwise determining an appropriate treatment plan.

VEEG monitoring **is considered not medically necessary** for all other indications.

NOTE 2: In most circumstances VEEG monitoring for an inpatient may continue 24 hours or more, to as many as 72 hours for long-term VEEG monitoring (LTM); whereas outpatient may have a duration of 6 to 8 hours.

Digital Electroencephalogram (DEEG) Analysis
Digital analysis of electroencephalogram (DEGG) **is considered not medically necessary** as there is no evidence that such additional processing and interpretation has been shown to improve outcomes in patient management.

NOTE 3: Digital analysis of an EEG is not the same as a digital recording of an EEG. Refer to the Description section for more information.

NOTE 4: This policy does not address resting/conventional EEGs.

Policy Guidelines

None.

Description

The brain is created by the structural and functional properties of interconnected neurons or brain cells. Neurons communicate with each other by electrical changes. These electrical changes can be seen in the form of brain waves, shown in an electroencephalogram (EEG). Variations in the brain wave characteristics correlate with some neurological conditions. EEGs are used to diagnose specific medical conditions, such as suspected seizures or seizures associated with epilepsy. (1, 2)

Various ictal (during a seizure, stroke, headache) and interictal (period between seizures) EEG patterns correspond to specific seizure types and types of epilepsy. While the EEG is almost always abnormal during a seizure, it may be normal between seizures. Thus, lack of interictal EEG abnormalities does not exclude a diagnosis of epilepsy. However, at some time, most epilepsy patients have abnormal EEG discharges. In contrast, some persons with EEG'S that show epilepsy-like activity never have seizures. Thus, physicians interpret EEG results within the context of other information they are gathering. Blood tests, EEGs and scans are used to gather information for a diagnosis. Tests on their own cannot confirm or rule out epilepsy. Apart from the patient history and the neurological exam, the EEG is the most influential tool in the diagnosis of seizures and epilepsy. (1-3)

Background
In resting/conventional surface/scalp EEG, the recording is obtained by placing electrodes with recording channels on the scalp with a conductive gel or paste, usually after preparing the scalp area by light abrasion to reduce impedance due to dead skin cells. Many systems typically use electrodes, each of which is attached to an individual wire. Some systems use caps or nets into which electrodes are embedded; this is particularly common when high-density arrays of electrodes are needed.

A very low electrical current is sent through the electrodes and the baseline brain energy is recorded on a diagnostic machine. The electrical activity recording is analyzed through a differential amplifier system. Patients are then exposed to a variety of external stimuli, including bright or flashing light, noise, certain drugs. They also may be asked to open and close their eyes or to change breathing patterns. The electrodes transmit the resulting changes in brain wave patterns. With identification and classification of brain waves, the analysis of data provides information useful in mapping the brain and various areas involved with body function in relation to disease status. Since movement and artifacts can alter brain wave patterns, patients usually recline in a chair or on a bed during the test, which takes up to an hour. Testing for certain disorders may also require an EEG during sleep.

During the recording, a series of activation procedures may be used. These procedures may induce normal or abnormal EEG activity that might not otherwise be seen. These procedures include hyperventilation, photic stimulation (with a strobe light), eye closure, mental activity, sleep and sleep deprivation. During (inpatient) epilepsy monitoring, a patient's typical seizure medications may be withdrawn. (4, 5)

Ambulatory Electroencephalography (AEEG) Monitoring

AEEG, 24-hour electroencephalographic (EEG) monitoring, or mobile EEG monitoring allows a prolonged EEG recording of the electrical current potential or brain activity utilizing the same process as the conventional scalp/surface EEG. An AEEG has the ability to record continuously for up to 72 hours which increases the opportunity of recording an ictal event (during a seizure), or interictal (between seizures) epileptiform discharge. This method of recording offers the ability to gather data on a long term, outpatient basis with the option to remain in the home. This allows the patient to be evaluated while performing daily activities and at rest. (6)

In the past decade, computer technology has enabled portable recording of up to 36 channels with sampling rates of up to 400 Hz (hertz). (6) To date, virtually all contemporary EEG recordings use digital technology to acquire, store, and review data and are considered the industry standard (7) although there is a distinction between digital recording and digital analysis of EEG data:

- A digital recording uses a digital EEG recorder (machine); but it still involves visual analysis of the wave forms. It is digital to the extent that an analog, close-ended paper recorder is not used at the time of wave form (data) capture. This type of reading-by-eye represents the typical EEG interpretation in most clinical situations.
- A digital analysis requires the use of quantitative analytical techniques. Data selection, quantitative software processing and dipole source analysis are some of the techniques utilized. (7, 8)

Video Electroencephalogram (VEEG) Monitoring

Routine EEGs and AEEGs may not capture all the suspected events therefore it may be necessary to add video. A VEEG records brainwave activity on an EEG simultaneously with video in order to compare what is happening when a seizure or event occurs. A VEEG may be needed

in a select group of patients that require mediation adjustment such as patients with a history of status epilepticus, those with frequent or severe seizures, or those with severe medication reactions requiring abrupt discontinuation (e.g., allergic reaction). When a seizure occurs, subtle clinical features with lateralizing importance can be better evaluated, such as dystonic posturing, eye deviation, facial clonus, postictal nose-wiping, brief Todd's paresis, etc. The addition of video can also help identify artifacts produced by non-seizure related rhythmic movements (e.g., blinking, chewing, toothbrushing, scratching) that can mimic seizure like activity on EEG. (7, 9)

Regulatory Status

There are numerous EEG devices that have been cleared for marketing by the United States (U.S.) Food and Drug Administration (FDA) under the guidance of the Center for Devices and Radiological Health (CDRH), under section 510(k) clearance process. Today's EEG devices have many more features than the devices that were in existence at the creation of the first EEG product code, GWQ, in the late 1970s. Contemporary designs of EEG devices may include classic features, such as standard full-montage EEG acquisition systems or polysomnography devices, but they may also include more novel features, such as automatic event detection software or source localization software. Product codes allow the FDA to distinguish among distinct types of EEG devices marketed in the U.S. and more effectively regulate EEG devices in both premarket and post-market settings. A current list of product codes can be found at <https://www.accessdata.fda.gov>.

Rationale

This medical policy was created in 1990 and, since then updated periodically using the PubMed database. The most recent literature review was performed through June 1, 2023. The following is a summary of the key literature to date.

The electroencephalogram (EEG) is a key tool in the diagnosis and management of epilepsy and other seizure disorders. It is also used to assist in the diagnosis of brain damage and disease (e.g., stroke, tumors, and encephalitis), mental retardation/intellectual disability, sleep disorders, degenerative diseases such as Alzheimer's disease and Parkinson's disease.

Literature suggests that ambulatory electroencephalogram (AEEG) and video electroencephalogram (VEEG) are also useful in the diagnosis in young children, in patients with poorly characterized seizure types, and in those with suspected psychogenic seizures, especially if episodes are frequent.

Ambulatory Electroencephalogram (AEEG) Monitoring

AEEG is beneficial in documenting seizures when routine EEG is non-diagnostic. In 2012 Faulkner et al. completed a study due to the International League Against Epilepsy **(**ILAE**)** guidelines recommend the use of prolonged EEG where the diagnosis of epilepsy or the classification of the seizure syndrome is proving difficult. (10) Due to its limited provision, VEEG

monitoring is unavailable to many patients. This study examined the utility of the alternate of outpatient AEEG. This retrospective study analyzed 324 consecutive prolonged outpatient AEEGs lasting 72-96 hours, without medication withdrawal. EEG data and the clinical records of 324 studies were examined. Two hundred nineteen (68%) studies gave positive data, 116 (36%) showed interictal epileptiform discharges (IEDs), 167 (52%) had events. One hundred five (32%) studies were normal. Overall, 51% of studies changed management of which 22% of studies changed the diagnosis and 29% of studies refined the diagnosis by classifying the epilepsy into focal or generalized. This study confirmed the diagnostic utility of outpatient AEEG in the diagnosis of paroxysmal events. Therefore, when compared to routine EEG, AEEG demonstrated a higher yield and diagnostic sensitivity.

In 2012, Dash et al. evaluated AEEG and the cost effectiveness as an alternative to inpatient VEEG in adult patients. (11) This study evaluated EEG activity when patients are at home, without the necessity of admission to the hospital for prolonged VEEG monitoring. This was a prospective, cohort study performed in a Canadian academic center to assess the yield and tolerability of AEEG in the adult population. Over a period of 3 years, 101 patients were included (45 males, 56 females). Most of the patients had at least 1 previous routine EEG (93%). The primary reasons for the AEEGs were subdivided into the following 4 categories:

- To differentiate between seizures and non-epileptic events;
- To determine the frequency of seizures and epileptiform discharges;
- To characterize seizure type or localization; and
- To potentially diagnose epilepsy.

The mean duration of AEEG recording was 15-96 hours. For 73 (72%) patients, the AEEG provided information that was useful for patient management. For 28 (28%) patients, the AEEG did not provide information on diagnosis because no events or epileptiform activity occurred. In only 1 patient was the AEEG inconclusive due to non-physiological artifacts. Three patients were referred for epilepsy surgery without the necessity of VEEG. The main use of AEEG is the characterization of patients with non-epileptic events and in patients with a diagnosis of epilepsy that is not clear. Quantification of spikes and seizures continue to improve the medical management of these patients. AEEG is a cost-effective solution for increasing demands for in-hospital VEEG monitoring in adult patients.

In 2013, Sanchez et al. evaluated survey data that indicated that continuous EEG (CEEG) monitoring is used with increased frequency to identify electrographic seizures in critically ill children. (12) Eleven North American centers retrospectively enrolled 550 critically ill children who underwent CEEG. Indications were encephalopathy with possible seizures in 67% of subjects, event characterization in 38% of subjects, and management of refractory status epilepticus in 11% of subjects. CEEG was initiated outside routine work hours in 47% of subjects. CEEG duration was <12 hours in 16%, 12-24 hours in 34%, and >24 hours in 48%. Substantial variability existed among sites in CEEG indications and neurologic diagnoses, yet within each acute neurologic diagnosis category a similar proportion of subjects at each site had electrographic seizures. Electrographic seizure characteristics including distribution and duration varied across sites and neurologic diagnoses. This indicated variability in practice. The

results suggest that multicenter studies are feasible if CEEG monitoring pathways can be standardized. However, the data also indicated that electrographic seizure variability must be considered when designing studies that address the impact of electrographic seizures.

In 2015, Lawley et al. (13) performed a systematic review on the use of AEEG in the diagnosis of epilepsy and nonepileptic attacks in adult patients. The findings confirmed that AEEG is a useful diagnostic tool in patients with equivocal findings on routine EEG studies and it influenced management decisions in the majority of studies. In addition, they noted that there is evidence that AEEG is also more likely to capture events than sleep-deprived EEG; however, there are currently insufficient data available to compare the diagnostic utility of modern AEEG technology with inpatient video-telemetry therefore additional research is warranted in scenario.

In 2016, Keezer and colleagues (14) examined a consecutive sample of 72 individuals who had undergone 32-channel AEEG immediately following a routine EEG. Each recording was prospectively assessed for epileptiform discharges and non-epileptiform abnormalities. The median duration was 22.5 hours (interquartile range: 22.0-23.0). The sensitivity of AEEG was 2.23 times greater than that of routine EEG [sensitivity ratio: 2.23 (95% CI=1.49-3.34)]. These findings support the use of AEEG in the diagnosis and characterization of epilepsy.

In 2023, UpToDate presented the following recommendations for the use of AEEG in the diagnosis of seizures and epilepsy (9):

- “Because of its longer recording that typically includes one or more periods of sleep, AEEG monitoring can increase the yield of routine EEG in detecting IEDs.
- AEEG is most helpful in quantifying or capturing clinical events and associating these with the presence or absence of electrographic seizures. However, absence of an EEG correlate does not exclude epilepsy and AEEG cannot "rule out" epileptic seizures.”

AEEG Utilization in Neonates

In 2010, van Rooij et al. studied the effect of treatment of subclinical neonatal seizures detected with amplitude-integrated EEG. (15) This was a randomized, multicenter controlled trial of 33 infants. The goal was to investigate how many subclinical seizures in full-term neonates with hypoxic-ischemic encephalopathy (HIE) would be missed without continuous EEG and whether immediate treatment of both clinical and subclinical seizures would result in a reduction in the total duration of seizures and a decrease in brain injury, as seen on magnetic resonance imaging (MRI) scans. Term infants with moderate to severe HIE and subclinical seizures were assigned randomly to either treatment of both clinical seizures and subclinical seizure patterns (group A) or blinding of the amplitude-integrated EEG registration and treatment of clinical seizures only (group B). All recordings were reviewed with respect to the duration of seizure patterns and the use of antiepileptic drugs (AEDs). MRI scans were scored for the severity of brain injury. Nineteen infants in group A and 14 infants in group B were available for comparison. The median duration of seizure patterns in group A was 196 minutes, compared with 503 minutes in group B (not statistically significant). No significant differences in the number of AEDs were seen. Five infants in group B received AEDs when no seizure

discharges were seen on amplitude-integrated EEG traces. Six of 19 infants in group A and 7 of 14 infants in group B died during the neonatal period. A significant correlation between the duration of seizure patterns and the severity of brain injury in the blinded group, as well as in the whole group, was found. In this small group of infants with neonatal HIE and seizures, there was a trend for a reduction in seizure duration when clinical and subclinical seizures were treated. The severity of brain injury seen on MRI scans was associated with a longer duration of seizure patterns.

In 2016, Liu et al. (16) conducted monitoring analysis of lesion degree and long-term prognosis using AEEG in newborns with HIE. Forty-eight newborns with HIE (aged 37 to 41 weeks) as the observation group and 50 cases of full-term infants with non-traumatic brain illness as the control group were examined over 1 year. The AEEG were observed, and the continuity and sleep-wake cycle (SWC) between the 2 groups were compared. The relevance of AEEG monitoring results and HIE, as well as the long-term prognosis, were analyzed. Thirty three percent (16/48) of EEG results appeared to be continuous and 20.83% (10/48) of the SWC results were mature for observation group. These EEG and SWC results are conspicuously lower than the control group 100% (50/50) and differences were statistically significant ($p<0.05$). The maximum voltage of observation group was 56.54±19.33 LV (low voltage), notably higher than the control group (37.77±2.79 LV). The minimum voltage of the observation group was 4.26±1.25 LV, markedly lower than the control group (7.75±0.67 LV) and these differences were statistically significant ($p<0.05$). Correlational analysis based on the Spearman approach showed that the monitoring results are positively correlated with clinical classification of HIE. After 6 months of follow-up, 11 of the 48 cases (22.92%) were found to be disabled (including mental retardation and cerebral palsy). The authors concluded that AEEG provides easy operation, effective diagnosis, supports continuous monitoring and reflects the lesion degree as well as long-term prognosis of newborns with HIE therefore highly recommended in clinical practice.

Video Electroencephalogram (VEEG) Monitoring

VEEG monitoring has generally been considered the standard to accurately differentiate epileptic from nonepileptic events and to localize the epileptogenic zone in patients being investigated for epilepsy surgery. VEEG is considered a necessary tool in determining surgical candidacy as it provides a detailed description of both ictal clinical signs and EEG discharge, as well as prolonged interictal recordings. Additionally, VEEG allows for the patient to be subjected to provocative measures such as medication reduction, sleep deprivation, hyperventilation, or photic stimulation to increase the likelihood of capturing epileptiform activity. (17-19)

Occasionally, AEDs may be withdrawn in order to evaluate seizures. Several studies have shown that the rapid reduction of antiseizure drugs during video-EEG monitoring increases the risk of focal seizures and evolution to bilateral convulsive seizures. (20, 21) Up to half of all patients who have never had a generalized seizure at baseline will have one in the context of rapid medication withdrawal. (20)

In 2018, Kumar et al. (22) evaluated the efficacy of rapid and slow AED taper in an open-label RCT. Patients aged 2-80 years with drug-resistant epilepsy (DRE) were randomly assigned (1:1) to rapid and slow AED taper groups. Outcome assessor was blinded to the allocation arms. Daily AED dose reduction was 30% to 50% and 15% to <30% in the rapid and slow taper groups, respectively. The primary outcome was difference in mean duration of long-term VEEG monitoring between the rapid and slow AED taper groups. Secondary outcomes included diagnostic yield, secondary generalized tonic-clonic seizure (GTCS), 4- and 24- hour seizure clusters, status epilepticus, and need for midazolam rescue treatment. One hundred forty patients were randomly assigned to rapid (n = 70) or slow taper groups (n = 70), between June 13, 2016 and February 20, 2017. The difference in mean long-term VEEG monitoring duration between the rapid and slow taper groups was -1.8 days (95% CI] -2.9 to -0.8, P = .0006). Of the secondary outcome measures, time to first seizure (2.9 ± 1.7 and 4.6 ± 3.0 days in the rapid and slow taper groups respectively, P = .0002) and occurrence of 4-hour seizure clusters (11.9% and 2.9% in the rapid and slow taper groups, respectively, P = .04) were statistically significant. None of the other safety variables were different between the 2 groups. Long-term VEEG monitoring diagnostic yield was 95.7% and 97.1%, in rapid and slow taper groups respectively (P = .46). The RCT concluded that rapid AED tapering has the advantage of significantly reducing long-term VEEG monitoring duration over slow tapering, without any serious adverse events.

In 2023, UpToDate offered the following recommendations for the use of VEEG in the diagnosis of seizures and epilepsy (9):

- "While relatively inexpensive and convenient to perform, AEEG monitoring has significant disadvantages compared with inpatient VEEG recording, including the inability to interact and test the patient during a spell, or withdraw medications safely and the higher potential for artifact and misinterpretation;
- Inpatient VEEG monitoring facilitates ongoing maintenance of video and EEG quality, permits interaction with the patient during or after an event, and allows medication withdrawal in a safer, monitored setting;
- VEEG is used most commonly to determine whether epilepsy is the cause of recurrent seizure-like events;
- VEEG can also aid in seizure classification, quantification, and determination of patient awareness of their seizures. It is also vital for presurgical evaluation of epilepsy patients."

<u>VEEG Utilization in Neonates</u>

In February 2013, the Vermont Oxford Network Collaborative attempted to create and implement an evidence-based standard-of-care approach to neonatal encephalopathy, to deliver consistent care, and to optimize outcomes. (23) By using an evidence-based approach, potentially better practices were developed by the topic expert, modified by the collaborative, and implemented at each hospital. These included the following:

- Timely identification of at-risk infants;
- Coordination with referring hospitals to ensure therapeutic hypothermia (TH) was available within 6 hours after birth;
- Staff education for both local and referring hospitals;

- Non-sedated MRI;
- Incorporating amplitude-integrated EEG into a TH protocol; and
- Ensuring standard neurodevelopmental follow-up of infants.

Each center used these practices to develop a matrix for implementation. Local self-assessments directed the implementation and adaptation of the Potentially Better Practices at each center. Resources, based on common identified barriers, were developed and shared among the group. The implementation of a TH program to improve the consistency of care for patients in neonatal intensive care units (NICUs) is feasible using standard quality improvement methodology. The successful introduction of new interventions such as TH to the NICU culture requires a collaborative multidisciplinary team, use of a systematic quality improvement process, and perseverance.

In April 2014, Glass et al. conducted a three-center observational cohort study to assess to assess the risk factors for electrographic seizures among neonates treated with TH for HIE. (24) Ninety term-neonates treated with hypothermia, were monitored with continuous VEEG within the first day of life (median age at onset of recording 9.5 hours, interquartile range 6.3-14.5), and continued for >24 hours (total recording 93.3 hours, interquartile range 80.1-112.8 among survivors). A pediatric electroencephalographer at each site reviewed continuous VEEGs for electrographic seizures and initial EEG background category. A total of 43 (48%) had electrographic seizures, including 9 (10%) with electrographic status epilepticus. Abnormal initial EEG background classification (excessively discontinuous, depressed and undifferentiated, burst suppression, or extremely low voltage), but not clinical variables (including pH <6.8, base excess ≤-20, or 10-minute Apgar ≤ 3), was strongly associated with seizures. The authors concluded that electrographic seizures are common among neonates with HIE undergoing hypothermia and are difficult to predict based on clinical features. These results justify the recommendation for continuous VEEG monitoring in neonates treated with hypothermia.

Duration of VEEG Monitoring

In 2016, Hupalo et al. (25) sought to determine the optimal duration of the long-term VEEG and diagnostic utility of long-term monitoring (LTM) in patients with epilepsy and other paroxysmal events in terms of diagnosis and management. These researchers carried out a retrospective analysis of 282 LTMs performed in the last 5 years in their Epilepsy Monitoring Unit (EMU), in 202 consecutive patients. The analysis included demographic data, monitoring time, number and type of paroxysmal events, the time until their onset, and the influence of LTM on the diagnosis and future management. There were 117 women and 85 men, mean age of 34.2 years. Mean duration of LTM was 5 days (range of 3 to 9), with 447 paroxysmal events recorded in 131 (65 %) patients. Epileptic seizures were recorded in 82 % cases (in 11 % associated with psychogenic non-epileptic seizures [PNES]). The remaining 18 % had either PNES (11 %) or parasomnias (7 %). Only 15 % of epileptic seizures took place within the first 24 hours of the LTM (53 % and 32 % on the 2nd and 3rd day, respectively), whereas as many as 62 % of PNES did (while only 28 % and 10 % on the 2nd and 3rd day, respectively). The LTM results changed the diagnosis in 36 % of the patients, most frequently in PNES (from 2 % to 14 %). Overall, it

changed the management in 64 % of the patients, especially with PNES and those who underwent epilepsy surgery. The authors concluded that LTM should last at least 72 hours in patients with refractory epilepsy; most of cases with PNES could be diagnosed after 48 hours.

Digital Electroencephalogram (DEEG) Analysis

Analysis of DEEG is proposed as an automated analysis, by combining digital signals processing with neural network techniques. In 2013, Sharanreddy and Kulkami reported on automated EEG signal analysis for the identification of epilepsy seizures and brain tumors. (26) The system reviewed uses a multi-wavelet transform for feature extraction in which an input EEG signal is decomposed in a sub-signal. Irregularities and unpredictable fluctuations present in the decomposed signal are measured using approximate entropy. A feed-forward neural network is used to classify the EEG signal as a normal, epilepsy or brain tumor signal. The proposed technique is implemented and tested on data of 500 EEG signals for each disease. Results are promising, with classification accuracy of 98% for normal, 93% for epilepsy and 87% for brain tumor. Along with classification, the paper also highlights the EEG abnormalities associated with brain tumor and epilepsy seizure.

Practice Guidelines and Position Statements

American Clinical Neurophysiology Society (ACNS)

According to ACNS, guidelines for long term EEG monitoring (2008) (e.g., ambulatory EEG) include the following (7):

- Identification of epileptic paroxysmal electrographic and/or behavioral abnormalities. These included epileptic seizures, overt and subclinical, and documentation of interictal epileptiform discharges.
- Verification of the epileptic nature of the new “spells” in a patient with previously documented and controlled seizures.
- Classification of clinical seizure type(s) in a patient with documented but poorly characterized epilepsy.
- Characterization (lateralization, localization, distribution) of EEG abnormalities, both ictal and interictal, associated with seizure disorders. Characterization of epileptiform EEG features, including both ictal discharges and interictal transients, is essential in the evaluation of patients with intractable epilepsy for surgical intervention.
- Characterization of the relationship of seizures to specific precipitating circumstances or stimuli (e.g., nocturnal, catamenial, situation-related, activity-related). Verification and/or characterization of temporal patterns of seizure occurrence, either spontaneous or with respect to therapeutic manipulations (e.g., drug regimens).
- Characterization of the behavioral consequences of epileptiform discharges as measured by specific tasks.
- Quantification of the number or frequency of seizures and/or interictal discharges and their relationship to naturally occurring events or cycles.
- Quantitative documentation of the EEG response (ictal and interictal) to a therapeutic intervention or modification (e.g., drug alteration).

- Monitoring objective EEG features are useful in patients with frequent seizures, particularly with absence and other seizures having indiscernible or minimal behavioral manifestations.

The ACNS further stated that EEG and/or behavioral abnormalities may assist in the differential diagnosis between epileptic disorders and conditions associated with intermittent symptoms due to non-epileptic mechanisms (e.g., syncope, narcolepsy, other sleep disturbances, psychogenic seizures) (7).

The 2011 ACNS's Guidelines on "Continuous EEG Monitoring in Neonates" includes the following (27):

- "The use of synchronized video monitoring: Synchronized video is strongly recommended for the characterization of events and is often helpful in assessing for artifacts that may mimic electrographic seizures…"
- "The committee recommends that neonates at high risk for seizures be monitored with conventional EEG for 24 hours to screen for seizures. Seizures suspected by aEEG were documented in more than half of term neonates with hypoxic-ischemic encephalopathy who fulfilled the criteria for selective head cooling within 6 hours of birth…and studies of neonates undergoing EEG monitoring during therapeutic hypothermia for hypoxic-ischemic encephalography have also demonstrated a high incidence of seizures…"
- "…If seizures are detected, it is recommended that EEG monitoring continue until the patient has been found to be seizure-free for at least 24 hours, unless in consultation with a neurologist a decision is made to discontinue monitoring earlier…"

<u>American Academy of Pediatrics (AAP)</u>

The AAP Clinical Report on Hypothermia and Neonatal Encephalopathy published in 2014 concluded (28):

- "Medical centers offering hypothermia should be capable of providing comprehensive clinical care, including…seizure detection and monitoring with aEEG or EEG…"
- "…If preferential head cooling is used, an abnormal background activity on either EEG or aEEG also is required…"

<u>American Academy of Neurology (AAN)</u>

The July 1997 Assessment of Digital EEG, Quantitative EEG, and EEG Brain Mapping report by the American Academy of Neurology and the American Clinical Neurophysiology Society (29) provided the following recommendations:

A. "Digital EEG is an established substitute for recording, reviewing, and storing a paper EEG record. It is a clear technical advance over previous paper methods. It is highly recommended. (Class III evidence, Type C recommendation)
B. EEG brain mapping and other advanced QEEG techniques should be used only by physicians highly skilled in clinical EEG, and only as an adjunct to and in conjunction with traditional EEG interpretation. These tests may be clinically useful only for patients who have been well selected on the basis of their clinical presentation.

C. Certain quantitative EEG techniques are considered established as an addition to digital EEG in:
    - C.1 Epilepsy: For screening for possible epileptic spikes or seizures in long-term EEG monitoring or ambulatory recording to facilitate subsequent expert visual EEG interpretation. (Class I and II evidence, Type A recommendation as a practice guideline)
    - C.2 OR and ICU monitoring: For continuous EEG monitoring by frequency-trending to detect early, acute intracranial complications in the OR or ICU, and for screening for possible epileptic seizures in high-risk ICU patients. (Class II evidence, Type B recommendation as a practice option)

D. Certain quantitative EEG techniques are considered possibly useful practice options as an addition to digital EEG in:
    - D.1 Epilepsy: For topographic voltage and dipole analysis in presurgical evaluations. (Class II evidence, Type B recommendation)
    - D.2 Cerebrovascular Disease: Based on Class II and III evidence, QEEG in expert hands may possibly be useful in evaluating certain patients with symptoms of cerebrovascular disease whose neuroimaging and routine EEG studies are not conclusive. (Type B recommendation)
    - D.3 Dementia: Routine EEG has long been an established test used in evaluations of dementia and encephalopathy when the diagnosis remains unresolved after initial clinical evaluation. In occasional clinical evaluations, QEEG frequency analysis may be a useful adjunct to interpretation of the routine EEG when used in expert hands. (Class II and III evidence as a possibly useful test, Type B recommendation)

E. On the basis of current clinical literature, opinions of most experts, and proposed rationales for their use, QEEG remains investigational for clinical use in post-concussion syndrome, mild or moderate head injury, learning disability, attention disorders, schizophrenia, depression, alcoholism, and drug abuse. (Class II and III evidence, Type D recommendation)
F. On the basis of clinical and scientific evidence, opinions of most experts, and the technical and methodologic shortcomings, QEEG is not recommended for use in civil or criminal judicial proceedings. (Strong Class III evidence, Type E recommendation)
G. Because of the very substantial risk of erroneous interpretations, it is unacceptable for any EEG brain mapping or other QEEG techniques to be used clinically by those who are not physicians highly skilled in clinical EEG interpretation. (Strong Class III evidence, Type E recommendation).

The AAN et al., included their strength and recommendation ratings specific to the evidence used for their recommendations.

Strength of Recommendation Ratings

- Type A - Strong positive recommendation, based on Class I evidence, or overwhelming Class II evidence.

- Type B - Positive recommendation, based on Class II evidence.
- Type C - Positive recommendation, based on strong consensus of Class III evidence.
- Type D - Negative recommendation, based on inconclusive or conflicting Class II evidence.
- Type E - Negative recommendation, based on evidence of ineffectiveness or lack of efficacy.

Quality of Evidence Ratings

- Class I - Evidence provided by one or more well-designed, prospective, blinded, controlled clinical studies.
- Class II - Evidence provided by one or more well-designed clinical studies such as case control, cohort studies, etc.
- Class III - Evidence provided by expert opinion, nonrandomized historical controls or case reports of one or more.

National Institute for Health and Care Excellence (NICE)

In 2022, the United Kingdom's NICE published their clinical guideline for the diagnosis and management of epilepsy (30) which offers the following recommendations:

- If the person's history and examination suggest an epileptic seizure, and a diagnosis of epilepsy is suspected, consider a routine EEG carried out while awake to support diagnosis and provide information about seizure type or epilepsy syndrome.
- Do not use EEG to exclude a diagnosis of epilepsy.
- If an EEG is requested after a first seizure, perform it as soon as possible (Ideally within 72 hours after the seizure).
- When offering an EEG, discuss the benefits and risks of provoking maneuvers during EEG, such as hyperventilation and photic stimulation, with the person and their family or caregiver if appropriate. If agreed, include provoking maneuvers during routine EEG to assess a suspected first seizure.
- If routine EEG is normal, consider a sleep-deprived EEG if agreed with the person, and their family or caregiver if appropriate, after discussing the benefits and risks.
- If routine and sleep-deprived EEG results are normal and diagnostic uncertainty persists, consider ambulatory EEG (for up to 48 hours).
- Refer people with epilepsy to a tertiary epilepsy service, to be seen within 4 weeks, if any of the following apply:
    - There is uncertainty about the diagnosis or cause of epilepsy, the seizure type or epilepsy syndrome; or
    - The person has an epilepsy syndrome likely to be drug resistant, their seizures are drug resistant, or their treatment is associated with intolerable side effects; or
    - Further assessment and treatment approaches are indicated, such as: video electroencephalogram (VEEG), telemetry, neuropsychology or neuropsychiatry, specialized neuroimaging, specialized treatments (i.e., medication that can only be prescribed by a tertiary epilepsy service or a ketogenic diet), epilepsy surgery or vagus nerve stimulation; or
    - The person is eligible for and wishes to participate in a clinical trial or research study.

- Refer children with suspected or confirmed epilepsy to a tertiary pediatric epilepsy service to be seen within 2 weeks when they are:
    - Under 3 years of age; or
    - Under 4 years of age with myoclonic seizures; or
    - Have a unilateral structural lesion.

Summary of Evidence

The evidence for the use of ambulatory electroencephalogram (AEEG) monitoring in individuals includes one randomized controlled, prospective, and clinical trial. Relevant outcomes are overall survival, morbid events, functional outcomes, and treatment-related mortality and morbidity. AEEG monitoring is not necessary to evaluate most seizures, as they are usually readily diagnosed by routine or resting electroencephalogram (EEG) studies and patient history. However, AEEGs are helpful at identifying seizures that are unrecognized or unreported by the individual and are easily accomplished on an outpatient basis. Therefore, the evidence is sufficient that this technology results in a meaningful improvement for the net health outcome in the treatment of adults, children, and neonates.

The evidence for the use of video electroencephalogram (VEEG) monitoring in individuals includes one cohort study, and professional guidelines/recommendations. Relevant outcomes are overall survival, morbid events, functional outcomes, and treatment-related mortality and morbidity. VEEG is a useful tool to diagnosis seizure type and epilepsy syndrome in individuals who present diagnostic difficulties following clinical assessment and standard EEG; for identification and localization of a seizure focus in individuals with intractable epilepsy who are being considered for surgery; to monitor neonates with hypoxic-ischemic encephalopathy (HIE) who are being treated with therapeutic hypothermia (TH); and to document provocation of seizures after medication withdrawal for the purpose of making medication adjustments or otherwise determining an appropriate treatment plan. The evidence is sufficient that this technology results in a meaningful improvement for the net health outcome in the treatment of adults, children, and neonates.

The evidence for the use of digital analysis of electroencephalogram (DEEG) in individuals includes reports and reviews, no known clinical trials. Relevant outcomes are overall survival, morbid events, functional outcomes, and treatment-related mortality and morbidity. Overall, there is a lack of evidence that clinical outcomes are improved. The evidence is insufficient to determine the effects of the technology on health outcomes. DEEG is considered not medically necessary as there is no evidence that such additional processing and interpretation has been shown to improve outcomes in individual management.

Ongoing and Unpublished Clinical Trials

Some unpublished trials that might influence this policy are listed in Table 1.

Table 1. Summary of Key Trials

NCT Number	Trial Name	Planned Enrollment	Completion Date

Unpublished			
NCT02679846	Safety of Antiepileptic Withdrawal in Long Term Video-EEG Monitoring (SAVE)	1440	Dec 2020 (no results posted)
NCT01862952	Continuous Video- EEG Monitoring in the Acute Phase in Patients with a Cerebrovascular Attack- Randomization of a Subpopulation Regarding Treatment Strategy (Video-EEG)	100	Dec 2018 (no results posted)

NCT: National Clinical Trial.

Coding

Procedure codes on Medical Policy documents are included **only** as a general reference tool for each policy. **They may not be all-inclusive.**

The presence or absence of procedure, service, supply, or device codes in a Medical Policy document has no relevance for determination of benefit coverage for members or reimbursement for providers. **Only the written coverage position in a Medical Policy should be used for such determinations.**

Benefit coverage determinations based on written Medical Policy coverage positions must include review of the member's benefit contract or Summary Plan Description (SPD) for defined coverage vs. non-coverage, benefit exclusions, and benefit limitations such as dollar or duration caps.

CPT Codes	95700, 95705, 95706, 95707, 95708, 95709, 95710, 95711, 95712, 95713, 95714, 95715, 95716, 95717, 95718, 95719, 95720, 95721, 95722, 95723, 95724, 95725, 95726, 95954, 95957 (Deleted 1/1/2020: 95827, 95950, 95951, 95953, 95956)
HCPCS Codes	None

*Current Procedural Terminology (CPT®) ©2023 American Medical Association: Chicago, IL.

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Centers for Medicare and Medicaid Services (CMS)

The information contained in this section is for informational purposes only. HCSC makes no representation as to the accuracy of this information. It is not to be used for claims adjudication for HCSC Plans.

The Centers for Medicare and Medicaid Services (CMS) does not have a national Medicare coverage position. Coverage may be subject to local carrier discretion.

A national coverage position for Medicare may have been developed since this medical policy document was written. See Medicare's National Coverage at <http://www.cms.hhs.gov>.

Policy History/Revision

Date	Description of Change
12/31/2025	Document became inactive.
07/15/2024	Reviewed. No changes.
07/15/2023	Document update with literature review. Coverage unchanged. Added references 2, 8, 30; others updated, some removed.
01/01/2023	Reviewed. No changes.
01/15/2022	Document update with literature review. The following change was made to Coverage: Added “To diagnose a seizure disorder when the clinical history or

	examination is suggestive of epilepsy, but routine EEG is non-diagnostic" as a medically necessary indication for ambulatory electroencephalogram (AEEG) monitoring. Added reference 16, others updated.
09/15/2020	Document update with literature review. The following change was made in Coverage: 1) Added "To document provocation of seizures after medication withdrawal for the purpose of making medication adjustments or otherwise determining an appropriate treatment plan" as a medically necessary indication for Electroencephalogram Video (VEEG) Monitoring. Added references 1, 3, 5, 6, 8, 13-15, 17, 20-22, 25.
09/15/2019	Document updated with literature review. Coverage unchanged. Added the following NOTEs to coverage with no change in coverage intent: 1) NOTE 2: In most circumstances VEEG monitoring for an inpatient may continue 24 hours or more, to as many as 72 hours for long-term VEEG monitoring (LTM); whereas, outpatient may have a duration of 6 to 8 hours; 2) NOTE 3: Digital analysis of an EEG is not the same as a digital recording of an EEG. Refer to the Description section for more information; and 3) NOTE 4: This policy does not address resting/conventional EEGs. Reference 13 added; several removed. Title changed from Electroencephalogram.
02/01/2018	Reviewed. No changes.
03/15/2017	Document updated with literature review. The following changes were made to Coverage: 1) Added the following: "NOTE: In most circumstances extended ambulatory electroencephalogram (AEEG) monitoring (i.e., longer than 72 hours) is not necessary, as AEEG is generally diagnostic within the first 24 to 72 hours." 2) Added medical necessity indication for video electroencephalogram (EEG): "For identification and localization of a seizure focus in individuals with intractable epilepsy who are being considered for surgery." 3) Added a not medically necessary statement for video EEG for "all other indications."
12/01/2014	Literature reviewed. The follow change was made to coverage: Ambulatory cassette recorded electroencephalogram (AEEG), completed over 24 hours, or EEG video monitoring (VEEG), may be considered medically necessary when used to monitor neonates with hypoxic-ischemic encephalopathy (HIE) who are being treated with therapeutic hypothermia (TH). Ambulatory cassette recorded electroencephalogram (AEEG) completed over 24 hours is considered not medically necessary for the study of neonates who do not meet the criteria above.
02/15/2014	Document updated with literature review. The following was changed in coverage: 1) Ambulatory cassette recorded electroencephalogram (AEEG), completed over 24 hours, may be considered medically necessary when used: a) To classify seizure type in individuals with epilepsy after a routine EEG is non-diagnostic and classification will be used to select drug therapy; b) To determine characterization (lateralization, localization, distribution) of EEG abnormalities, both ictal and interictal, associated with seizure disorders

	in the evaluation of patients with intractable epilepsy for surgical evaluation. 2.) EEG video monitoring (VEEG) may be considered medically necessary to diagnosis seizure type and epilepsy syndrome in individuals who present diagnostic difficulties following clinical assessment and standard EEG. CPT/HCPCS code(s) updated.
03/01/2010	Routine scheduled review with literature search; no changes in coverage. Policy for no further routine review
03/01/2008	This policy is no longer scheduled for routine literature review and update.
03/15/2006	Revised/updated entire document. The following was added to coverage: Digital analysis of electroencephalogram (EEG) is considered ineligible for coverage as there is no evidence that such additional processing and interpretation has been shown to be of value in effecting patient management.
06/16/2005	CPT/HCPCS code(s) updated, medical policy unchanged
09/17/2004	Revised/updated entire document
03/30/2004	Document updated with literature review. The following was removed from coverage 1) Electroencephalogram telephone transmission may be eligible for coverage when transmitting from remote areas for the following conditions: a) Altered consciousness such as stuporous, semicomatose, or comatose states; b) Atypical seizure variants in patients experiencing bizarre, distressing symptoms; c) Differential diagnosis of complicated migraine with epilepsy-like symptoms from true seizure disorders (e.g., auras, alterations in level of consciousness); and d) Seizure disorders. 2) Electroencephalogram (EEG), transmitted by radio and cable may be eligible for coverage during provocation testing (e.g., withdrawal of anticonvulsant drugs) which requires that the patient be hospitalized, but not bed-ridden, and testing which attempts to localize the seizure focus prior to surgery when ambulation is desirable.
11/01/1999	Revised/updated entire document
07/01/1999	Revised/updated entire document
05/01/1990	New medical document