

Subject: Ambulatory Electroencephalographic (EEG) and Video EEG Monitoring for Adults and Children		Original Effective Date: 4/24/13
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**PREFACE**

*This Medical Guidance is intended to facilitate the Utilization Management process. It expresses Molina's determination as to whether certain services or supplies are medically necessary, experimental, investigational, or cosmetic for purposes of determining appropriateness of payment. The conclusion that a particular service or supply is medically necessary does not constitute a representation or warranty that this service or supply is covered (i.e., will be paid for by Molina) for a particular member. The member's benefit plan determines coverage. Each benefit plan defines which services are covered, which are excluded, and which are subject to dollar caps or other limits. Members and their providers will need to consult the member's benefit plan to determine if there are any exclusions or other benefit limitations applicable to this service or supply. If there is a discrepancy between this policy and a member's plan of benefits, the benefits plan will govern. In addition, coverage may be mandated by applicable legal requirements of a State, the Federal government or CMS for Medicare and Medicaid members. CMS's Coverage Database can be found on the following website: <http://www.cms.hhs.gov/center/coverage.asp>.*

**FDA INDICATIONS**

Ambulatory EEG and Video EEG monitoring are a procedure and, therefore, not subject to FDA regulation. However, any medical devices, drugs, or tests used as a part of this procedure may be subject to FDA regulation. There are numerous EEG monitors approved for use by the FDA. EEG monitors are defined by the FDA as devices used to measure and record the electrical activity of the brain. Readings are obtained by placing two or more electrodes on the head.

**CENTERS FOR MEDICARE AND MEDICAID SERVICES (CMS)**

*The coverage directive(s) and criteria from an existing National Coverage Determination (NCD) or Local Coverage Determination (LCD) will supersede the contents of this Molina medical coverage guidance (MCG) document and provide the directive for all Medicare members. The directives from this MCG document may be followed if there are no available NCD or LCD documents available and outlined below.*

CMS has a National Coverage Determination (NCD) for Ambulatory Event monitoring and covers this as a diagnostic procedure for patients in whom a seizure diathesis is suspected but not defined by history, physical or resting EEG. Ambulatory EEG can be utilized in the differential diagnosis of syncope and transient ischemic attacks if not elucidated by conventional studies. Ambulatory EEG should always be preceded by a resting EEG.<sup>1</sup>

No CMS National Coverage Determination (NCD) was found for video EEG for any indication.

**INITIAL COVERAGE CRITERIA**

1. Outpatient ambulatory encephalography (EEG) monitoring may be authorized for up to 48 hours<sup>31 34</sup> as medically necessary when all of the following criteria are met:<sup>1 3 4 6 17 20 31</sup> [ALL]
  - Awake and an asleep EEG must be performed first;

- Routine EEG and history and physical exams are inadequate to diagnose the following suspected conditions<sup>31 34</sup>: [ONE]
  - Seizures or seizure like activity occurring  $\geq 3$  times per week;
  - To differentiate epileptic from non-epileptic events;
  - To characterize the frequency or location of seizures in a nonclinical setting;
  - To document epilepsy response to treatment or to medication adjustment

2. Out-patient video encephalography (EEG) monitoring may be authorized for up to 23 hours as medically necessary when all of the following criteria are met:<sup>2 3 8 9 14 15 16 31</sup> [ALL]

- Medical history, neurological exam and lab results are non-diagnostic for seizure etiology; and
- Routine EEG, Ambulatory EEG monitoring (without video) or outpatient sleep study with EEG monitoring is inconclusive or non-diagnostic; and
- MRI is normal or nondiagnostic for seizure etiology<sup>33 35</sup>; and
- Used to diagnose the following suspected conditions<sup>3 8 9 14 15 16 31</sup>: [ONE]
  - Intractable recurrent seizures despite therapeutic levels of  $\geq 2$  anticonvulsant medications; or
  - Seizure or seizure like events occurring  $< 3$  times per week; or
  - Suspected psychogenic non-epileptic seizures (psuedoseizures) or other paroxysmal seizure or seizure-like behavioral events; or
  - Choice of anticonvulsant therapy depends on seizure diagnosis or classification<sup>3</sup>, and it cannot be identified by observation and interictal EEG; or
  - Suspected nocturnal seizures or paroxysmal arousals, with unconscious dystonic movement, repetitive motor activity, or episodic nocturnal ambulation; or
  - To localize the seizure focus in members with documented medically refractory seizures prior to epilepsy surgery or intracranial electrode implantation and surgery; or<sup>3 31</sup>
  - To quantify seizure frequency<sup>3</sup> and patient has poor awareness or ability to communicate: [ONE]
    - ◇ Indistinct seizure events (eg. absence seizures)
    - ◇ Hampered ability to communicate (eg. autism, infants, or young children)
    - ◇ Encephalopathy ( eg. mental status changes)
- If Anticonvulsant medication withdrawal is deemed unsafe in the outpatient setting (documentation is required),<sup>31</sup> and ALL criteria above are met, then inpatient video EEG may be pre-authorized as inpatient.
- Out-patient Video EEG length of stay is 23 hour observation, and
  - The event being monitored does not occur in this time frame, then inpatient video encephalography (EEG) monitoring may be authorized using McKesson InterQual LOC: Acute Adult and Pediatric Epilepsy criteria<sup>15 16</sup>
    - ◇ Goal length of stay is 2 days<sup>31 34</sup>

**CONTINUATION OF THERAPY**

- Outpatient ambulatory EEG may be used for 48 hours.<sup>3 31 34</sup>
- Out-patient Video EEG length of stay is 23 hour observation but if the event being monitored does not occur in this time frame admission may be necessary for further monitoring or for preoperative localization of seizure foci.<sup>31</sup>
- Goal length of stay for in-patient video EEG is 2 days.<sup>31 34</sup> Per McKesson InterQual LOC: Acute Adult and Pediatric Epilepsy criteria, the length of stay is assigned per day, based on clinical review<sup>15 16</sup>. Inpatient stay beyond four days requires medical director review.<sup>3 15 16 21 28</sup>

- ❑ Once the cause of seizures and specific type of epilepsy has been established, continued video EEG monitoring is considered not medically necessary.

#### COVERAGE EXCLUSIONS

Ambulatory and video-EEG monitoring is considered not medically necessary for all other indications.

#### DESCRIPTION OF PROCEDURE/SERVICE/PHARMACEUTICAL

Electroencephalography (EEG) is the recording of the brain's spontaneous electrical activity over a short period of time, usually 20–40 minutes, as recorded from multiple electrodes placed on the scalp. At times, a routine EEG is not sufficient, particularly when it is necessary to record an individual while they are having a seizure.

Ambulatory electroencephalography (AEEG) monitoring allows prolonged electroencephalographic (EEG) recording in the home setting, with a device slightly larger than a portable cassette player that continuously records brain wave patterns during 24 hours of a patient's routine daily activities and sleep. The device has the ability to record continuously for up to 72 hours increasing the chance of recording a seizure (i.e. ictal event, or the time between seizures, known as the interictal period). The interictal period is often used by neurologists when diagnosing epilepsy since an EEG trace will often show small interictal spiking and other abnormalities known by neurologists as subclinical seizures. The monitoring equipment consists of an electrode set, preamplifiers, and a cassette recorder. The electrodes attach to the scalp, and their leads are connected to a recorder, usually worn on a belt.

Video EEG monitoring is the simultaneous recording of clinical behavior and EEG. The purpose of the monitoring is to record seizure activity. The EEG is recorded continuously while a video camera records behavior. Video electroencephalography (EEG) monitoring is the synchronous recording and display of EEG patterns and video-recorded clinical behavior. Short recordings of several hours can be performed as an outpatient in an EEG laboratory, while longer recordings of 24 hours or more are generally done in a hospital inpatient setting. Since seizure medicine is often reduced or stopped in order to provoke a seizure, the hospital setting is preferable so as to ensure the safety of the patient undergoing the seizure. The average hospital stay in the video EEG monitoring unit ranges from 3 to 4 days.<sup>3 8 9</sup>

Video EEG monitoring is conducted for two main reasons: (1) for diagnostic monitoring when it is not clear from the clinical evaluation and routine EEG whether the patient has epileptic seizures or non-epileptic (psychiatric) events; and (2) for identifying the area of the brain from which seizures arise, especially for patients whose seizures are not controlled with antiepileptic medications and for whom surgery for epilepsy is being considered.<sup>8 9</sup>

#### GENERAL INFORMATION

##### Summary of Medical Evidence

***Ambulatory EEG Monitoring:*** Faulkner (2012) conducted a retrospective analysis of 324 consecutive prolonged outpatient ambulatory EEGs lasting 72-96 h (4-5 days), without medication withdrawal. EEG data and the clinical record were reviewed to examine the utility of the alternate investigation of outpatient ambulatory EEG. Of 324 studies: 219 (68%) studies gave positive data, 116 (36%) showed interictal epileptiform discharges (IEDs), 167 (52%) had events. 105 (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. The author concluded that the study results confirmed the diagnostic utility of outpatient ambulatory EEG in the diagnosis of paroxysmal events.<sup>6</sup>

Dash and colleagues (2012) performed a prospective cohort study in a Canadian academic centre in order to assess the yield and tolerability of AEEG in the adult population. Over a period of three years, 101 patients were included. The yield of AEEG was assessed by taking into account the questions asked by the clinician before and after the investigation. One hundred and one patients undergoing AEEG were prospectively recruited during a three-year-period. Our population consisted of 45 males (44.6%) and 56 females (55.4%). The mean age of the group was  $36.6 \pm 16.1$  years. Most of the patients had at least one previous routine EEG (93%). The primary reasons for the AEEGs were subdivided into four categories: a) to differentiate between seizures and non-epileptic events; b) to determine the frequency of seizures and epileptiform discharges; c) to characterize seizure type or localization; and d) to potentially diagnose epilepsy. The mean duration of AEEG recording was  $32 \pm 17$  hours (15-96 hours). For 73 (72%) patients, the AEEG provided information that was useful for the 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 video-EEG telemetry. The authors concluded that AEEG has a high diagnostic yield (72%) and believe that careful selection of patients is the most important factor for a high diagnostic yield. The main use of AEEG is the characterization of patients with non-epileptic events, in patients with a diagnosis of epilepsy that is not clear, and quantification of spikes and seizures to improve the medical management. Ambulatory EEG is a cost-effective solution for increasing demands for in-hospital video-EEG monitoring of adult patients.<sup>20</sup>

González and colleagues (2008) conducted a retro-review to describe and analyze the results obtained with ambulatory EEG in their clinical practice. The results of 264 ambulatory EEG records were analyzed and grouped according to the reason for the request: a) group 1: diagnostic evaluation of episodes of epileptic nature; b) group 2: diagnostic evaluation of paroxysmal episodes, and c) group 3: evaluation of the risk of relapse during anti-seizure treatment withdrawal in certain epileptic patients. RESULTS: a) Group 1 (n=137): normal results were found in 54 records (39.4%). There was generalized epileptic activity in 20 (14.6%) of them (5 with ictal activity) and focal epileptic activity was detected in 57 cases (42%) (8 with ictal activity). No EEG diagnosis could be reached in 6 (4%) recordings due to the presence of artifacts; b) group 2 (n=99): in 47 records (47.5%), there were no episodes and the Holter-EEG was normal. There was a clinically documented episode without anomalies during Holter-EEG registration in 14 cases (14.2%). In 29 records (29.3%), focal epileptic activity was recorded (ictal 4) and generalized epileptic activity (ictal in 1) was recorded in 4 patients (4%). No EEG diagnosis could be reached in 5 cases (5%), and c) group 3 (n=28): the study was normal in 15 cases (53.6%) and showed focal interictal epileptic activity in 8 (28.6%) and generalized interictal epileptic activity in 5 of them (17.8%). The authors concluded that the ambulatory EEG recordings in correctly selected cases can provide important additional information regarding global assessment of patients with epilepsy.<sup>17</sup>

Wirrell and colleagues (2008) conducted a review of sixty-four children, aged 0-17 years, undergoing ambulatory electroencephalography (EEG) during a 12-month period. The diagnostic yield of ambulatory electroencephalography was determined for each of the following groups: group 1: differentiation of seizures from nonepileptic events; group 2: determination of seizure/interictal discharge frequency; and group 3: classification of seizure type or localization. The ambulatory electroencephalography answered the clinical question in 61% of group 1 (27/44) and 100% of groups 2 (16/16) and 3 (4/4). Of 44 cases in Group 1, clinical events were recorded in 61%; the ambulatory electroencephalography result changed the diagnosis from epileptic to nonepileptic or vice versa in 27%. The authors concluded that when clinicians suspected that events were epileptic, ambulatory electroencephalography changed the clinical impression in 50%, whereas when events were suspected to be nonepileptic, ambulatory electroencephalography confirmed that impression in 83%.<sup>19</sup>

Tatum and colleagues (2001) performed a study to assess the frequency of unreported seizures recorded during routine outpatient ambulatory EEG recording. The authors reviewed 552 records from 502 patients who underwent outpatient 16-channel computer-assisted ambulatory EEG monitoring (CAA-EEG). Seizure identification was evaluated by assessing push-button activation. Partial seizures were seen most commonly. A total of 47 of 552 records (8.5%) had partial seizures recorded on CAA-EEG, with 29 of 47 (61.7%) with electroclinical seizures identified by push-button activation. Seizures on EEG without push-button activation were analyzed separately and compared with a self-reported written diary to verify lack of recognition. A total of 18 of 47 records (38.3%) had some partial seizures that were unrecognized by the patient, and 11 of 47 records (23.4%) had seizures recognized only by the computer. The authors concluded that patients frequently have seizures outside of the hospital that go unrecognized. Underreporting of seizure frequency occurs in the outpatient setting and impacts optimal diagnosis and treatment for patients with epilepsy.<sup>24</sup>

Video EEG Monitoring: Hu and colleagues (2012) conducted a study to explore the clinical manifestations and electroencephalogram (EEG) features in children with frontal and temporal onset seizures. The method used was video-EEG monitoring that was conducted for 24 h in children with seizure disorders. The results were as follows: There were fewer children with temporal EEG onset seizure (TOS) than with frontal EEG onset seizure (FOS) ( $p = 0.132$ ). Within the TOS category, PTOS was most frequent, and ATOS was rare ( $p = 0.001$ ). The mean duration of ATOS was longer than that of TOS and PTOS ( $p < 0.05$ ). There were no significant differences in seizure frequency and nocturnal attacks between children with TOS and children with FOS. Furthermore, we observed the interictal EEG from three aspects: the background, the location of discharges, and the time of discharges. The frequency of the multi-focal and bilateral discharges of FOS was higher than that of TOS ( $p < 0.01$ ). The FOS discharged easily and quickly spread to the bilateral hemisphere and formed secondary bilateral synchrony. Focal discharges predominated in TOS, and rarely showed the paroxysm of bilateral synchronous rhythm. Bursts of fast rhythms predominated in the onset of TOS. In contrast, there were a variety of ictal EEG in FOS. Finally, it was concluded that in the group of children studied, the clinical and EEG characteristics of TOS were different from those of FOS.<sup>10</sup>

Guldiken and colleagues (2012) sought to determine the agreement of different classifications before and after short term video EEG. Three hundred ninety-one patients who had undergone VEM were enrolled in the study. Forty-five cases, whose epileptic seizures could be recorded, were classified before and after VEM according to 1981 Classification of Epileptic Seizures, 1989 Epileptic Syndrome Classification, 2010 Seizure and Electroclinical Syndrome Classifications proposed by International League Against Epilepsy (ILAE) Commission on Terminology and Classification, and Semiological Seizure Classification reported by Luders et al. in 1998. Results: The intra-observer agreements of Semiological Seizure, 1989 and 2010 Electroclinical Syndrome Classifications were found to be substantial, whereas those of 1981 and 2010 Epileptic Seizure Classifications were moderate. The initial clinical diagnosis was changed in 44.7% to 56.5% of patients where a change of treatment was needed in 36.5% of the cases. The authors concluded that while the Semiological Seizure Classification appears to be more consistent than the 1981 and 2010 Seizure Classifications, the impact of short term VEM on the accurate classification is remarkable.<sup>11</sup>

Uysal-Soyer and colleagues (2012) performed a prospective study to classify and define properties of subgroups of absence epilepsies. 31 patients were included, of whom seven were in the differential diagnosis group. On admission, absence epilepsy provisional diagnosis was considered in 16 patients clinically and in the other 15 patients based on routine EEG findings. Ictal EEGs were recorded by video-EEG monitoring in 23 of the patients (totally 202 ictal recordings). Patients were diagnosed as childhood absence epilepsy ( $n=8$ ), juvenile absence epilepsy ( $n=10$ ), juvenile myoclonic epilepsy ( $n=3$ ), eyelid myoclonia with absences ( $n=2$ ), and perioral myoclonia with absences ( $n=1$ ). Neuroimaging, video-EEG monitoring and especially ictal recordings are important for classification of epilepsies in

addition to history, physical examination and routine EEG findings. The authors concluded that video-EEG monitoring is required to classify, to make differential diagnosis and to determine the treatment plan and prognosis.<sup>12</sup>

Williams and colleagues (2011) performed a study to determine the occurrence of seizures in a cohort of pediatric and neonatal intensive care unit patients. Long-term video electroencephalography (EEG) monitoring studies performed in the pediatric and neonatal intensive care units were reviewed. Age, gender, diagnosis, EEG background, epileptiform activity, time of onset and duration of seizures, presence of electroclinical or electrographic seizures, and survival were collected. Key Findings: One hundred thirty-eight recordings encompassing 122 patients were identified. Thirty-four percent of the sessions identified seizures in the first 24 h (38% of the cohort experienced a seizure at some time during monitoring, which ranged from 1-22 days): 17% captured only electro-clinical seizures, 49% were electrographic only, and 34% had both electroclinical and electrographic seizures. Seventy percent of those patients experiencing seizures had their first seizure within the first hour of EEG recording. Younger age and epileptiform activity (including periodic) were associated with the occurrence of seizures. Diagnoses of head trauma and status epilepticus/recent prior seizure were more likely than other at-risk diagnoses to be associated with seizures; cardiac arrest managed with hypothermia was less likely to be associated with seizures. One-fourth of the recordings identified nonepileptic events. The authors concluded that seizures occurred in one-third of critically ill pediatric patients at risk for seizures who underwent video-EEG monitoring, and many of these seizures did not have a clinical correlate. In those at risk for seizures in intensive care units, there should be a low threshold for obtaining long-term monitoring.<sup>13</sup>

Dobesberger and associates (2011) sought to analyze safety and adverse events (AEs) during video-EEG monitoring. 596 video-EEG sessions in 507 patients (233 men, mean age 36 years, standard deviation = 14, range 9-80 years) within a 6-year period were retrospectively evaluated. AEs were examined in detail and their risk factors were assessed using multiple logistic regression analysis. Key Findings: Forty-four patients (9%) experienced 53 AEs: 20 had psychiatric events (17 postictal psychosis, 2 panic attacks, 1 interictal psychosis), 15 had injuries (14 falls with minor injuries, 2 falls with fractures, 2 fractures without fall, 1 fall with epidural hematoma), 10 patients had 13 episodes of status epilepticus (SE), and one AE was treatment-related (valproic acid - induced encephalopathy). Patients with AEs were older ( $p = 0.036$ ) and had a longer duration of epilepsy ( $p = 0.019$ ). All AEs resulted in a prolonged hospital stay ( $p < 0.001$ ). Ninety-one percent of the AEs occurred within the first 4 days of monitoring. Independent risk factors were duration of epilepsy  $>17$  years [odds ratio (OR) 3.096; 95% confidence interval (CI) 1.548-6.189], a previous history of psychiatric illness (OR 16.882; 95% CI 5.469-52.110), a history of seizure-related injuries (OR 3.542; 95% CI 1.069-11.739), or a history of SE (OR 3.334; 95% CI 1.297-8.565). The authors concluded that the most common AEs were postictal psychosis, falls, and SE. Patients with an older age, long disease duration, psychiatric comorbidity, history of injuries, and SE have a higher risk.<sup>29</sup>

Elgavish and colleagues (2011) sought to establish the diagnostic value of repeat admissions for VEEG and to determine if the commonly available clinical information could predict the diagnostic outcome, "diagnostic" or "nondiagnostic," of a repeat study. A study was deemed diagnostic if the admission resulted in a definitive diagnosis of the patient's typical events. The authors retrospectively reviewed the charts of 3,727 patients completing scalp VEEG at the University of Alabama at Birmingham Epilepsy Center from 2002 to 2009. Minors, mentally retarded patients, and patients readmitted for surgical procedures or presurgical localization were excluded. Single and multiple regressions were used to determine if any of the parameters could predict the diagnostic outcome of a repeat VEEG study. Only younger age was independently predictive of a diagnostic readmission ( $P < 0.05$ ), while longer total duration of monitoring was suggestive ( $P = 0.07$ ). A repeat VEEG study was useful in 55.2% of patients, most of whom were diagnosed after only 1 additional admission. In the patient population studied, 82.4% were diagnosed on the first admission (2,622 of 3,183),

52.9% on the second (46 of 87), and 40% on the third (2 of 5). The authors concluded that repeat VEEG admissions are useful, and clinical expertise may be the best tool for planning potential readmissions.<sup>27</sup>

Villanueva and colleagues (2010) evaluated the characteristics of patients on whom long-term Video-EEG monitoring is performed in a specialist center and to assess its suitability to study refractory epilepsy patients. A prospective analysis and study of Video-EEG monitoring was performed in a series of 100 refractory epilepsy patients from a single center. The analysis included demographic data, the time until the first seizure, the methods used to provoke seizures, and the outcome (usefulness, change in the management, pharmacological and surgical improvement). A subgroup analysis based on diagnosis was performed. The study was performed mainly on young people (mean 34.4 years) and the first seizure appeared in a mean of 30 hours, requiring most of the patients to withdraw the medication. Nevertheless, there were no cases of status epilepticus. The usefulness of the test was high in all the groups. The management was changed in 65% of the patients with pharmacological and surgical improvement. The authors concluded long-term Video-EEG monitoring is a suitable test to study refractory epilepsy patients.<sup>22</sup>

Okda and associates (2010) performed a comparative controlled study to evaluate and compare the role of routine day EEG recording, sleep deprived video (SD) EEG and nocturnal polysomnography in diagnosis and classification of nocturnal epilepsies (NE), in addition to study the effect of NE on sleep. Methods: Forty nocturnal epileptic patients (NEP) and 40 matched controls were subjected to sleep questionnaire, routine awake EEG recording, sleep-deprived video EEG (sleep deprivation for 24 hours) including at least one sleep cycle, and nocturnal polysomnography. Results: Both sleep-deprived video EEG and nocturnal polysomnography were superior to routine EEG recording in diagnosis of NE, but none of them was superior to the other, and finally nocturnal seizures disrupt sleep structure strongly. The authors concluded that SD-video EEG is an easy and inexpensive method for diagnosis of nocturnal seizures compared to nocturnal polysomnography, which is important only when we fail to reach a diagnosis by SD- video EEG and when we need to study sleep structure of nocturnal epileptic patients. Also nocturnal fits disrupt the sleep structure strongly.<sup>25</sup>

Badawy and colleagues (2010 International Federation of Clinical Neurophysiology) compared continuous with sampled reviewing of VEM data to assess whether their diagnostic yield differs. VEM data acquired from 50 consecutive patients (31 females) admitted for VEM were reviewed by two independent electroencephalographers, one using the continuous review method, and the other sampling the first five minutes of each hour together with events identified by push buttons and automated spike detection software. Overall agreement between reviewers was calculated using the Kappa statistic. Comparison between the total number of clinical events detected by the two methods was done by Pearson's correlation coefficient. Results: A substantial number of events were missed using sampled review. Despite this, there was excellent agreement between the two methods on the final electro-clinical diagnosis for each patient (Kappa = 0.89). Conclusion: In our laboratory, continuous VEM more comprehensively captured information of interest, but it did not substantially alter the final electro-clinical diagnosis. Significance: Sampled review of VEM data captures sufficient data to reliably make accurate clinical decisions. It may be considered as a more cost and labor efficient alternative to continuous review.<sup>26</sup>

Freidman and Hirsch (2009) reported the results of a study regarding the existence of patients requiring prolonged monitoring with video-electroencephalography to make an accurate diagnosis and to quantify how often this occurs. The authors performed a retrospective review of 248 consecutive adult patients admitted to the epilepsy monitoring unit during 12 months for event characterization or presurgical evaluation. For the diagnosis of definite epilepsy, at least one epileptic seizure must have been recorded with video-electroencephalography. The median time to first diagnostic event, whether epileptic seizure or nonepileptic event, was 2 days; 35% required 3 or more days and 7% >1 week. Twelve percent of those with definite epilepsy never had interictal epileptiform discharges and 17% of those with nonepileptic

events had interictal epileptiform discharges. Six percent of patients with definite epilepsy had neither epileptic seizures nor interictal epileptiform discharges until day 3 or after. The authors concluded that based on our results, it is common to require 3 or more days in an epilepsy monitoring unit to record and diagnose the nature of paroxysmal episodes and not rare to require more than a week. Interictal electroencephalography alone cannot reliably distinguish between those with epileptic seizures and nonepileptic events.<sup>21</sup>

Noe and Drazowski (2009) evaluated the rate of medical complications from long-term video-electroencephalographic (EEG) monitoring for epilepsy. The medical records of 428 consecutive adult patients with epilepsy who were admitted for diagnostic scalp video-EEG monitoring at Mayo Clinic's site in Arizona from January 1, 2005, to December 31, 2006 were reviewed; 149 met inclusion criteria for the study. Seizure number and type as well as timing and presence of seizure-related adverse outcomes were noted. Of the 149 adult patients included in the study, seizure clusters occurred in 35 (23%); 752 seizures were recorded. The mean time to first seizure was 2 days, with a mean length of stay of 5 days. Among these patients, there was 1 episode of status epilepticus, 3 potentially serious electrocardiographic abnormalities, 2 cases of postictal psychosis, and 4 vertebral compression fractures during a generalized convulsion, representing 11% of patients with a recorded generalized tonic-clonic seizure. No deaths, transfers to the intensive care unit, falls, dental injuries, or pulmonary complications were recorded. An adverse event requiring intervention or interfering with normal activity occurred in 21% of these patients. Length of stay was not affected by occurrence of adverse events. The authors concluded that prolonged video-EEG monitoring is an acceptably safe procedure. Adverse events occur but need not result in substantial morbidity or increase length of hospitalization. Appropriate precautions must be in place to prevent falls and promptly detect and treat seizure clusters, status epilepticus, serious electrocardiographic abnormalities, psychosis, and fractures.<sup>38</sup>

Lobello and associates (2006) conducted a retrospective chart review of 199 consecutive patients, in an attempt to determine the number of days that would be needed to conduct Video EEG behavioral event monitoring of adults. The majority of the patients admitted had rapid tapering of their antiepileptic drugs. Patients were subjected to hyperventilation and photic stimulation and told that these stimuli could activate seizures. One hundred and sixty-seven patients did experience an event during admission with the median number of events equaling two. The median number of monitoring days for all patients was three. The authors concluded that the use of outpatient V-EEG may be an informative alternative to inpatient monitoring; as the diagnostic yield of monitoring beyond two–three days may be low. The authors also indicated that a limitation was a lack of documentation concerning tapering schedules and the use of placebo was inconsistent between physicians and patients.<sup>28</sup>

In 2002 Guerreiro et al. conducted a study to evaluate the efficacy of inpatient versus daytime outpatient telemetry as a presurgical investigation in refractory temporal lobe epilepsy (TLE) patients. The authors evaluated prospectively 73 patients with medically intractable TLE. Ninety-one telemetry sessions were performed: 35 as inpatients and 56 as outpatients. Outpatient monitoring was performed in the EEG laboratory. They used 18-channel digital EEG. Medications were not changed in the outpatient group. For analysis of the data, time was counted in periods (12 hours = 1 period). Statistical analyses were performed using Student's t-test and the chi2 test. There were no differences between the two groups (outpatient versus inpatient) with respect to age and mean seizure frequency before monitoring, mean time to record the first seizure (1.1 versus 1.4 periods), mean number of seizures per period (0.6 for both groups), lateralization by interictal spiking (46% versus 57%), and lateralization by ictal EEG (59% versus 77%). The authors concluded that daytime outpatient video-EEG monitoring for presurgical evaluation is efficient and comparable with inpatient monitoring. Therefore, the improved cost benefit of outpatient monitoring may increase the access to surgery for individuals with intractable TLE.<sup>30</sup>



Hayes, Cochrane, UpToDate, MD Consult etc.: Hayes does not have a directory report for ambulatory EEG monitoring or Video EEG.

UpToDate has topics for EEG, video and ambulatory EEG monitoring in the diagnosis of seizures and epilepsy, updated in 2012:

#### *Ambulatory EEG:*<sup>3</sup>

- Ambulatory EEG monitoring can increase the yield of routine EEG in detecting interictal epileptiform discharges (IEDs) because of its longer duration of recording that typically includes one or more periods of sleep.
- Ambulatory EEG is most helpful in quantifying or capturing clinical events and associating these with the presence or absence of electrographic seizures
- Disadvantages of ambulatory EEG monitoring compared with inpatient video-EEG recording include absence of simultaneous high-fidelity video recording, lack of ability to interact and test the patient during a spell, and a higher potential for artifact and misinterpretation.

#### *EEG:*<sup>4</sup>

- A single routine EEG has low sensitivity for detection of interictal epileptiform discharges (IED) (20 to 50 percent) for patients with epilepsy. The sensitivity can be increased by repeating the study, recording for a longer period of time (such as overnight), including a recording of sleep (spontaneous, after sleep deprivation, or via administration of a sedative), performing the EEG within 24 hours of a seizure, and by using special electrodes for temporal lobe epilepsy.
- EEG alone cannot be used to make or refute a specific diagnosis of epilepsy because of the following:
  - Most EEG patterns can be caused by a wide variety of different neurologic diseases.
  - Many diseases can cause more than one type of EEG pattern.
  - Intermittent EEG changes, including interictal epileptiform discharges, can be infrequent and may not appear during the relatively brief period of routine EEG recording.
  - The EEG can be abnormal in some persons with no other evidence of disease.
  - Not all cases of brain disease are associated with an EEG abnormality, particularly if the pathology is small, chronic, or located deep in the brain

#### *Video EEG*<sup>3</sup>

- Inpatient video-EEG monitoring combines both a video and EEG recording of clinical events, allows 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.
- For patients with recurrent clinical events, video-EEG recording in an epilepsy monitoring unit is the best and sometimes the only, way to make a definitive diagnosis and is used most commonly to determine whether epilepsy is the cause of recurrent seizure-like events.
- Video EEG 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.
- The duration of recording will depend on the indication: subjects undergoing presurgical evaluation often require a significantly longer period of long-term monitoring to obtain clinically relevant (and previously

unreported) information (mean 3.5 days) compared to patients who are being recorded for diagnosis or classification (2.4 and 2.3 days, respectively)

### Professional Organizations

American Academy of Neurology, the Child Neurology Society, and the American Epilepsy Society<sup>35</sup> published guidelines in 2000 (reaffirmed in 2006) for the evaluation of non-febrile seizures in children. This guideline recommends EEG testing as part of the neurodiagnostic evaluation of a child with an apparent first unprovoked seizure.

American Academy of Neurology and the Practice Committee of the Child Neurology Society<sup>36</sup> published guidelines in 2006 for the diagnostic assessment of the child with status epilepticus (SE). This guideline has the following recommendations:

- An EEG may be considered in a child presenting with new onset SE as it may determine whether there are focal or generalized abnormalities that may influence diagnostic and treatment decisions.
- Although non-convulsive status epilepticus (NCSE) occurs in children who present with SE, there are insufficient data to support or refute recommendations regarding whether an EEG should be obtained to establish this diagnosis.
- An EEG may be considered in a child presenting with SE if the diagnosis of pseudo status epilepticus is suspected.

The American Clinical Neurophysiology Society<sup>2</sup> published guidelines in 2008 regarding the use of long term EEG monitoring for epilepsy. These guidelines recommend the following:

#### *Diagnosis:*

- Identification of epileptic paroxysmal electrographic and/or behavioral abnormalities. These include epileptic seizures, overt and subclinical, and documentation of interictal epileptiform discharges.
- Verification of the epileptic activity in a patient with previously documented and controlled seizures.

#### *Classification:*

- 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:*

- 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 is useful in patients with frequent seizures, particularly with absence and other seizures having indiscernible or minimal behavioral manifestations.

National Institute for Health and Clinical Excellence (NICE)<sup>5</sup> published guidelines in 2012 that indicate that an EEG should be performed only to support a diagnosis of epilepsy in adults in whom the clinical history suggests that the seizure is likely to be epileptic in origin. The EEG should not be used in isolation to make a diagnosis of epilepsy and when a

standard EEG has not contributed to diagnosis or classification, a sleep EEG should be performed. Long-term video or ambulatory EEG may be used in the assessment of children, young people and adults who present diagnostic difficulties after clinical assessment and standard EEG.

*International League Against Epilepsy*<sup>23</sup> published guidelines in 2002 for the use of EEG methodology in the diagnosis of epilepsy. The guidelines indicate that long-term video-EEG monitoring may be the only way to distinguish epileptic from nonepileptic seizures and is mandatory as part of presurgical evaluation.

CODING INFORMATION	
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CPT	Description
95950	Monitoring for identification and lateralization of cerebral seizure focus, electroencephalographic (eg. 8 channel EEG) recording and interpretation, each 24 hours
95951	Monitoring for localization of cerebral seizure focus by cable or radio, 16 or more channel telemetry, combined electroencephalographic (EEG) and video recording and interpretation (eg, for presurgical localization ), each 24 hours
95953	Monitoring for localization of cerebral seizure focus by computerized portable 16 or more channel EEG, electroencephalographic (EEG) recording and interpretation, each 24 hours, unattended
95956	Monitoring for localization of cerebral seizure focus by cable or radio, 16 or more channel telemetry, electroencephalographic (EEG) recording and interpretation, each 24 hours

HCPCS	Description
N/A	N/A

ICD-9	Description
89.19	Video and Radio-telemetered electroencephalographic monitoring; EEG Monitoring
345.0	Generalized nonconvulsive epilepsy
345.1	Generalized convulsive epilepsy
345.00	Generalized nonconvulsive epilepsy, without mention of intractable epilepsy
345.01	Generalized nonconvulsive epilepsy, with intractable epilepsy
345.10	Generalized convulsive epilepsy, without mention of intractable epilepsy
345.11	Generalized convulsive epilepsy, with intractable epilepsy
345.2	Petit mal status
345.3	Grand mal status
345.40	Partial epilepsy with impairment of consciousness, without mention of intractable epilepsy
345.41	Partial epilepsy with impairment of consciousness, with intractable epilepsy
345.50	Partial epilepsy without mention of impairment of consciousness, without mention of intractable epilepsy
345.51	Partial epilepsy without mention of impairment of consciousness, with intractable epilepsy
345.60	Infantile spasms, without mention of intractable epilepsy
345.61	Infantile spasms, with mention of intractable epilepsy

345.70	Epilepsia partialis continua, without mention of intractable epilepsy
345.71	Epilepsia partialis continua, with mention of intractable epilepsy
345.90	Epilepsy, unspecified, without mention of intractable epilepsy
345.91	Epilepsy, unspecified, with mention of intractable epilepsy
779.0	Convulsions in the newborn
780.39	Other Convulsions

ICD-10	Description
G40.101	Localization-related (focal) (partial) symptomatic epilepsy and epileptic syndromes with simple partial seizures, not intractable, with status epilepticus
G40.109	Localization-related (focal) (partial) symptomatic epilepsy and epileptic syndromes with simple partial seizures, not intractable, without status epilepticus
G40.111	Localization-related (focal) (partial) symptomatic epilepsy and epileptic syndromes with simple partial seizures, intractable, with status epilepticus
G40.119	Localization-related (focal) (partial) symptomatic epilepsy and epileptic syndromes with simple partial seizures, intractable, without status epilepticus
G40.201	Localization-related (focal) (partial) symptomatic epilepsy and epileptic syndromes with complex partial seizures, not intractable, with status epilepticus
G40.209	Localization-related (focal) (partial) symptomatic epilepsy and epileptic syndromes with complex partial seizures, not intractable, without status epilepticus
G40.211	Localization-related (focal) (partial) symptomatic epilepsy and epileptic syndromes with complex partial seizures, intractable, with status epilepticus
G40.219	Localization-related (focal) (partial) symptomatic epilepsy and epileptic syndromes with complex partial seizures, intractable, without status epilepticus
G40.309	Generalized idiopathic epilepsy and epileptic syndromes, not intractable, without status epilepticus
G40.311	Generalized idiopathic epilepsy and epileptic syndromes, intractable, with status epilepticus
G40.401	Other generalized epilepsy and epileptic syndromes, not intractable, with status epilepticus
G40.409	Other generalized epilepsy and epileptic syndromes, not intractable, without status epilepticus
G40.411	Other generalized epilepsy and epileptic syndromes, intractable, with status epilepticus
G40.419	Other generalized epilepsy and epileptic syndromes, intractable, without status epilepticus
G40.901	Epilepsy, unspecified, not intractable, with status epilepticus
G40.909	Epilepsy, unspecified, not intractable, without status epilepticus
R56.9	Unspecified convulsions

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