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Subject Magnetoencephalography (MEG)

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Coverage Policy

CIGNA does not cover magnetoencephalography (MEG) or magnetic source imaging (MSI) for any condition because they are considered experimental, investigational or unproven.

General Background

Neurofunctional testing and functional imagings are used to map motor, sensory, language, and memory areas in neurosurgical patients (e.g., brain tumors, vascular lesions, and epilepsy). Functional imaging is imaging performed while a patient is also undergoing neurofunctional testing. Neurofunctional testing involves asking the patient to perform a number of small tasks, such as tapping the thumb of one hand against each of the fingers of that hand, or rubbing a block of sandpaper, or answering simple questions. Localizing specific areas of the brain

responsible for particular critical functions, such as thought, speech, movement and sensation, as well as white matter tracts connecting critical areas, is an essential component of the presurgical planning process when treating brain disorders. The protection of functions that may be at risk during surgery is facilitated by functional mapping of critical eloquent areas.

Neurofunctional Testing

Determining the function of a given area of the brain can be accomplished by observation, blocking, and stimulation. Observational mapping methods reveal increased electrical or metabolic activity in specific brain regions while neurofunctional testing is completed. Blocking (or inhibition) methods localize function by reversibly inhibiting neuronal functioning in specific brain areas and looking for a consequent reversible functional deficit. Stimulation or activation methods involve stimulation of a targeted brain area with the goal of eliciting a specific neurological response, such as movement of a specific body part. Some techniques may be used for both activation and inhibition (Tharin, et al., 2007).

Functional Imaging Techniques

Localization of eloquent areas in the brain is critical prior to surgery (e.g., seizure disorders, neoplasm or vascular resection). Numerous tools allow convergent evidence from multiple brain mapping techniques to bear on pre- and intraoperative decision-making.

- Examples of observational techniques include: functional magnetic resonance imaging (fMRI); positron emission tomography (PET); anisotropic diffusion tensor imaging (DTI) (not strictly a functional study, DTI is able to demonstrate white matter tracts by using MRI to measure the direction of diffusion of water molecules as a marker for the axis of these tracts); electrocorticography (the direct recording of electrical potentials associated with brain activity from the cerebral cortex [e.g., somatosensory evoked potentials]); electroencephalography (may be recorded by means of extracranial [scalp] electrodes or intracranial electrodes); magnetoencephalography (MEG); and optical imaging (brain tissue exhibits optical properties such as scattering and absorption. These intrinsic optical signals [IOSs] can be measured directly at the brain surface).
- Examples of inhibition and activation techniques include: intracarotid amytal test (IAT) or Wada test (injection of amobarbital sodium into the carotid artery, conventional angiography performed with iodinated contrast material, and imaging with ionizing radiation); electrocortical stimulation (ECS) (may be performed under general anesthesia for motor mapping, or with patient awake and participatory for language mapping); and transcranial magnetic stimulation (TMS) (stimulation or inhibition of neuronal electrical activity via a magnetic field delivered at the scalp) (Tharin, et al., 2007; Medina, et al., 2005; Kim, et al., 2003; Pouratian, et al., 2002).

The gold standard for identifying eloquent areas of the brain to be avoided in resections is direct ECS (Bookheimer, 2007; Tharin, et al., 2007; Kim, et al., 2003).

Magnetoencephalography (MEG)

MEG is a complex, noninvasive functional brain imaging method that detects neuromagnetic signals produced by neuronal activity in the cortex of the brain. Magnetic activity measured outside the head is produced primarily by intracellular electrical currents within dendrites of cells in brain structures. With electroencephalogram (EEG), the secondary volume currents are detected outside the head; whereas, with MEG, the magnetic flux that is detected at the surface of the head penetrates the skull and tissues without significant distortion. The data with MEG is filtered and subjected to mathematical modeling to estimate the location, strength and orientation of the current sources in the brain that are associated with the magnetic fields. When combined with structural (e.g., magnetic resonance imaging [MRI], MEG is known as magnetic source imaging (MSI). The two techniques are combined in order to enable anatomical localization of MEG recordings on the patient's MRI scan. MEG is usually performed with simultaneous EEG (Makela, et al., 2006; Papanicolaou, et al., 2005a).

MEG was introduced in the late 1970s as a result of the development of Superconducting Quantum Interference Device (SQUID) devices. Since magnetic signals associated with bioelectrical activity are weak, special techniques are needed to discriminate them from extraneous magnetic fields or noise. The instrument used to measure these signals is the neuromagnetometer and is equipped with an array of sensors (i.e., magnetometers or gradiometers), each coupled to a special low noise amplifier. Systems are equipped with 150 to 250 or more sensors that cover the entire head. The sensors are made superconductive by liquid helium. Recordings occur

inside a magnetically shielded room designed to reduce extraneous magnetic fields. Due to the high cost of MEG scanners, their use is mainly restricted to centers pursuing research programs (Tharin, et al., 2007; Makela, et al., 2006; Papanicolaou, et al., 2005a).

The primary clinical applications of MEG that have been studied include the identification of epileptogenic foci in candidates for epilepsy surgery and the mapping of functional-specific cortex prior to resection. It has been reported that several groups have merged functional MEG data with anatomic data to locate key functional cortex near and within cortical lesions, including arteriovenous malformations, gliomas, and brain metastases. Other proposed applications include the noninvasive estimation of language lateralization and the follow-up of brain plasticity elicited by central or peripheral neural lesions or during treatment of chronic pain. The proposed applications of MEG have not been assessed in detail with randomized control groups, including sham measurements to display effects on clinical outcome (Tharin, et al., 2007; Makela, et al., 2006; Papanicolaou, et al., 2005a).

U.S. Food and Drug Administration (FDA)

MEG machines are classified by the FDA as Class II devices. Class II devices are cleared through the FDA's 510(k) process and require special controls but do not require premarket application approval.

Literature Review

Epilepsy: Tuberos sclerosis complex (TSC) is a neurocutaneous disorder. Patients are most commonly first seen with seizures, and epilepsy occurs in > 90% of children with TSC. In many children, seizures cannot be managed with antiepileptic medications and may require surgery to relieve seizures. In a retrospective study, Iida et al. (2006) evaluated the use of MEG spike sources (MEGSSs) for localizing epileptic zones in TSC patients. The researchers characterized MEGSSs and correlated them to EEG and magnetic resonance imaging (MRI) results. Data was analyzed from seven children who underwent prolonged video electroencephalographic (VEEG) monitoring, MEG, and MRI. MEGSSs were classified as clusters (six or more spike sources, ≤ 1 cm between sources) and scatters (fewer than six spike sources regardless of distance between sources; sources with > 1 cm between sources regardless of number of sources). A single, unilateral cluster with additional scatters occurred in two patients; these predominantly lateralized dipoles correlated to prominent tubers on MRI and ictal/interictal EEG zones. Bilateral clusters with scatters existed in two patients; cluster locations partly overlapped multiple prominent tubers. These patients also had bilateral or diffuse interictal discharges, bilateral or generalized seizures, and changing seizure types and EEG findings. Only bilateral scatters occurred in three patients; scatters partly overlapped EEG interictal/ictal-onset regions; one patient had coexisting generalized seizures. In one patient with equally bilateral scatters, scatters overlapped a prominent tuber and interictal/ictal-onset zones in the right frontal region.

Wu et al. (2006) assessed whether MEG/MSI identified epileptogenic zones in patients with TSC. In six TSC children with focal seizures, ictal VEEG predicted the region of resection with 56% sensitivity, 80% specificity, and 77% accuracy ($p=0.02$), whereas interictal MEG/MSI fared better (100%, 94%, and 95%, respectively; $p=0.0001$). The authors did emphasize this is a preliminary report, and their results are applicable to TSC patients with lateralized seizure onsets by VEEG. The authors state their results may not be relevant for TSC patients with generalized or bilateral ictal seizure onsets; therefore, they emphasize a larger cohort of TSC patients undergoing epilepsy neurosurgery will be needed to verify their findings.

Jansen et al. (2006) compared epileptiform activity recorded with EEG and MEG in 19 patients with TSC and epilepsy. High-resolution (HR) EEG, HR-MEG, and 1.5-T MRI scans were performed. Epileptiform spikes were identified in EEG and MEG recordings offline by three observers. Spikes for which the interobserver agreement (spike consensus) was > 0.40 were used for source localization with CURRYV 3.0 software. MUSIC analysis was performed. The distance between the source determined from EEG and MEG recordings and the border of the closest tuber was calculated and compared. It was found that consensus spikes ($\kappa > 0.4$) were identified in 12 patients in the EEG recording and in 14 patients in the MEG recording. MEG sources were closer to tubers in all but one patient. Three patients underwent epilepsy surgery, two of whom are seizure-free after complete resection of the tuber.

Kamimura et al. (2006) researched the usefulness of MEG for diagnosis of the spatial relations between spike foci and suspicious epileptogenic tubers on MRI in patients with tuberous sclerosis (TS) and to compare MEG spike foci with single-photon emission computed tomography (SPECT) findings. The researchers analyzed magnetic fields of epileptic spike discharges in 15 patients with TS and localization-related epilepsy (LRE) by

using whole-head MEG. The spatial relation between the equivalent current dipoles (ECDs) of interictal spike discharges and visible cortical tubers on MRI were investigated. The results of MEG and MRI with SPECT findings were compared. MEG detected a cluster of ECDs around one cortical tuber in six of 15 patients and clusters of ECDs around two cortical tubers in five patients. Interictal SPECT was disappointing in detection of epileptic foci in TS. However, MEG spike foci showed spatial consistency with ictal hyperperfusion areas in two patients. Three patients with single ECD clusters underwent surgical treatment: two have been seizure-free, and one has obtained seizure reduction of > 90%. The authors stated, "The present study also suggests that interictal MEG could be substituted for ictal SPECT in epilepsy patients with TS; however, analysis of further similar cases is needed to confirm this."

Oishi et al. (2006) defined and compared locations of single and multiple clusters of ECDs for interictal spikes with MRI findings, ictal-onset zones (IOZs) from subdural electroencephalography (SDEEG), resected areas, and postsurgical outcomes of 20 patients who underwent cortical resection for medically intractable neocortical epilepsy. A total of 14 patients had single clusters, and six patients had multiple clusters. Overlap of clusters and IOZs defined group A (nine patients), in which a single cluster coincided with the IOZ; group B1 (four patients), in which a single cluster was within or partially overlapped the IOZ; group B2 (five patients), in which multiple cluster sections overlapped IOZs; group C (two patients—one single, one multiple), in which no overlap was seen. More single clusters (nine of 14) than multiple clusters (none of six) coincided with the IOZ ($p=0.014$). More patients with single clusters (10 of 14) than patients with multiple clusters (one of six) had seizure-free outcomes ($p=0.049$). Eight of nine patients in group A, versus three of 11 in groups B1, B2, and C, achieved seizure-free outcomes ($p=0.0098$). Correlations between MRI findings and postsurgical outcomes were not statistically significant.

Knowlton et al. (2006) conducted a prospective study to measure the agreement between MSI and IEEG localization in surgical candidates. Within their facility, 49 patients (age 1–61 years) were evaluated for surgical resection after surface EEG, video-EEG, MRI, flurodeoxyglucose-PET and ictal SPECT. All patients agreed to have an MSI study conducted along with their IEEG mapping. During the epilepsy surgical consultation, after initial planning was completed for the placement of the intracranial electrodes, the results of the MSI were revealed. Localization results according to epilepsy type produced similar sensitivity outcomes (MSI, 65% and IEEG, 69%). The MSI did not record seizure activity in 20% of the cases, while the IEEG was negative in 10% of the cases. For all 49 cases, 27 (55%) were localized, and the data was concordant between the MSI and IEEG; three cases (6%) were localized with both tests but differed on the site of activity; IEEG localized seven cases (14%), not localized by MSI; while MSI localized three cases (6%). The researchers concluded that additional studies are warranted to determine the feasibility of using MSI versus IEEG in a select population of patients prior to epileptic surgical resection.

Wolff et al. (2005) conducted a case series study of 27 children to investigate the topographic relation between focal spikes and neuropsychological findings in children with benign partial epilepsy (BPE). All children in the study had an MEG/EEG and MRI. Psychological assessments, including language and motor performance, were also conducted. Of the 27 children, 20 had sufficient MEG data that could be used to evaluate the recorded findings versus the psychological test findings. The researchers saw a correlation between the interictal spikes that were recorded with MEG as compared to the other test findings. They concluded that high-level cognitive functions that depend on interaction of diverse cortical areas of the brain are particularly susceptible to interference by interictal discharges. They also concluded that these findings may have implications for therapeutic planning for children with BPE, but additional research is needed to verify these findings.

Papanicolaou et al. (2005b) compared the localization accuracy of interictal MEG with ictal and interictal invasive VEEG in identifying the epileptogenic zone in epilepsy surgery patients. The study included 41 patients, 29 with temporal lobe epilepsy (TLE) and 12 with extratemporal lobe epilepsy (ETLE). Only patients with interictal changes during the MEG recordings were included. A comparison of the accuracy of invasive VEEG and MEG seizure zone identification was based on the degree of overlap between the location of the actual surgical resection, the zone identified by each method, and the success of surgery in reducing seizure activity. No statistical differences were observed between the accuracy of invasive VEEG and MEG in determining the location of the seizure zone across TLE and ETLE cases. Invasive VEEG and MEG localization judgments were correct in 54% and 56% of the cases, respectively. Separate group analyses suggested that MEG may be less beneficial relative to invasive VEEG in ETLE than TLE cases. MEG is of statistically equivalent accuracy to invasive VEEG, despite the fact that its use has not reached optimal conditions. The authors predict that in the

near future, MEG will replace the more invasive procedure for TLE cases, subsequent to the optimization of the conditions under which preoperative MEG is performed.

A group of researchers performed spike and seizure recording simultaneously with EEG and MEG on two patients with intractable TLE and on five patients with extratemporal epilepsy (ETE) to evaluate visual patterns and source localization of ictal MEG (Assaf, et al., 2003). The researchers concluded that ictal MEG can demonstrate ictal onset, frequency and evolution and provide useful localizing information before epilepsy surgery.

In a comparative study, researchers evaluated the sensitivity and selectivity of interictal MEG versus prolonged ictal and interictal scalp VEEG in order to identify patient groups that would benefit from preoperative MEG testing (Patarraia, et al., 2004). The study included 113 consecutive patients with medically refractory epilepsy. The final data set included complete clinical, scalp and invasive V-EEG data, and MEG results for 82 patients. The epileptogenic region predicted by interictal and ictal VEEG and MEG was defined in relation to the resected area as perfectly overlapping, partially overlapping, or non-overlapping. Overall, MEG and VEEG results were equivalent in 32.3% of the cases, and MEG yielded additional localization information in 40% of the patients. In following correspondence, the authors reiterate that a substantial proportion (40%) of patients with either non- or partially-localizable VEEG results may benefit from an interictal MEG study. This information alone, provided that it is confirmed by later studies, will offer clinically significant input to the selection of candidates for noninvasive tests, including MEG. The authors stated that future studies with larger samples are needed to assess the additive advantage of MEG localization data for surgical outcome.

In an evaluation of 455 epilepsy patients who underwent MSI investigations, the average sensitivity of MEG for specific epileptic activity was 70% (Stefan, et al., 2003). Among 131 patients who underwent surgical therapy in addition to antiepileptic drug medication, MSI identified the lobe to be treated in 89%, with results for extratemporal cases superior even to those who had temporal lobe surgery. When a measure was introduced to quantify the contribution of MSI to the general result of presurgical evaluation for 104 patients, the results showed that MSI supplied additional information in 35% and information crucial to final decision-making in 10%. The authors state that accuracy, as well as contribution findings, underlined MSI appropriateness even for extratemporal epilepsies, which otherwise frequently prove difficult with respect to focus localization.

Twenty patients with frequent or predictable seizures were studied to determine the feasibility and usefulness of ictal MEG recordings in the presurgical evaluation of patients with epilepsy (Eliashiv, et al., 2002). Successful ictal MEG recordings were made in six of 20 patients with neocortical epilepsy. As determined by invasive EEG recording and postsurgical outcome, ictal MEG provided localizing information superior to that of interictal MEG in three of the six patients. Localization of ictal onset by MEG was at least as good as by invasive EEG in five of the six patients and was superior in two patients, as determined by postsurgical outcome. The researchers concluded that larger studies are necessary to confirm that, in patients with frequent or easily provoked neocortical seizures, ictal MEG recordings can contribute localizing information equivalent or superior to that of invasive EEG recording.

Brain Tumors: Korvenoja et al. (2006) compared MEG and functional magnetic resonance imaging (fMRI) with intraoperative cortical mapping in 15 patients with a lesion near the primary sensorimotor cortex (13 gliomas, one cavernous hemangioma, and one meningioma). Researchers utilized “the most widely applied paradigms for MEG and fMRI for primary sensorimotor cortex localization, which is a motor task at fMRI and an electric stimulation of a peripheral nerve at MEG.” Results indicated that MEG enabled more reliable localization of the central sulcus compared with fMRI. Specifically, in all 15 patients, MEG depicted the central sulcus correctly. In 11 (73%) patients, the area of primary activation at functional MR imaging was concordant with that at MEG and intraoperative mapping. The authors stated their results “emphasize that the limited temporal resolution must be appreciated when interpreting fMRI results. Because fMRI is more accessible than is MEG, it will likely remain the primary method used for noninvasive functional mapping. Ultimately, it may be beneficial to use both methods, if feasible, to achieve the most complete and reliable characterization of the functional anatomy.”

Technology Assessments/Reviews

In a systematic review, Lau et al. (2008) determined the effectiveness of MEG/MSI in the presurgical evaluation of localization-related epilepsies. Studies including a minimum of four patients with at least six months follow-up after surgery were reviewed. In each study, surgical outcome (seizure freedom) was correlated with the concordance of MEG source localization and resection area. Twenty-eight studies satisfied the inclusion criteria.

Eleven of the 28 studies were excluded due to an inability to determine the concordance between the MEG epileptic focus and the resected area based on the published data. Data from the remaining studies found sensitivity (range: 0.20—1.0) values for all articles, and specificity (0.06—1.00) values, positive likelihood ratios (0.67—2.0) and negative likelihood ratios (0.40—2.13) for some studies. The authors concluded that as a primary diagnostic tool the sensitivity and/or specificity of MEG has not been consistently high. The authors noted that there are multiple sources of variation between studies, and the sample size of each population was fairly small. More controlled and consistent studies need to be done to determine whether MEG is an adequate replacement as a diagnostic tool for intracranial EEG. There is insufficient evidence in the current literature to support the relationship between the use of MEG in surgical planning and seizure-free outcome after epilepsy surgery.

In September 2008, Hayes, Inc. conducted a review of the literature regarding the use of MEG and MSI of the brain. A total of 19 studies met inclusion criteria and were reviewed; ten studies for identification of epileptogenic foci and presurgical assessment of epilepsy patients; five studies for pretreatment assessment and operative planning in patients with brain lesions (tumors and AVMs); and four studies for neuropsychiatric and learning disorders. The authors reported that “overall, evaluation of the effectiveness of MEG/MSI for epilepsy, structural brain lesions, and psychiatric and learning disorders was hampered by the lack of large, well-designed, randomized studies, lack of post-surgical outcomes, heterogeneity of study populations, and the diversity among both interventions and, outcome measures. The vast majority of studies involved adult patients, and there was very little evidence regarding the use of MEG/MSI in children. Most of the available studies failed to report any follow-up, although five studies reported follow-up of \geq one year. The reviewed studies did not examine the effect of MEG/MSI on patient management or disease outcomes. Therefore, there is currently no evidence that MEG/MSI reduce the morbidity or mortality associated with epilepsy, brain lesions, or neuropsychiatric or learning disorders” (Hayes, Inc., 2008).

In January 2007, the Ontario Health Technology Advisory Committee (OHTAC) reviewed the clinical utility of functional brain imaging (i.e., MEG) in the diagnosis or management of patients with epilepsy. The authors reported, “MEG provides a possible opportunity to replace the invasive EEG because it can potentially localize the seizure foci noninvasively. There is some limited observational data (five studies, $n=190$) to suggest that MEG may be as accurate as invasive EEG at localizing the seizure foci. MEG is not only non-invasive but the investigation is performed during a single examination.” Based on the results of the health technology and policy assessment, the OHTAC recommendation for epilepsy states that a field evaluation needs to be conducted to determine the potential substitutive role of MEG versus IEEG.

In a review of the use of MEG in the presurgical evaluation of epilepsy patients, the authors concluded that, “As far as the importance of ictal recording is emphasized, long-term video/EEG monitoring is of utmost importance. Thus, it is concluded that, once the epileptogenic focus is identified by the video/EEG monitoring, then MEG is superior to EEG in order to precisely localize the current source of the interictal epileptic discharge.” The authors discuss the question of whether MEG can replace the invasive IEEG recording, stating different coverage of the cortical areas by MEG versus invasive IEEG recording has to be taken into account to explain some of the recent reports related to this question. The authors reported that MEG can be applied to the investigation of cortical functions near the epileptogenic focus when combined with other noninvasive studies like fMRI (Shibasaki, et al., 2007).

In a review of MEG/MSI use in children with epilepsy, the authors stated that MEG/MSI requires a comprehensive multidisciplinary team of epileptologists, neurosurgeons, neuropsychologists, technologists, and neuroradiologists to be successful. The authors also stated, “Although MEG and MSI cannot replace scalp EEG, neuropsychologic testing, and the need for meticulous intraoperative cortical mapping in patients undergoing excision of epileptogenic lesions, their increasing availability should ultimately persuade many clinicians of their key, if not essential, role in the evaluation and treatment of children with epilepsy” (Chuang, et al., 2006).

Makela et al. (2006) published a review of the applications of MEG in studies of neurosurgical patients. The authors stated the main applications of MEG are localization of epileptic foci and functional mapping of eloquent areas. The authors emphasize that the previously mentioned applications have not been assessed in detail with randomized controlled groups, including sham measurements, to display effects on clinical outcome. Furthermore, the authors state that large prospective studies of the clinical impact of MEG investigations are needed.

Another review of clinical applications of MEG states the primary clinical applications of MEG are the identification of epileptogenic foci in patients with epilepsy who are surgical candidates and the mapping of function-specific cortex in neurosurgical candidates. The authors stated that MEG is as accurate as both invasive and noninvasive VEEG in identifying the epileptogenic zones with strongest results for patients with TLE, thus possibly substituting the invasive monitoring technique. The authors stated that current efforts are directed toward the optimization of the conditions under which MEG recordings are obtained and processed (Papanicolaou, et al., 2005a).

A published review summarized the literature's data on the application of MEG in the field of pediatric neurology (Verrotti, et al., 2003). The primary application of MEG in pediatrics is the study of epileptic activity. The authors concluded that MEG may have advantages over EEG source localization in patients with large structural lesions. With advances in PET, ictal SPECT, and magnetic resonance spectroscopic imaging, the authors state it will be important to perform future studies with both MEG and EEG spike source localization coregistered with other noninvasive localization tools. The combination of these techniques should improve, and may sometimes even eliminate, invasive EEG recording, but should also help characterize in vivo functional disturbances in focal human epilepsy. The authors concluded that although both MEG and EEG localization methods appear to have potential value for noninvasive preoperative screening of patients with intractable, complex partial epilepsy, further refinements and better understanding of evolving patterns of interictal activity are necessary before routine clinical applications are justified.

Professional Societies/Organizations

The American Academy of Neurology (AAN) and American Epilepsy Society (AES) practice parameters for the use of neuroimaging and EEG for evaluation of an apparent unprovoked first time seizure in adults recommends that brain imaging using computed tomography (CT) or MRI should be considered as part of the neurodiagnostic evaluation of adults presenting with an apparent unprovoked first seizure. There is no mention of MEG/MSI in the practice parameter (Krumholz et al., 2007).

The American College of Radiology (ACR) Appropriateness Criteria™ for summary of literature for epilepsy states, "Only MEG and EEG are capable of measuring epileptic brain activity directly and with high temporal resolution. The temporal resolution of PET, single-emission computed tomography (SPECT), and functional MRI (fMRI) is poor by comparison (seconds-minutes). Recent improvements in MEG technology now allow whole brain coverage and overlay of source information on MR or CT images (with MSI). Available data indicate that interictal MEG can be an effective tool for localization of seizure foci in patients with medical refractory partial epilepsy. Significant shortcomings include limited availability and assessment limited to relatively superficial and tangential sources. Nonetheless, MSI does provide unique, accurate, and useful information about epileptogenic regions in the brain and, where available, has a potential role in the diagnostic workup of most patients with epilepsy." The ACR appropriateness criteria scale ranges from 1–9, with a score of 1 indicating the least appropriate imaging examination and a 9 indicating the most appropriate. The ACR gave MEG/MSI a rating of 2 for most variants. For the variant chronic epilepsy, poor therapeutic response and a surgery candidate, ACR gave MEG/MSI a rating of 5, stating the data is probably equivalent to blood oxygen level development (BOLD) and SPECT (Karis, et al., 2006).

The Report of the Quality Standards Subcommittee of the American Academy of Neurology (AAN) and the Child Neurology Society states that there is insufficient evidence to suggest a role for event-related potentials or MEG in the evaluation of autism (Filipek, et al., 2000).

The AAN practice guideline for the use of MEG for epilepsy is currently being updated. It is not known when that guideline will become available (AAN, 2008).

Summary

Evidence in the current, published, peer-reviewed scientific literature is primarily in the form of several small studies. While results to date appear promising for the future clinical application of magnetoencephalography (MEG) or magnetic source imaging (MSI) in epileptic patients, overall, insufficient evidence exists to support specific patient- selection criteria. The ultimate clinical utility of MEG has yet to be defined in relation to invasive and noninvasive electroencephalography (EEG), interictal positron emission tomography (PET), interictal single-photon emission computed tomography (SPECT), magnetic resonance spectroscopy (MRS), and functional magnetic resonance imaging (fMRI). More definitive data from large, randomized, prospective controlled studies will help evaluate MEG's/MSI's efficacy and clarify patient selection.

Coding/Billing Information

Note: This list of codes may not be all-inclusive.

Experimental/Investigational/Unproven/Not Covered:

CPT* Codes	Description
95965	Magnetoencephalography (MEG), recording and analysis; for spontaneous brain magnetic activity (e.g., epileptic cerebral cortex localization)
95966	Magnetoencephalography (MEG), recording and analysis; for evoked magnetic fields, single modality (e.g., sensory, motor, language, or visual cortex localization)
95967	Magnetoencephalography (MEG), recording and analysis; for evoked magnetic fields, each additional modality (e.g., sensory, motor, language, or visual cortex localization) (List separately in addition to code for primary procedure)

HCPCS Codes	Description
S8035	Magnetic source imaging

ICD-9-CM Diagnosis Codes	Description
	All codes

*Current Procedural Terminology (CPT®) ©2007 American Medical Association: Chicago, IL.

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Policy History

<u>Pre-Merger Organizations</u>	<u>Last Review Date</u>	<u>Policy Number</u>	<u>Title</u>
CIGNA HealthCare	12/15/2007	0248	Magnetoencephalography (MEG)

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