



Louisiana

Magnetoencephalography/Magnetic Source Imaging

Policy # 00082

Original Effective Date: 03/25/2002

Current Effective Date: 12/20/2017

Applies to all products administered or underwritten by Blue Cross and Blue Shield of Louisiana and its subsidiary, HMO Louisiana, Inc. (collectively referred to as the "Company"), unless otherwise provided in the applicable contract. Medical technology is constantly evolving, and we reserve the right to review and update Medical Policy periodically.

When Services Are Eligible for Coverage

Coverage for eligible medical treatments or procedures, drugs, devices or biological products may be provided only if:

- *Benefits are available in the member's contract/certificate, and*
- *Medical necessity criteria and guidelines are met.*

Based on review of available data, the Company may consider magnetoencephalography/magnetic source imaging (MEG/MSI) for the purpose of determining the laterality of language function, as a substitute for the Wada test, in patients being prepared for surgery for epilepsy, brain tumors and other indications requiring brain resection, to be **eligible for coverage**.

Based on review of available data, the Company may consider magnetoencephalography/magnetic source imaging (MEG/MSI) as part of the preoperative evaluation of patients with drug-resistant epilepsy when standard techniques, such as magnetic resonance imaging (MRI) and electroencephalogram (EEG), do not provide satisfactory localization of epileptic lesion(s), to be **eligible for coverage**.

When Services Are Considered Investigational

Coverage is not available for investigational medical treatments or procedures, drugs, devices or biological products.

Based on review of available data, the Company considers magnetoencephalography/magnetic source imaging (MEG/MSI) for all other indications to be **investigational**.*

Background/Overview

MAGNETOENCEPHALOGRAPHY

Magnetoencephalography (MEG) is a noninvasive functional imaging technique in which weak magnetic forces associated with brain electrical activity are recorded externally. Using mathematical modeling, recorded data are then analyzed to provide an estimated location of electrical activity. This information can be superimposed on an anatomic image of the brain, typically a magnetic resonance imaging (MRI) scan, to produce a functional/anatomic image of the brain, referred to as magnetic source imaging or magnetic source imaging (MSI). The primary advantage of MSI is that, while conductivity and thus measurement of electrical activity as recorded by electroencephalogram is altered by surrounding brain structures, magnetic fields are not. Therefore, MSI permits a high-resolution image.

Detection of weak magnetic fields requires gradiometer detection coils coupled to a superconducting quantum interference device, which requires a specialized room shielded from other magnetic sources.

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Mathematical modeling programs based on idealized assumptions are then used to translate detected signals into functional images. In its early evolution, clinical applications were limited by the use of only 1 detection coil requiring lengthy imaging times, which, because of body movement, also were difficult to match with the MRI. However, more recently, the technique has evolved to multiple detection coils in an array that can provide data more efficiently over a wide extracranial region.

Applications

One clinical application is localization of epileptic foci, particularly for screening of surgical candidates and surgical planning. Alternative techniques include MRI, positron emission tomography (PET), or single photon emission computed tomography scanning. Anatomic imaging (ie, MRI) is effective when epilepsy is associated with a mass lesion, such as a tumor, vascular malformation, or hippocampal atrophy. If an anatomic abnormality is not detected, patients may undergo a PET scan. In a small subset of patients, extended electrocorticography (ECoG) or stereotactic electroencephalography with implanted electrodes is considered the criterion standard for localizing epileptogenic foci. MEG/MSI has principally been investigated as a supplement to or an alternative to invasive monitoring.

Another clinical application is localization of the pre- and postcentral gyri as a guide to surgical planning in patients scheduled to undergo neurosurgery for epilepsy, brain neoplasms, arteriovenous malformations, or other brain disorders. These gyri contain the "eloquent" sensorimotor areas of the brain, the preservation of which is considered critical during any type of brain surgery. In normal situations, these areas can be identified anatomically by MRI, but frequently, anatomy is distorted by underlying disease processes. In addition, location of eloquent functions varies, even among healthy people. Therefore, localization of the eloquent cortex often requires such intraoperative invasive functional techniques as cortical stimulation with the patient under local anesthesia or somatosensory-evoked responses on ECoG. Although these techniques can be done at the same time as the planned resection, they are cumbersome and can add up to 45 minutes of anesthesia time. Furthermore, these techniques can sometimes be limited by the small surgical field. A preoperative test, which is often used to localize the eloquent hemisphere, is the Wada test. MEG/MSI has been proposed as a substitute for the Wada test.

FDA or Other Governmental Regulatory Approval

U.S. Food and Drug Administration (FDA)

The FDA regulates MEG devices as class II devices cleared for marketing through the 510(k) process. The FDA product codes OLX and OXY are used to identify the different components of the devices. OLX coded devices are source localization software for electroencephalography or magnetoencephalography; the software correlates electrical activity of the brain using various neuroimaging modalities. This code does not include electrodes, amplitude-integrated electroencephalograph, automatic event-detection software used as the only or final electroencephalograph analysis step, electroencephalography software with comparative databases (normal or otherwise), or electroencephalography software that outputs an index, diagnosis, or classification.

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Louisiana

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Policy # 00082

Original Effective Date: 03/25/2002

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The OLY coded devices are magnetoencephalographs that acquire, display, store, and archive biomagnetic signals produced by electrically active nerve tissue in the brain to provide information about the location of active nerve tissue responsible for certain brain functions relative to brain anatomy. This includes the magnetoencephalograph recording device (hardware, basic software).

The intended use of these devices is to “non-invasively detect and display biomagnetic signals produced by electrically active nerve tissue in the brain. When interpreted by a trained clinician, the data enhance the diagnostic capability by providing useful information about the location relative to brain anatomy of active nerve tissue responsible for critical brain functions.” More recent approval summaries add: “MEG is routinely used to identify the locations of visual, auditory, somatosensory, and motor cortex in the brain when used in conjunction with evoked response averaging devices. MEG is also used to noninvasively locate regions of epileptic activity within the brain. The localization information provided by MEG may be used, in conjunction with other diagnostic data, in neurosurgical planning.”

The MagView Biomagnetometer System (Tristan Technologies) has the unique intended use for patient populations who are neonates and infants and those children with head circumferences of 50 cm or less.

MEG devices (hardware, software) are summarized in Table 1.

Table 1. Magnetoencephalography Devices Cleared by FDA (Product Codes OLX and OLY)

Device	Manufacturer	Date Cleared	510(k) No.
Neuromagneometer	Biomagnetic Technologies	Feb 1986	K854466
700 Series Biomagnetometer	Biomagnetic Technologies	Jun 1990	K901215
Neuromag-122	Philips Medical Systems	Oct 1996	K962764
Magnes 2500 Wh Biomagnetometer	Biomagnetic Technologies	May 1997	K962317
CTF Systems, Whole-Cortex Meg System	CTF Systems	Nov 1997	K971329
Magnes II Biomagnetometer	Biomagnetic Technologies	May 1998	K941553
Image Vue EEG	Sam Technology	Aug 1988	K980477
Electroencephalograph Software eemagine	eemagine Medical Imaging Solutions	Oct 2000	K002631
Curry Multimodal Neuroimaging Software	Neurosoft	Feb 2001	K001781
Neurosoft's Source	Neurosoft	Sep 2001	K011241
Megvision Model Eq1000c Series	Eagle Technology	Mar 2004	K040051
Elekta Oy	Elekta Neuromag Oy	Aug 2004	K041264
MaxInsight	eemagine Medical Imaging Solutions	Jul 2007	K070358
Elekta Neuromag With Maxfilter	Elekta Neuromag Oy	Oct 2010	K091393
Geosource	Electrical Geodesics	Dec 2010	K092844
Babymeg Biomagnetometer System (also called Artemis 123 Biomagnetometer)	Tristan Technologies	Jul 2014	K133419
MagView Biomagnetometer System	Tristan Technologies	Apr 2016	K152184

EEG: electroencephalogram; FDA: Food and Drug Administration.

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Louisiana

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Policy # 00082

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In January 2000, Biomagnetic Technologies acquired Neuromag, a Finnish MEG company, and began doing business as 4-D NeuroImaging. The latter company ceased operations in 2009.

Centers for Medicare and Medicaid Services (CMS)

There is no national coverage determination (NCD). In the absence of an NCD, coverage decisions are left to the discretion of local Medicare carriers.

Rationale/Source

Assessment of a diagnostic technology typically focuses on 3 categories of evidence: (1) its technical reliability (test-retest reliability or interrater reliability); (2) clinical validity (sensitivity, specificity, and positive and negative predictive value) in relevant populations of patients; and (3) clinical utility demonstrating that the diagnostic information can be used to improve patient outcomes.

MAGNETOENCEPHALOGRAPHY/MAGNETIC SOURCE IMAGING FOR LOCALIZATION OF SEIZURE FOCI

Clinical Context and Test Purpose

The purpose of MEG and MSI in the mapping of epileptic foci is to facilitate surgical treatment planning for persons with drug-resistant epilepsy.

The question addressed in this evidence review is: Does the use of MEG/MSI enhance localization of epileptic foci in conjunction with other noninvasive testing or replace invasive testing and, thus, result in changes in clinical management and improvement in health outcomes?

The following PICOTS were used to select literature to inform this review.

Patients

The relevant population of interest is patients with drug-resistant epilepsy who are being evaluated for resective surgery.

Interventions

The intervention of interest is MEG/MSI used to map epileptic foci.

Comparators

MEG/MSI is primarily used as preoperative adjunct to other noninvasive tests used in clinical practice for epileptic foci localization. These tests include EEG, magnetic resonance imaging, PET, and single-photon emission computerized tomography.

Outcomes

Outcomes of interest are diagnostic accuracy (eg, test accuracy, test validity [sensitivity, specificity]) and clinical utility (eg, consideration of avoidance of invasive testing).

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Louisiana

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Timing

MEG/MSI is used when evaluating a patient with drug-resistant epilepsy for interventional surgery.

Setting

MEG/MSI is provided in an interdisciplinary specialty care setting.

Technical Reliability

The technical reliability can be assessed by correlating results for of MEG/MSI for epileptic foci localization with the results of invasive intracranial diagnostic testing. Invasive intracranial and ictal video EEG are considered the reference standard. Methods of intracranial electrical monitoring include stereotactically implanted depth electrodes, implanted strip electrodes, and implanted grids that require craniotomy. Implanted electrodes can be used to monitor for epilepsy and during intraoperative evaluation, which is referred to as electrocortigraphy.

Implanted electrodes can detect interictal and ictal spike activity to localize epileptic foci. Generally MEG/MSI as well as other noninvasive imaging or EEG evaluations are performed in the interictal state. Interictal brain spike activity is thought to reflect “irritative” activity rather than the seizure origin itself. Epilepsy has been described as a “network disease” and thus there may be an imperfect correlation between interictal and ictal activity localization.

A 2003 TEC Assessment on MEG/MSI reviewed the available evidence and did not conclude that MEG/MSI was equivalent to invasive intracranial EEG or electrocortigraphy for localizing epileptic foci.

Section Summary: Technical Reliability

There are no randomized trials or prospective comparative studies that address the correlation between MEG/MSI performed preoperatively and intracranial EEG or intraoperative electrocortigraphy to localize epileptic foci. The evidence is limited to observational case series, which do not provide a basis for conclusions about the reliability of MEG/MSI.

Clinical Validity

This section of our review is based on a 2008 TEC Special Report that reviewed the evidence on MEG for localization of epileptic lesions. MEG has been proposed as a method for localizing seizure foci for patients with normal or equivocal magnetic resonance imaging and negative video-EEG examinations, so-called “nonlesional” epilepsy. Such patients often undergo MEG, positron emission tomography, or ictal single-photon emission computed tomography to localize the seizure focus. They then often undergo invasive intracranial EEG (IC-EEG), a surgical procedure in which electrodes are inserted next to the brain. Definitive proof that MEG is effective would be comparative evidence that when compared with not using MEG, it improved patient outcomes. Such improvement in outcomes would include more patients being rendered seizure-free, use of a less invasive and morbid diagnostic workup, and overall improved patient outcomes. This is a complicated array of outcomes that has not been thoroughly evaluated in a comprehensive manner. Because MEG is used to make decision regarding further diagnostic testing, which

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Policy # 00082

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Current Effective Date: 12/20/2017

may affect the decision to have surgery and the extent of surgery, solely examining surgical outcomes excludes the assessment of outcomes of patients who did not have surgery.

Ideally, a randomized trial comparing the outcomes of patients who receive MEG as part of their diagnostic workup compared with patients who do not receive MEG could determine whether MEG improves patient outcomes. However, almost all of the studies evaluating MEG have been retrospective, where MEG, other tests, and surgery have been selectively applied to patients. Because patients often drop out of the diagnostic process before having IC-EEG, and many patients ultimately do not undergo surgery, most studies of associations between diagnostic tests and between diagnostic tests and outcomes are biased by selection and ascertainment biases. For example, studies that evaluate the correlation between MEG and IC-EEG invariably do not account for the fact that MEG information was sometimes used to deselect a patient from undergoing IC-EEG. In addition, IC-EEG findings only imperfectly correlate with surgical outcomes, meaning that it is an imperfect reference standard.

Numerous studies have shown associations between MEG findings and other noninvasive and invasive diagnostic tests, including IC-EEG, and between MEG findings and surgical outcomes. However, such studies do not allow any conclusions whether MEG added incremental information to aid the management of such patients and whether patients' outcomes were improved as a result of the additional diagnostic information.

A representative study of MEG by Knowlton et al (2008) demonstrated many of the problematic issues of evaluating MEG. In this study of 160 patients with nonlesional epilepsy, all had MEG, but only 72 proceeded to IC-EEG. The calculations of diagnostic characteristics of MEG are biased by incomplete ascertainment of the reference standard. However, even examining the diagnostic characteristics of MEG using the 72 patients who underwent IC-EEG, sensitivities and specificities were well below 90%, indicating the likelihood of both false-positive and false-negative studies. Predictive values based on these sensitivities and specificities mean that MEG can neither rule in nor rule out a positive IC-EEG, and that MEG cannot be used as a triage test before IC-EEG to avoid potential morbidity in a subset of patients.

One study more specifically addressed whether MEG can improve the yield of IC-EEG, thus, allowing more patients to receive surgery. In a 2009 study by Knowlton et al, MEG results modified the placement of electrodes in 18 (23%) of 77 patients who were recommended to have IC-EEG. Seven (39%) of 18 patients had positive intracranial seizure recordings involving additional electrode placement because of MEG results. It was concluded that 4 (5%) patients were presumed to have had surgery modified as a result of the effect of MEG electrode placement.

Section Summary: Clinical Validity

There are no clinical trials or other high-quality studies demonstrating the diagnostic accuracy of MEG in determining location of seizure foci. Available evidence on diagnostic accuracy is limited by ascertainment and selection biases because MEG findings were used to select and deselect patients in the diagnostic pathway, thus making it difficult to determine the role of MEG for the purpose of seizure localization.

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Louisiana

Magnetoencephalography/Magnetic Source Imaging

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Current Effective Date: 12/20/2017

Clinical Utility

Several studies correlated MEG findings with surgical outcomes. Lau et al (2008) performed a meta-analysis of 17 such studies. In this meta-analysis, sensitivity and specificity had unorthodox definitions. Sensitivity was the proportion of patients cured with surgery in whom the MEG-defined epileptic region was resected, and specificity was the proportion of patients not cured with surgery in whom the MEG-defined epileptic region was not resected. Pooled sensitivity was 84%, meaning that among the total number of cured patients, 16% occurred despite the MEG-defined region not being resected. Pooled specificity was 52%, meaning that among 48% of patients not cured, the MEG-localized region was resected. These results are consistent with an association between resection of the MEG-defined region and surgical cure, but that it is an imperfect predictor of surgical success. However, it does not address the question as to whether MEG contributed original information to improve the probability of cure. In a retrospective review of 22 children with medically intractable focal epilepsy (median age at epilepsy surgery, 11 years), Kim et al (2013) used a cutoff of 70% or more for the number of MEG-identified spike dipole sources located within the resection margin to define a positive study. Sensitivity, specificity, and positive and negative predictive values for seizure-free status postoperatively were 67%, 14%, 63%, and 17%, respectively.

Other studies implied a value of MEG, but it is difficult to make firm conclusions regarding its value. In a 2013 study by Schneider et al, 14 patients with various findings on MEG, IC-EEG, and interictal single-photon emission computed tomography underwent surgery for nonlesional neocortical focal epilepsy. Concordance of IC-EEG and MEG occurred in 5 patients, 4 of whom became seizure-free. This concordance of the 2 tests was the best predictor of becoming seizure-free. Although this was prognostic for success, whether this would actually change surgical decision making, such as declining to operate where there is not such concordance, is uncertain. A similar study by Widjaja et al (2013) showed that concordance of MEG findings with the location of surgical resection correlated with better seizure outcomes. However, the authors acknowledged that MEG was entrenched in clinical practice, and the decision to proceed further in diagnostic and therapeutic endeavors was based on results of MEG and other tests.

Other case series of surgical patients have suggested a value to MEG. A study by Albert et al (2014) reviewed a series of pediatric patients undergoing surgery for epilepsy who had only undergone noninvasive monitoring prior to surgery. MEG was proposed to have avoided the need for the morbidity associated with invasive monitoring. Of 16 patients, 62.5% were seizure-free following surgery, and 20% experienced improvement. Two cases required additional surgery with invasive monitoring. Although most patients improved, it cannot be determined whether the outcomes were equivalent to the standard practice of pre-resection invasive monitoring. A study by Wang et al (2015) compared fluorine 18 fluorodeoxyglucose positron emission tomography (FDG-PET) with MEG in identifying the epileptogenic zone, using invasive monitoring as the reference standard. FDG-PET identified the zone in 8 (50%) of patients and MEG identified the zone in 12 (75%) of patients. Although MEG was more sensitive than FDG-PET in this study, it still missed epileptogenic areas identified by invasive monitoring. Another study, by Koptelova et al (2013), compared MEG with video-EEG monitoring in 22 patients. Of 75 "irritative" zones identified in the 22 patients by either method, a higher proportion was identified by MEG. Note that there is

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Louisiana

Magnetoencephalography/Magnetic Source Imaging

Policy # 00082

Original Effective Date: 03/25/2002

Current Effective Date: 12/20/2017

no true reference standard in this type of analysis. However, in analyses of intraoperative EEG, several zones identified only with this method were only identified by MEG, confirming to some extent increased sensitivity over video EEG. These recent studies suggest clinical utility for MEG in evaluation of epilepsy patients, but, due to the aforementioned problems, firm conclusions about the clinical utility of MEG cannot be determined.

In 2009, the American Clinical Magnetoencephalography Society released a position statement that supported routine clinical use of MEG/MSI for presurgical evaluation of patients with medically intractable seizures. This statement cited a 2008 study by Sutherling et al as being a “milestone class I study.” Class I evidence usually refers to randomized comparisons of treatment. However, the authors of Sutherling study described it as a “prospective, blinded crossover-controlled, single-treatment, observational case series.” The study attempted to determine the proportion of patients in whom diagnostic or treatment strategy was changed as a consequence of MEG. They concluded that the test provided nonredundant information in 33% of patients, changed treatment in 9% of surgical patients, and benefited 21% of patients who had surgery. There was no control group in this study. Benefit of MEG was inferred by assumptions of what might have occurred in the absence of MEG results. Less than half of 69 enrolled patients went on to receive IC-EEG; thus, there appeared to be incomplete accounting for outcomes of all patients in the study. A similar study by De Tiege et al (2012) also attempted to determine the number of patients in whom management decisions were altered based on MEG results. They concluded that clinical management was altered in 13% of patients.

Section Summary: Clinical Utility

Evidence supporting the effect of MEG on patient outcomes is indirect and incomplete. Surgical management may be altered in a minority of patients based on MEG, but the evidence does not support conclusion that outcomes are improved as a result of these management changes. Trials with a control group are needed to determine whether improved outcomes can be attributed to the change in management induced by knowledge of MEG findings.

MEG/MSI FOR LOCALIZATION OF ELOQUENT AND SENSORIMOTOR AREAS

Clinical Context and Test Purpose

The purpose of MEG/MSI in the localization of eloquent and sensorimotor areas of the brain in persons with cortical brain lesions is to create a precise surgical plan for resective procedures to avoid postoperative speech, sensory, and motor dysfunction where possible.

The question addressed in this evidence review is: Does the use of MEG/MSI to map eloquent and sensorimotor brain areas accurately localize these areas and reduce postoperative functional impairment and, thus, result in changes in management and improvement in health outcomes?

The following PICOTS were used to select literature to inform this review.

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Policy # 00082

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Patients

The relevant population of interest is patients with brain lesions who are being evaluated for resective surgery.

Interventions

The intervention of interest is use of MEG/MSI to map eloquent and sensorimotor brain areas.

Comparators

MEG/MSI is primarily a noninvasive alternative to the preoperative Wada test (intracarotid sodium amobarbital procedure) used to map eloquent brain areas.

Outcomes

Outcomes of interest are diagnostic accuracy (eg, test accuracy, test validity [sensitivity, specificity]) and clinical utility (eg, consideration of avoidance of invasive testing).

Timing

MEG/MSI is used when a patient with a brain lesion in close proximity to eloquent or sensorimotor areas is being evaluated for interventional surgery.

Setting

MEG/MSI is provided in an interdisciplinary specialty care setting.

Technical Reliability

The 2003 TEC Assessment assessing MEG/MSI concluded that the evidence supported the technique as relatively accurate when identifying functional brain areas. However, the evidence supporting this conclusion was based on a limited number of subjects in nonrandomized studies.

Clinical Validity

The 2003 TEC Assessment of MEG/MSI concluded that evidence for this particular indication was insufficient to demonstrate efficacy. At that time, studies reviewed had relatively weak designs and small sample sizes. There are 2 ways to analyze the potential utility of MEG for this indication: MEG could potentially be a noninvasive substitute for the Wada test, which is a standard method of determining hemispheric dominance for language. The Wada test requires catheterization of the internal carotid arteries, which carries the risk of complications. The determination of language laterality is important to know to determine the suitability of a patient for surgery and what types of additional functional testing might be needed before or during surgery. If MEG provided concordant information with the Wada test, then such information would be obtained in a safe, noninvasive manner.

Several studies have shown high concordance between the Wada test and MEG. In the largest study, by Papanicolaou et al (2004), among 85 patients, there was concordance between the MEG and Wada tests in 74 (87%) patients. In no cases were the tests discordant in a way that the findings were completely

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Louisiana

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opposite. Discordant cases occurred mostly when the Wada test indicated left dominance and MEG indicated bilateral language function. In an alternative type of analysis, when the test is being used to evaluate the absence or presence of language function in the side in which surgical treatment is being planned, using the Wada procedure as the criterion standard, MEG was 98% sensitive and 83% specific. Thus, if the presence of language function in the surgical site requires intraoperative mapping and/or a tailored surgical approach, use of MEG rather than Wada would have “missed” 1 case where such an approach would be needed (false-negative MEG), and resulted in 5 cases where such an approach was unnecessary (false-positive MEG). However, it should be noted that the Wada test is not a perfect reference standard, and some discordance may reflect inaccuracy of the reference standard. In another study by Hirata et al (2004), MEG and the Wada test agreed in 19 (95%) of 20 cases.

Section Summary: Clinical Validity

Available evidence comprises studies that correlate the results of MEG with results of intracarotid amobarbital injection (Wada test), which is an alternative method for localization. Evidence has generally shown that concordance between MEG and the Wada test is high. However, the studies have not been replicated and their generalizability is limited.

Clinical Utility

One potential use (utility) of MEG would be to map the sensorimotor area of the brain to avoid such areas in the surgical resection area. Intraoperative mapping just before resection is generally done as the reference standard. Preoperative mapping as potentially done by MEG might aid in determining the suitability of the patient for surgery or for assisting in the planning of other invasive testing. Similar to the situation for localization of epilepsy focus, the literature is problematic in terms of evaluating the comprehensive outcomes of patients due to ascertainment and selection biases. Studies tend to be limited to correlations between MEG and intraoperative mapping. Intraoperative mapping would be performed anyway in most resection patients. Several studies evaluated in the 2003 TEC Assessment showed good to high concordance between MEG/MSI findings and intraoperative mapping. A 2006 technology assessment of functional brain imaging prepared by the Ontario Ministry of Health reviewed 10 studies of MEG and invasive functional mapping and showed good to high correspondence between the 2 tests. However, these studies do not demonstrate that MEG would replace intraoperative mapping or reduce the morbidity of such mapping by allowing a more focused procedure.

Recent studies of the use of MEG in localizing the sensorimotor area provide only indirect evidence of utility. A 2013 study by Niranjan et al reviewed results of 45 patients in whom MEG was used for localizing somatosensory function. In 32 patients who underwent surgery, surgical access routes were planned to avoid regions identified as somatosensory by MEG. All patients retained somatosensory function. It is unknown to what extent MEG provided unique information not provided by other tests. In a 2012 study by Tarapore et al, 24 patients underwent MEG, transcranial magnetic stimulation, and intraoperative direct cortical stimulation to identify the motor cortex. MEG and navigated transcranial magnetic stimulation were both able to identify several areas of motor function, and the median distance between corresponding motor areas was 4.71 mm. When comparing MEG with direct cortical stimulation, median distance between

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Magnetoencephalography/Magnetic Source Imaging

Policy # 00082

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corresponding motor sites (12.1 mm) was greater than the distance between navigated transcranial magnetic stimulation and direct cortical stimulation (2.13 mm). This study did not determine whether MEG provided unique information that contributed to better patient outcomes.

Section Summary: Clinical Utility

There are no clinical trials that demonstrate the clinical utility of using MEG for localization and lateralization of eloquent and sensorimotor regions of the brain. Because MEG is a less invasive alternative to the Wada test, this evidence indicates that it is a reasonable alternative. There is also some evidence that the correlation between MEG and intraoperative mapping of eloquent and sensorimotor regions is high, but the test has not demonstrated sufficient accuracy to replace intraoperative mapping.

SUMMARY OF EVIDENCE

For individuals who have drug-resistant epilepsy and are being evaluated for possible resective surgery who receive MEG/MSI, the evidence for MEG/MSI as an adjunct to standard clinical workup includes various types of case series. Relevant outcomes are test accuracy and functional outcomes. Published evidence on MEG is suboptimal, with no clinical trials demonstrating clinical utility. Literature on diagnostic accuracy has methodologic limitations, primarily selection and ascertainment bias. Studies of functional outcomes do not fully account for the effects of MEG, because subjects who received MEG were not fully accounted for in the studies. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have brain lesions and a planned brain resection who receive MEG/MSI, the evidence for MEG/MSI for localization of eloquent function areas includes comparative studies. Relevant outcomes include test accuracy and functional outcomes. Available studies have reported that this test has high concordance with the Wada test, which is currently the main alternative to localize eloquent functions. Management is changed in some patients based on MEG testing, but it has not been demonstrated that these changes lead to improved outcomes. The evidence is insufficient to determine the effects of the technology on health outcomes.

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Louisiana

Magnetoencephalography/Magnetic Source Imaging

Policy # 00082

Original Effective Date: 03/25/2002

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03/21/2002 Medical Policy Committee review

03/25/2002 Managed Care Advisory Council approval

06/24/2002 Format revision. No substance change to policy.

03/08/2004 Medical Director review

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Louisiana

Magnetoencephalography/Magnetic Source Imaging

Policy # 00082

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03/16/2004 Medical Policy Committee review. Format revision. No substance change to policy.

03/29/2004 Managed Care Advisory Council approval

03/09/2006 Medical Director review

03/15/2006 Medical Policy Committee review. Format changes. FDA information added. No change to coverage eligibility.

03/12/2008 Medical Director review

03/19/2008 Medical Policy Committee approval

03/04/2009 Medical Director review

03/18/2009 Medical Policy Committee approval. Coverage changed from investigational to eligible for coverage for determining the laterality of language function, as a substitute for the Wada test, in patients undergoing diagnostic workup for evaluation of surgery for epilepsy, brain tumors and other indications requiring brain resection.

03/05/2010 Medical Policy Committee review

03/19/2010 Medical Policy Implementation Committee approval. No changes to coverage.

03/03/2011 Medical Policy Committee review

03/16/2011 Medical Policy Implementation Committee approval. No changes to coverage.

03/01/2012 Medical Policy Committee review

03/21/2012 Medical Policy Implementation Committee approval. Policy coverage changed from investigational to eligible for coverage to localize seizure focus for specific indications.

03/07/2013 Medical Policy Committee review

03/20/2013 Medical Policy Implementation Committee approval. Coverage eligibility unchanged.

03/06/2014 Medical Policy Committee review

03/19/2014 Medical Policy Implementation Committee approval. Coverage eligibility unchanged.

08/03/2015 Coding update: ICD10 Diagnosis code section added; ICD9 Procedure code section removed.

10/29/2015 Medical Policy Committee review

11/16/2015 Medical Policy Implementation Committee approval. Coverage eligibility unchanged.

12/01/2016 Medical Policy Committee review

12/21/2016 Medical Policy Implementation Committee approval. Coverage eligibility unchanged.

01/01/2017 Coding update: Removing ICD-9 Diagnosis Codes

12/07/2017 Medical Policy Committee review

12/20/2017 Medical Policy Implementation Committee approval. Coverage eligibility unchanged.

Next Scheduled Review Date: 12/2018

Coding

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Codes used to identify services associated with this policy may include (but may not be limited to) the following:

Code Type	Code
CPT	95965, 95966, 95967
HCPCS	S8035
ICD-10 Diagnosis	C71.0-C71.9, G40.001-G40.009, G40.011-G40.019, G40.101.-G40.109, G40.111-G40.119, G40.201-G40.209, G40.211-G40.219, G40.301-G40.309, G40.311-G40.319, G40.401-G40.409, G40.411-G40.419, G40.501-G40.509, G40.801-G40.804, G40.811-G40.814, G40.821-G40.824, G40.89, G40.901-G40.909, G40.911-G40.919, G40.A01-G40.A09, G40.A11-G40.A19, G40.B01-G40.B09, G40.B11-G40.B19, I67.1, Q28.2-Q28.3

*Investigational – A medical treatment, procedure, drug, device, or biological product is Investigational if the effectiveness has not been clearly tested and it has not been incorporated into standard medical practice. Any determination we make that a medical treatment, procedure, drug, device, or biological product is Investigational will be based on a consideration of the following:

- A. Whether the medical treatment, procedure, drug, device, or biological product can be lawfully marketed without approval of the U.S. FDA and whether such approval has been granted at the time the medical treatment, procedure, drug, device, or biological product is sought to be furnished; or
- B. Whether the medical treatment, procedure, drug, device, or biological product requires further studies or clinical trials to determine its maximum tolerated dose, toxicity, safety, effectiveness, or effectiveness as compared with the standard means of treatment or diagnosis, must improve health outcomes, according to the consensus of opinion among experts as shown by reliable evidence, including:
 - 1. Consultation with the Blue Cross and Blue Shield Association TEC or other nonaffiliated technology evaluation center(s);
 - 2. Credible scientific evidence published in peer-reviewed medical literature generally recognized by the relevant medical community; or
 - 3. Reference to federal regulations.

**Medically Necessary (or "Medical Necessity") - Health care services, treatment, procedures, equipment, drugs, devices, items or supplies that a Provider, exercising prudent clinical judgment, would provide to a patient for the purpose of preventing, evaluating, diagnosing or treating an illness, injury, disease or its symptoms, and that are:

- A. In accordance with nationally accepted standards of medical practice;
- B. Clinically appropriate, in terms of type, frequency, extent, level of care, site and duration, and considered effective for the patient's illness, injury or disease; and
- C. Not primarily for the personal comfort or convenience of the patient, physician or other health care provider, and not more costly than an alternative service or sequence of services at least as likely to produce equivalent therapeutic or diagnostic results as to the diagnosis or treatment of that patient's illness, injury or disease.

For these purposes, "nationally accepted standards of medical practice" means standards that are based on credible scientific evidence published in peer-reviewed medical literature generally recognized by the relevant medical community, Physician Specialty Society recommendations and the views of Physicians practicing in relevant clinical areas and any other relevant factors.

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