Paraspinal Surface Electromyography (EMG) to Evaluate and Monitor Back Pain

Policy Number: 2.01.35  Last Review: 8/2018
Origination: 8/2002  Next Review: 8/2019

Policy
Blue Cross and Blue Shield of Kansas City (Blue KC) will not provide coverage for Paraspinal Surface Electromyography (EMG). This is considered investigational.

When Policy Topic is covered
Not Applicable

When Policy Topic is not covered
Paraspinal surface electromyography (SEMG) is considered investigational as a technique to diagnose or monitor back pain.

Description of Procedure or Service

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A noninvasive procedure that records the summation of muscle electrical activity, paraspinal surface electromyography (SEMG) has been investigated as a technique to evaluate the physiologic functioning of the back. Additionally, this procedure has been studied as a technique to evaluate abnormal patterns of electrical activity in the paraspinal muscles in patients with back pain symptoms, such as spasm, tenderness, limited range of motion, or postural disorders.

For individuals who have back pain who receive paraspinal SEMG for evaluation and monitoring, the evidence includes a systematic review of interrater reliability, a systematic review of validity and reliability, and several nonrandomized studies
on using findings to classify back pain. Relevant outcomes are test accuracy and validity, symptoms, functional outcomes, quality of life, and resource utilization. Addressing the technical performance of SEMG, systematic reviews of small nonrandomized studies have concluded that the validity and reliability of SEMG have not been established. Heterogeneity on how SEMG recordings of muscle activity are taken limit generalizability. Across studies, patients may be sitting or standing, and exercises are isometric or dynamic. Addressing diagnostic performance of SEMG, there have been no studies directly comparing SEMG with other noninvasive techniques for evaluating back pain, and standard criteria for normal and abnormal SEMG measurements have not been determined. Addressing clinical utility, SEMG has been proposed as a noninvasive technique providing objective measurements that would inform treatment decisions in patients with back pain. While the studies have shown that SEMG results have detected different pathologies in patients with back pain, none of the studies reported health outcomes. There are no data on the impact of SEMG for patient management or health outcomes. The evidence is insufficient to determine the effects of the technology on health outcomes.

**Background**

Back pain is an extremely common condition, affecting most individuals at some point in their lives. Identifying the pathogenesis of back pain is a challenging task, in part due to the complex anatomy of the back, which includes vertebrae, intervertebral discs, facet joints, spinal nerve roots, and numerous muscles. For example, back pain may be related to osteoarthritis, disc disease, subluxation, or muscular pathology, such as muscle strain or spasm. Moreover, due to referred pain patterns, the location of the pain may not be anatomically related to the pathogenesis of the pain. For example, buttock or leg pain may be related to pathology in the spine. In addition to the diagnostic challenges of back pain is the natural history of acute back pain. The majority of cases of acute low back pain will resolve with conservative therapy, such as physical therapy, and continuing normal activities within limits permitted by the pain. Thus, initial imaging or other diagnostic testing is generally not recommended unless “red flag” warning signs are present or the pain persists for longer than 4-6 weeks. Red flag findings include significant trauma, history of cancer, unrelenting night pain, fevers or chills, and progressive motor or sensory deficits.

Aside from physical examination, diagnostic tests include imaging technologies, such as magnetic resonance imaging (MRI), designed to identify pathology (e.g., bulging discs) or tests such as discography to localize the abnormality by reproducing the pain syndrome. However, due to their lack of specificity, all diagnostic tests must be carefully interpreted in the context of the clinical picture. For example, 5% of asymptomatic patients will have bulging discs as identified by MRI. Therefore, the presence of a bulging disc may only be clinically significant if well correlated with symptoms. Assessment of the musculature may focus on ROM or strength exercises.

In contrast to anatomic imaging, SEMG, which records the summation of muscle activity from groups of muscles, has been investigated as a technique to evaluate
the physiologic functioning of the back. A noninvasive procedure, SEMG is contrasted with needle electromyography, an invasive procedure in which the electrical activity of individual muscles is recorded. Paraspinal SEMG, also referred to as paraspinal EMG scanning, has been explored as a technique to evaluate abnormal patterns of electrical activity in the paraspinal muscles in patients with back pain symptoms such as spasm, tenderness, limited ROM, or postural disorders. The technique is performed using 1 or an array of electrodes placed on the skin surface, with recordings made at rest, in various positions, or after a series of exercises. Recordings can also be made by using a handheld device, which is applied to the skin at different sites. Electrical activity can be assessed by computer analysis of the frequency spectrum (i.e., spectral analysis), amplitude, or root mean square of the electrical action potentials. In particular, spectral analysis that focuses on the median frequency has been used to assess paraspinal muscle fatigue during isometric endurance exercises. Paraspinal SEMG has been researched as a technique to establish the etiology of back pain and also has been used to monitor the response to therapy and establish physical activity limits, such as assessing capacity to lift heavy objects or ability to return to work.

Paraspinal SEMG is an office-based procedure that may be most commonly used by physiatrists or chiropractors. The following clinical applications of the paraspinal SEMG have been proposed:

- clarification of a diagnosis (i.e., muscle, joint, or disc disease)
- selection of a course of medical therapy
- selection of a type of physical therapy
- preoperative evaluation
- postoperative rehabilitation
- follow-up of acute low back pain
- evaluation of exacerbation of chronic low back pain
- evaluation of pain management treatment techniques

**Regulatory Status**

SEMG devices approved by the U.S. Food and Drug Administration (FDA) include those that use a single electrode or a fixed array of multiple surface electrodes. Examples include the CMAP Pro (Medical Technologies) and Model 9200 EMG System (Myotronics-Noromed).

Several FDA-approved devices combine surface EMG along the spine with other types of monitors. For example, in 2007, the Insight Discovery (Fasstech; Burlington, MA) was cleared for marketing through the 510(k) process. The device contains 6 sensor types, 1 of which is surface EMG. The indications include measuring bilateral differences in surface EMG along the spine and measuring surface EMG along the spine during functional tasks. (Earlier Insight models had fewer sensor types).
Rationale
This evidence review was created in August 2000 and has been updated regularly with searches of the MEDLINE database. Most recently, the literature was reviewed through April 25, 2017.

Assessment of a diagnostic technology typically focuses on 3 categories of evidence: (1) its technical performance (test-retest reliability or interrater reliability); (2) diagnostic accuracy (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. The following is a summary of the key literature to date.

Surface Electromyography
Surface electromyography (SEMG) has been used as a research tool to evaluate the performance of paraspinal muscles in patients with back pain and to further understand the etiology of low back pain. Preliminary research has also been performed to determine which SEMG parameters best differentiate patients with and without back pain.

Clinical Context and Test Purpose
The purpose of paraspinal SEMG in patients who have back pain is to identify the pathogenesis of the pain (ie, muscle, joint, or disc disease) to inform a decision on a treatment plan.

The question addressed in this evidence review is: Does paraspinal SEMG improve the net health outcome in individuals with back pain?

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

Patients
The relevant population of interest is individuals with back pain.

Interventions
Paraspinal SEMG is a noninvasive technique that aggregates data on muscle activity from groups of muscles. One or more electrodes are placed on the skin surface, and recordings are taken at rest, in various positions, or during a series of exercises.

Comparators
Other noninvasive techniques to assess back pain include clinical examination and imaging technologies.

Outcomes
The general outcomes of interest are reduction in back pain and improvement in activities of daily living.
Both false-positive test results and false-negative results can lead to an incorrect recommendation for the type of treatment or no treatment at all. Some treatments are long-term programs, and if individuals are incorrectly referred to the program, resources will be used inefficiently and more appropriate therapy will be delayed.

**Timing**
Testing would occur before determining the treatment plan.

**Setting**
Paraspinal SEMG can be performed in an office setting by physiatrists, chiropractors, or physical therapists.

**Technical Performance**
Villafane et al (2016) conducted a systematic review of studies testing the validity and clinical applicability of SEMG among patients with chronic nonspecific low back pain (LBP). The literature review, conducted through September 2014, identified 24 studies for inclusion. The quality of the studies was assessed using a modification of the checklist for cohort, case-control, and cross-sectional studies from Strengthening the Reporting of Observational Studies in Epidemiology. The checklist has 22 items, and reviewers used the 15 items that related to methods and results. Of a possible total 15 points, study scores ranged from 6 to 12. Reviewers focused on the 10 studies with scores from 10 to 12. One was large (N=349), the second largest had 67 patients, and the remaining studies had 40 or fewer patients. While SEMG recordings were taken, patient position (upright, seated) and type of test (eg, isometric trunk extension, semi-crouched lifting, Roman chair endurance) varied among the studies. Reviewers reported inconsistent findings on the validity and reliability for SEMG in discriminating between patients with chronic nonspecific LBP and healthy controls. Conclusions were limited due to the heterogeneity of methods across the studies.

A systematic review by Mohseni Bandpei et al (2014) identified 12 studies on the test-retest reliability of paraspinal SEMG. Seven included only healthy individuals. The remaining 5 studies evaluated SEMG in patients with low back pain; 3 of these included a healthy control group. Overall, the studies reported that interrater reliability, as measured by an intraclass coefficient, varied widely (range, 0.26-0.91), with most of the values in the moderate to high range. Studies were heterogenous regarding methodology and SEMG parameters used. This evidence demonstrated that the reliability of SEMG would at least be moderate in the assessment of back muscle fatigue, but it did not address the accuracy or validity of the test.

A literature review of spinal muscle evaluation in low back pain patients, published in 2007, indicated that the validity of SEMG remains controversial. Reviewers noted that, although many studies showed increased fatigability of the paraspinal muscles in patients with LBP, they could not determine whether these changes were causes or consequences of the LBP. Also, the utility of SEMG was found to be
limited because of the inability to distinguish between normal and abnormal profiles due to factors such as a lack of normative data.

**Diagnostic Performance**

No articles that directly compare the results of SEMG (which tests groups of muscles) with needle electromyography (which tests individual muscles) for diagnosing any specific muscle pathology were identified in literature searches. However, the pathology of individual muscles (ie, radiculopathy, neuropathy) may represent a different process than the pathology of muscle groups (ie, muscle strain, spasm), and thus SEMG may be considered by its advocates as a unique test for which there is currently no criterion standard. Nevertheless, even if one accepts this premise, there are inadequate data to evaluate the diagnostic performance of SEMG. In some instances, the asymmetrical electrical activity may have been used to define abnormality; results may be compared with normative data. However, we found no published literature defining what degree of asymmetry would constitute abnormality.

A study by du Rose and Breen (2016) looked into the relation between lumbar intervertebral range of motion and paraspinal muscle activity in healthy adults, as measured by SEMG and quantitative fluoroscopy, to establish “normal” measurements. Fluoroscopic images and SEMG measurements were taken for 20 men with no history of LBP. What would be considered normal intervertebral ranges of motion were related to a diverse set of muscle activation patterns as measured by SEMG. The authors concluded that larger sample sizes and measurements from patients with LBP are needed to establish standard criterion.

Absent a criterion standard diagnostic test, correlation with the clinical symptoms and physical exam is critical. De Luca (1993) published a series of studies investigating a type of SEMG called the Back Analysis System, consisting of surface electrodes and other components to measure the electrical activity of muscles during isometric exercises designed to produce muscle fatigue. Using physical exam and clinical history as a criterion standard, De Luca found that the Back Analysis System accurately identified control and back pain patients 84% and 91% of the time, respectively, with the values increasing to 100% in some populations. (Accuracy was defined as the sum of true-positive and true-negative results.) However, these studies were not designed as a clinical diagnostic tool per se but were intended to investigate the etiology of back pain and to investigate muscular fatigue patterns in patients with and without back pain.

Hu et al (2010, 2014) in Hong Kong published 2 articles on dynamic topography, an approach to analyzing SEMG findings. Both studies included patients with LBP and healthy controls; all participants underwent SEMG at study enrollment and then back pain patients participated in a rehabilitation program. The first study found different dynamic topography at baseline between the healthy people and back pain samples (a more symmetric pattern in healthy controls). After physical therapy, the dynamic topography images of back pain patients were more similar to the healthy controls on some of the parameters assessed. In the second
study, following rehabilitation, back pain patients were classified as responders or nonresponders based on changes in back pain severity. Some associations were found between baseline SEMG parameters and response to rehabilitation. SEMG was not repeated after the rehabilitation program, and thus it is unclear whether there are any significant associations between continued symptoms and SEMG abnormalities. Moreover, it is unclear how SEMG analysis would affect treatment decisions for patients with LBP.

**Clinical Utility**

A number of studies have described SEMG as an aid in classifying low back pain. Most of this research has focused on the use of SEMG to assess muscle fatigability rather than on how information from test findings could enhance patient management. While SEMG may be used to document muscle spasm or other muscular abnormalities objectively, it is unclear how such objective documentation would supplant or enhance clinical evaluation, or how this information would be used to alter the treatment plan. In part, the difficulty in clinical interpretation is understanding the extent to which the SEMG abnormalities are primary or secondary. Additionally, as noted in the Background section, no specific workup is recommended for acute LBP without warning signs.

The following studies have proposed using SEMG results to inform treatment decisions; however, none provided data to validate whether treatment based on SEMG results improved outcomes.

In a 2016 study of patients with chronic LBP (N=216), SEMG showed potential to discriminate between impaired and unimpaired neuromuscular regulation of back extensors, which would provide useful information for designing individualized exercise programs.

In a 2015 study of patients with LBP (n=27) and pain-free controls (n=23), SEMG detected a loss of discrete motor cortical organization of the paraspinal muscles among those with LBP. The invasive technique of needle electromyography is usually performed to detect this pathology. Patients with cortical reorganization may benefit from motor skill training.

In 2 studies (1988, 1992), SEMG was shown to differentiate muscle spasm from muscle contracture. Muscle spasm would be treated with relaxation therapy, and contracture would be treated with stretching exercises.

**Summary of Evidence**

For individuals who have back pain who receive paraspinal surface electromyography (SEMG) for evaluation and monitoring, the evidence includes a systematic review of interrater reliability, a systematic review of validity and reliability, and several nonrandomized studies on using findings to classify back pain. Relevant outcomes are test accuracy and validity, symptoms, functional outcomes, quality of life, and resource utilization. Addressing the technical performance of SEMG, systematic reviews of small nonrandomized studies have concluded that the validity and reliability of SEMG have not been established.
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**Supplemental Information**

**Practice Guidelines and Position Statements**
**American College of Occupational and Environmental Medicine**
In a 2011 guideline, the American College of Occupational and Environmental Medicine did not recommend SEMG as a technique for diagnosing low back disorders, based on insufficient evidence of efficacy.

**American Pain Society**
In 2009, the American Pain Society issued guidelines on the evaluation and management of low back pain. When discussing the diagnostic accuracy of nonimaging tests, the guidelines stated that “There is no evidence supporting the use of thermography or surface electromyography for diagnosis of low back pain (level of evidence: fair).”

**U.S. Preventive Services Task Force Recommendations**
Not applicable.

**Medicare National Coverage**
There is no national coverage determination. In the absence of a national coverage determination, coverage decisions are left to the discretion of local Medicare carriers.

**Ongoing and Unpublished Clinical Trials**
A search of ClinicalTrials.gov in May 2017 did not identify any ongoing or unpublished trials that would likely influence this review.

**References**


Billing Coding/Physician Documentation Information

96002 Dynamic surface electromyography, during walking or other functional
activities, 1-12 muscles

96003 Dynamic fine wire electromyography, during walking or other functional activities, 1 muscle

96004 Physician review and interpretation of comprehensive computer based motion analysis, dynamic plantar pressure measurements, dynamic surface electromyography during walking or other functional activities, and dynamic fine wire electromyography, with written report

S3900 Surface electromyography (EMG)

**ICD-10 Codes**

**M54.00-M54.9** Dorsalgia code range

There is no specific CPT code for surface electromyography (SEM; other than 96002 [Dynamic surface electromyography, during walking or other functional activities, 1 to 12 muscles], which is part of the CPT coding for motion analysis). Existing codes for electromyography (95860-95872) explicitly describe needle electromyography, in which a needle is inserted into an individual muscle. Therefore, these codes do not describe SEM.

*The following unlisted codes might also be used:*
- 95999 Unlisted neurological or neuromuscular diagnostic procedure
- 97799 Unlisted physical medicine / rehabilitation service or procedure
- 99199 Unlisted special service, procedure or report

**Additional Policy Key Words**

N/A

**Policy Implementation/Update Information**

8/1/02 New policy, considered investigational.
8/1/03 No policy statement changes.
8/1/04 No policy statement changes.
8/1/05 Policy statement revised to remove language regarding TMJ.
8/1/06 Policy statement revised to address back pain only. Title changed from *Surface Electromyography* to *Paraspinal Surface Electromyography (EMG) to Evaluate and Monitor Back Pain*.

8/1/07 No policy statement changes.
8/1/08 No policy statement changes.
8/1/09 No policy statement changes.
8/1/10 No policy statement changes.
8/1/11 No policy statement changes.
8/1/12 No policy statement changes.
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8/1/16 No policy statement changes.
8/1/17 No policy statement changes.
8/1/18    No policy statement changes.

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