Clinical Policy Bulletin: 
Surface Scanning and Macro Electromyography

Number: 0112

Policy

*Please see amendment for Pennsylvania Medicaid at the end of this CPB.

Aetna considers high-density surface electromyography (HD-sEMG), surface scanning EMG, paraspinal surface EMG, or macro EMG experimental and investigational as a diagnostic test for evaluating low back pain or other thoracolumbar segmental abnormalities such as soft tissue injury, intervertebral disc disease, nerve root irritation and scoliosis, and for all other indications because the reliability and validity of these tests have not been established.

Aetna considers surface EMG devices experimental and investigational for diagnosis and/or monitoring of nocturnal bruxism and all other indications because the reliability and validity of these tests have not been demonstrated.

Aetna considers the Neurophysiologic Pain Profile (NPP) and the spine matrix scan (lumbar matrix scan) experimental and investigational because the reliability and validity of these tests has not been established.

Aetna considers spinoscopy (Spinoscope, Spinex Corp.), a diagnostic technique that combines surface scanning EMG with video recordings, experimental and investigational as the clinical value of this diagnostic technique has not been validated.

Note: Surface scanning EMG should not be confused with conventional needle EMG, nor with the use of surface electrodes in EMG biofeedback techniques, which are considered medically necessary for appropriate indications.

Also see CPB 0502 - Nerve Conduction Studies

Background

Surface scanning electromyography (EMG) is different from the conventional needle EMG. Surface scanning EMG employs a scanner with self-contained electrodes and/or surface electrodes that are applied to the skin, and record a specific muscle or group of muscles’ electrical potential. There have been attempts to use this technology to diagnose back pain, soft tissue injury, temporomandibular joint dysfunction, nerve root irritation, and scoliosis.

Paraspinal EMG is a type of surface scanning EMG that has been used in evaluation of back pain. The rationale for the use of surface scanning EMG in the evaluation of low back pain (LBP) appears to be based on the notion that there is a direct relationship between muscular pain and elevated
myoelectrical behaviors. However, some investigators have reported no differences in paraspinal EMG levels as a function of pain state in patients with LBP, and a review of the literature indicates that the relationship between increased EMG activity and the diagnosis/severity of LBP is still highly controversial.

Spine matrix scans (also known as lumbar matrix scans) are theorized to collect thousands of bioelectrical signals from the back and reconstruct them into easily interpreted images. Another test that incorporates surface EMG as a component in the evaluation of chronic pain is the Neurophysiologic Pain Profile (NPP).

To date, surface scanning EMG has not been proven to be effective as a diagnostic tool in the evaluation of LBP and other thoracolumbar segmental abnormalities. The field of scanning EMG is only at the beginning of understanding the characteristics of the surface EMG signal and its relationship to impairment. Further investigation is needed before this technology can be used in a clinical setting.

Systematic evidence reviews supporting the use of surface EMG have suffered from substantial limitations. Mohseni-Bandpei et al (2000) reported on a literature review of surface EMG in the diagnosis of LBP. The authors found that substantial variation in the included studies regarding the methodology, procedure, type of muscle contraction, sample size, and the duration, degree and source of the patients’ pain. "However, based on this review, there appears to be convincing evidence that SEMG is a reliable and valid tool for differentiating LBP patients from normal people and for monitoring rehabilitation programmes." A critical assessment of the review by Mohensi-Bandpei et al by the Centre for Reviews and Dissemination (2003) found that "[t]he information presented does not provide adequate support for the authors' conclusions." The study by Mohensi-Bandpei et al was criticized on a number of counts: (i) the methods used to select the studies were not reported and validity was not formally assessed; (ii) the methods used to extract the data were not described; (iii) the studies were combined by counting the number of studies classified as having positive or negative conclusions without assessing the validity of the original authors' conclusions; (iv) the review contained insufficient details of the methods used to conduct the review, and no information on the internal or external validity of the results; and (v) the review examined whether the surface EMG levels were different in people with LBP and "normals", rather than assessing the diagnostic accuracy of surface EMG in LBP.

A more recent evidence review of surface EMG suffers from many of these same limitations. Based on a review of the evidence, Geisser et al (2005) found that some surface EMG measures had the potential to distinguish between people with and without LBP. A critical review of the study by Geisser et al by the Centre for Reviews and Dissemination stated that "[t]hese findings should be interpreted with extreme caution given the limitations in the search and analysis, and the failure to assess study quality and report review methods." The CRD found that the literature search by Geisser et al was limited to 1 database and no attempts were made to identify unpublished studies. "It was therefore likely that relevant studies had been missed and the review may be subject to publication bias." The CRD review also noted that the quality of the included studies was not assessed, so it was not possible to assess the validity of the findings. The CRD review also found that details of the review process were not reported, "thus it was unclear whether appropriate steps were taken to minimise bias." The CRD review also found that the methods used to pool the data "were not reported clearly and did not seem appropriate for the calculation of summary sensitivity and specificity, which appeared simply to be an average value." The CRD review found that, where multiple comparison groups shared a control group, no adjustment for statistical dependency was made. The CRD review also found that the range of reported diagnostic values suggested that results were not always consistent among studies and that pooling may not have been appropriate. "In view of the lack of reporting of review methods, the lack of a quality assessment of the included studies, differences between the studies and concerns about the methods of analysis, the authors' conclusions may not be reliable."

Surface EMG has also been attempted to diagnose and monitor nocturnal bruxism. Bruxism (the grinding and clenching of teeth) causes abnormal wear of the teeth, sounds associated with bruxism,
and jaw muscle discomfort. Portable EMG units are available for use by patients in the home, and involve placement of electrodes on the skin over the muscle being studied (e.g., masseter). Self-monitoring recordings can be imprecise due to recording problems, inconsistent and improper electrode placement, and the collection of muscle activity not associated with occlusal pressure (e.g., oral activity such as yawning and swallowing). An EMG is not required to diagnose bruxism as the consequences of this condition can be observed clinically during a regular dental examination.

Spinoscopy is a testing and analysis procedure that uses a Spinex Spinoscope® System to evaluate the functional status of the back. The Spinoscope is a computer-driven multi-camera video and EMG system that records vertebral movement and the corresponding muscular activity during movements of the back. Spinoscopy has been used to track the coordination of the back and identifies the conditions under which that coordination breaks down. The value of spinoscopy evaluation in diagnosing and monitoring patients with back problems and ultimately improving their outcomes has not been demonstrated in the published peer-reviewed medical literature.

Leclaire and colleagues (1996) examined the diagnostic accuracy of four technologies (namely clinical examination, spinoscopy, thermography, and tri-axial dynamometry) in assessing LBP. A total of 41 patients and 46 control subjects were assessed by each technology and by 2 clinical examiners blind to clinical status. Twenty patients were trained to simulate a healthy back without LBP, and 50% of the control subjects were trained to simulate the presence of a LBP disorder. Each technology was interpreted on 2 occasions by each of 2 readers. Thermography performed significantly worse than did tri-axial dynamometry, spinoscopy, and clinical examination. The diagnostic accuracy of the last 3 was similar, and inter-rater comparability did not differ significantly. Among simulators, the diagnostic accuracy of spinoscopy and tri-axial dynamometry was significantly higher than that of clinical examination, although considerable inaccuracy remained in assessing individual subjects. The authors concluded that the diagnostic accuracy of thermography in recent onset LBP does not support its use. Among those simulating normality or LBP, spinoscopy and tri-axial dynamometry have greater diagnostic accuracy than does a single clinical evaluation. However, for an individual, the inaccuracy that remains limits the use of spinoscopy or tri-axial dynamometry for diagnosis in recent onset LBP.

Furthermore, in a best-evidence review of diagnostic procedures for LBP and neck pain (Rubinstein and van Tulder, 2008), spinoscopy was not mentioned as a diagnostic option for these conditions.

Fuglsang-Frederiksen (2006) evaluated different EMG methods in the diagnosis of myopathy. These include manual analysis of individual motor unit potentials and multi-motor unit potential analysis sampled at weak effort. At high effort, turns-amplitude analyses such as the cloud analysis and the peak ratio analysis have a high diagnostic yield. The EMG can seldom be used to differentiate between different types of myopathy. In channelopathies and myotonia, exercise testing and cooling of the muscle are helpful. Macro-EMG, single-fiber EMG and muscle fiber conduction velocity analysis have a limited role in myopathy, but provide information about the changes seen. The authors concluded that analysis of the firing rate of motor units, power spectrum analysis, as well as multi-channel surface EMG may have diagnostic potential in the future.

Sanger (2008) presented the findings of a pilot study on the use of a portable surface EMG device for the evaluation of childhood hypertonia. A total of 7 children aged 5 to 17 years with hypertonia due to cerebral palsy were each examined by 6 clinicians, both with and without the use of surface EMG. The use of surface EMG resulted in an increase in inter-rater agreement as well as an increase in the self-reported confidence of the clinicians in their assessment. The authors concluded that these results support the importance of further testing of surface EMG as an adjunct to the clinical examination of childhood hypertonia.

The Work Loss Data Institute's clinical guidelines on "Low back - lumbar & thoracic (acute & chronic)" (2011) and "Neck and upper back (acute & chronic) (2011) do not recommend the use of surface EMG.

In a meta-analysis, Perinetti et al (2011) evaluated the scientific evidence for detectable correlations between the masticatory system and muscle activity of the other body districts, especially those mainly
responsible for body posture via the use of surface EMG. A literature survey was performed using the PubMed database, covering the period from January 1966 to April 2011, and choosing medical subject headings. After selection, 5 articles qualified for the final analysis. One study was judged to be of medium-quality, the remaining 4 of low-quality. No study included a control group or follow-up; in only 1 study, subjects with impairment of the masticatory system were enrolled. In all studies, detectable correlations between the masticatory systems and muscle activity of the other body districts, or vice versa, were found; however, after a re-appraisal of the data provided in these studies, only weak correlations were found, which reached biological, but not clinical relevance. With the limitations that arise from the poor methodological quality of the published studies discussed here, the conclusion was that a correlation between the masticatory system and muscle activity of the other body districts might be detected through surface EMG under experimental conditions; however, this correlation has little clinical relevance. While more investigations with improved levels of scientific evidence are needed, the current evidence does not support clinically relevant correlations between the masticatory system and the muscle activity of other body districts, including those responsible for body posture.

Drost et al (2006) stated that high density-surface EMG (HD-sEMG) is a non-invasive technique to measure electrical muscle activity with multiple (more than 2) closely spaced electrodes overlying a restricted area of the skin. Besides temporal activity, HD-sEMG also allows spatial EMG activity to be recorded, thus expanding the possibilities to detect new muscle characteristics. Especially muscle fiber conduction velocity (MFCV) measurements and the evaluation of single motor unit (MU) characteristics come into view. These investigators evaluated the clinical applications of HD-sEMG. Although beyond the scope of the present review, the search yielded a large number of "non-clinical" papers demonstrating that a considerable amount of work has been done and that significant technical progress has been made concerning the feasibility and optimization of HD-sEMG techniques. A total of 29 clinical studies and 4 reviews of clinical applications of HD-sEMG were considered. The clinical studies concerned muscle fatigue, motor neuron diseases (MND), neuropathies, myopathies (mainly in patients with channelopathies), spontaneous muscle activity and MU firing rates. In principle, HD-sEMG allows pathological changes at the MU level to be detected, especially changes in neurogenic disorders and channelopathies. Furthermore, the authors discussed several bioengineering aspects and future clinical applications of the technique and provided recommendations for further development and implementation of HD-sEMG as a clinical diagnostic tool.

Zhou et al (2012) noted that HD-sEMG has recently emerged as a potentially useful tool in the evaluation of amyotrophic lateral sclerosis (ALS). These researchers addressed a practical constraint that arises when applying HD-sEMG for supporting the diagnosis of ALS; specifically, how long the sEMG should be recorded before one can be confident that fascilitation potentials (FPs) are absent in a muscle being tested. High density-sEMG recordings of 29 muscles from 11 ALS patients were analyzed. These investigators used the distribution of intervals between FPs, and estimated the observation duration needed to record from 1 to 5 FPs with a probability approaching unity. Such an approach was previously tested by Mills with a concentric needle electrode. These researchers found that the duration of recording was up to 70 s in order to record a single FP with a probability approaching unity. Increasing recording time to 2 minutes, the probability of recording 5 FPs approached approximately 0.95. The authors concluded that HD-SEMG appears to be a suitable method for capturing FPs comparable to intra-muscular needle EMG.

Kleine et al (2012) compared the prevalence of FPs with F-responses between patients with ALS and patients with benign fasciculations. In 7 patients with ALS and 7 patients with benign fasciculations, HD-s EMG was recorded for 15 mins from the gastrocnemius muscle. Template matching was used to search for pairs of FPs with a repetition within 10 to 110 ms. Inter-spike interval (ISI) histograms were constructed from 282 pairs of benign fasciculations and from 337 FP pairs in ALS. Peaks attributable to F-waves were found at latencies of 32 ms (benign) and 35 ms (ALS); 5 patients with benign fasciculations and 4 patients with ALS had FPs with F-waves. The authors concluded that F-waves of FPs occur in both conditions; therefore they are not diagnostically helpful. They noted that F-waves confirm the distal origin of FPs for an individual axon. The occurrence of these FPs in a benign condition suggests that the generation of ectopic discharges in the distal axons is not specific to
progressive neurodegeneration.

Rojas-Martinez et al (2012) sEMG signal has been widely used in different applications in kinesiology and rehabilitation as well as in the control of human-machine interfaces. In general, the signals are recorded with bipolar electrodes located in different muscles. However, such configuration may disregard some aspects of the spatial distribution of the potentials like location of innervation zones and the manifestation of inhomogeneities in the control of the muscular fibers. On the other hand, the spatial distribution of motor unit action potentials (MUAPs) has recently been assessed with activation maps obtained from HD-EMG signals, these last recorded with arrays of closely spaced electrodes. These researchers analyzed patterns in the activation maps, associating them with 4 movement directions at the elbow joint and with different strengths of those tasks. Although the activation pattern can be assessed with bipolar electrodes, HD-EMG maps could enable the extraction of features that depend on the spatial distribution of the potentials and on the load-sharing between muscles, in order to have a better differentiation between tasks and effort levels. An experimental protocol consisting of isometric contractions at 3 levels of effort during flexion, extension, supination and pronation at the elbow joint was designed and HD-EMG signals were recorded with 2D electrode arrays on different upper-limb muscles. Techniques for the identification and interpolation of artifacts were explained, as well as a method for the segmentation of the activation areas. In addition, variables related to the intensity and spatial distribution of the maps, were obtained, as well as variables associated to signal power of traditional single bipolar recordings. Finally, statistical tests were applied in order to assess differences between information extracted from single bipolar signals or from HD-EMG maps and to analyze differences due to type of task and effort level. Significant differences were observed between EMG signal power obtained from single bipolar configuration and HD-EMG and better results regarding the identification of tasks and effort levels were obtained with the latter. Additionally, average maps for a population of 12 subjects were obtained and differences in the co-activation pattern of muscles were found not only from variables related to the intensity of the maps but also to their spatial distribution. The authors concluded that intensity and spatial distribution of HD-EMG maps could be useful in applications where the identification of movement intention and its strength is needed, for example in robotic-aided therapies or for devices like powered- prostheses or orthoses. Moreover, they stated that additional data transformations or other features are needed improve the performance of tasks identification.

The clinical effectiveness of HD-sEMG has not been established; well-designed studies are needed to ascertain the clinical utility of HD-sEMG.

### CPT Codes / HCPCS Codes / ICD-10 Codes

*Information in the [brackets] below has been added for clarification purposes. Codes requiring a 7th character are represented by "+":*

**CPT codes not covered for indications listed in the CPB:**

**Neurophysiologic Pain Profile (NPP), Spine Matrix Scan - no specific code:**

- **96002** Dynamic surface electromyography, during walking or other functional activities, 1-12 muscles
- **96004** Review and interpretation by physician or other qualified health care professional 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

**HCPCS codes not covered for indications listed in the CPB:**
ICD-10 codes not covered for indications listed in the CPB (not all-inclusive):

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>F45.8</td>
<td>Other somatoform disorders</td>
</tr>
<tr>
<td>G54.0 - G54.9</td>
<td>Nerve root and plexus disorders</td>
</tr>
<tr>
<td>G57.0 - G57.93</td>
<td>Mononeuropathies</td>
</tr>
<tr>
<td>M41.0 - M41.87, M41.9</td>
<td>Kyphoscoliosis and scoliosis</td>
</tr>
<tr>
<td>M50.00 - M51.9</td>
<td>Intervertebral disc disorders</td>
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<tr>
<td>M53.0 - M53.9</td>
<td>Other and unspecified disorders of back</td>
</tr>
<tr>
<td>M60.9, M79.1</td>
<td>Myalgia and myositis, unspecified</td>
</tr>
<tr>
<td>M62.830 - M62.838</td>
<td>Muscle spasm</td>
</tr>
<tr>
<td>M62.9 - M63.89</td>
<td>Disorders of muscle, ligament, and fascia, unspecified or in diseases classified elsewhere</td>
</tr>
<tr>
<td>Q67.5, Q76.2 - Q76.3</td>
<td>Certain congenital musculoskeletal anomalies of spine</td>
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<tr>
<td>Q76.425 - Q76.429</td>
<td>Sprains and strains of other and unspecified parts of thorax</td>
</tr>
<tr>
<td>S23.3xx+, S23.8xx+</td>
<td>Sprains and strains of other and unspecified parts of thorax</td>
</tr>
<tr>
<td>S30.0xx+</td>
<td>Contusion of low back and pelvis</td>
</tr>
<tr>
<td>S33.5xx</td>
<td>Sprain of ligaments of lumbar spine</td>
</tr>
<tr>
<td>S39.002+, S39.012+</td>
<td>Other specified injuries of lower back</td>
</tr>
<tr>
<td>S39.092+, S39.82x+</td>
<td>Other specified injuries of lower back</td>
</tr>
</tbody>
</table>

The above policy is based on the following references:

6. Triano JJ, et al. The use of instrumentation and laboratory examination procedures by the
11. McMaster University Health Science Center, Department of Clinical Epidemiology and Biostatistics. How to read clinical journals: II: To learn about a diagnostic test. Can Med Assoc J. 1981;124:703-710.


52. Drost G, Stegeman DF, van Engelen BG, Zwarts MJ. Clinical applications of high-density


AETNA BETTER HEALTH® OF PENNSYLVANIA

Amendment to
Aetna Clinical Policy Bulletin Number: 0112 Surface Scanning and Macro Electromyography

There are no amendments for Medicaid.