Name of Policy:
Electrical Bone Growth Stimulation of the Appendicular Skeleton

Policy #: 082
Category: DME
Latest Review Date: January 2014
Policy Grade: B

Background/Definitions:
As a general rule, benefits are payable under Blue Cross and Blue Shield of Alabama health plans only in cases of medical necessity and only if services or supplies are not investigational, provided the customer group contracts have such coverage.

The following Association Technology Evaluation Criteria must be met for a service/supply to be considered for coverage:

1. The technology must have final approval from the appropriate government regulatory bodies;
2. The scientific evidence must permit conclusions concerning the effect of the technology on health outcomes;
3. The technology must improve the net health outcome;
4. The technology must be as beneficial as any established alternatives;
5. The improvement must be attainable outside the investigational setting.

Medical Necessity means that health care services (e.g., procedures, treatments, supplies, devices, equipment, facilities or drugs) that a physician, exercising prudent clinical judgment, would provide to a patient for the purpose of preventing, evaluating, diagnosing or treating an illness, injury or disease or its symptoms, and that are:

1. In accordance with generally accepted standards of medical practice; and
2. Clinically appropriate in terms of type, frequency, extent, site and duration and considered effective for the patient’s illness, injury or disease; and
3. Not primarily for the convenience of the patient, physician or other health care provider; and
4. 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.
**Description of Procedure or Service:**

Bone growth stimulation is the technique of promoting bone growth in difficult to heal fractures by applying a low electrical current or ultrasound to the fracture. Bone growth stimulation is done when satisfactory healing is not occurring naturally. The result is a condition known as fracture nonunion. It is estimated that 5% of all long bone fractures will result in nonunion. The most recent FDA labeling states that a nonunion is considered established when the fracture site shows no visibly progressive signs of healing, with a reasonable time for lack of visible signs of healing at three months.

Electrical and electromagnetic fields can be generated and applied to bones through the following methods:

- **Surgical implantation of a cathode at the fracture site with the production of direct current (DC) electrical stimulation.** Invasive devices require surgical implantation of a current generator in an intramuscular or subcutaneous space, while an electrode is implanted within the fragments of bone graft at the fusion site. The implantable device typically remains functional for six to nine months after implantation, and, although the current generator is removed in a second surgical procedure when stimulation is completed, the electrode may or may not be removed. Implantable electrodes provide constant stimulation at the nonunion or fracture site but carry increased risks associated with implantable leads.

- **Noninvasive electrical bone growth stimulators generate a weak electrical current within the target site using pulsed electromagnetic fields, capacitive coupling, or combined magnetic fields.** In capacitive coupling, small skin pads/electrodes are placed on either side of the fusion site and worn for 24 hours per day until healing occurs or up to 9 months. In contrast, pulsed electromagnetic fields are delivered via treatment coils that are placed over the skin and are worn for six to eight hours per day for three to six months. Combined magnetic fields deliver a time-varying magnetic field by superimposing the time-varying magnetic field onto an additional static magnetic field. This device involves a 30-minute treatment per day for nine months. Patient compliance may be an issue with externally worn devices.

- **Semi-invasive (semi-implantable) stimulators use percutaneous electrodes and an external power supply obviating the need for a surgical procedure to remove the generator when treatment is finished.**

**Nonunion**

The definition of a fracture nonunion has remained controversial. The original U.S. Food and Drug Administration (FDA) labeling defined nonunion as follows: "A nonunion is considered to be established when a minimum of nine months has elapsed since injury and the fracture site shows no visibly progressive signs of healing for minimum of three months." Others have contended that nine months represents an arbitrary cut-off point that does not reflect the complicated variables that are present in fractures, i.e., degree of soft tissue damage, alignment of the bone fragments, vascularity, and quality of the underlying bone stock. Other proposed definitions of nonunion involve three to six months’ time from original healing, or simply when serial x-rays fail to show any further healing.
Delayed Union
Delayed union refers to a decelerating bone healing process, as identified in serial x-rays. (In contrast, nonunion serial x-rays show no evidence of healing.) When lumped together, delayed union and nonunion are sometimes referred to as "ununited fractures."

For Electrical Bone Stimulation for the Spine, please refer to policy #524, Electrical Stimulation of the Spine as an Adjunct to Spinal Fusion

Policy:
Noninvasive electrical bone growth stimulation (E0747) meets Blue Cross and Blue Shield of Alabama’s medical criteria for coverage as treatment of fracture nonunions or congenital pseudarthroses in the appendicular skeleton (the appendicular skeleton includes bones of the shoulder girdle, upper extremities, pelvis and lower extremities). The diagnosis of fracture nonunion must meet all the following criteria:

- The fracture must be of at least 90 days duration;
- Serial imaging confirms that no progressive healing has occurred;
- Fracture gap is ≤1 cm; and
- The individual can be adequately immobilized and is of an age likely to comply with non-weight bearing for fractures of the pelvis and lower extremities.

Additionally, noninvasive electrical bone growth stimulation is covered for:

- Failed joint fusion following arthrodesis ankle or knee (failed joint fusion is defined as a joint fusion that has not healed at a minimum of 6 months after the arthrodesis, as evidenced by serial imaging over a course of 3 months);
- When used in conjunction with surgical intervention for treatment of an established nonunion;
- Stress fracture that has a failed union after 90 days of treatment;

Electrical bone growth stimulation does not meet Blue Cross and Blue Shield of Alabama’s medical criteria for coverage and is considered investigational for, but not limited to the following applications:

- Immediate post-surgical treatment after appendicular skeletal surgery
- Treatment of fresh fractures
- Delayed or incomplete union fractures
- Fractures of the scapula, skull or pelvis
- Lunate fractures
- Spondylosis
- Synovial pseudarthroses
- Draining osteomyelitis
- Fresh bunionectomies
- Severe osteoporosis
- Significant motion at the fracture site
- In patients with a demand-type pacemaker or an implantable cardioverter defibrillator
Invasive and semi invasive electrical bone growth stimulators (E0749) do not meet Blue Cross and Blue Shield of Alabama’s medical criteria for coverage and are considered investigational.

Blue Cross and Blue Shield of Alabama does not approve or deny procedures, services, testing, or equipment for our members. Our decisions concern coverage only. The decision of whether or not to have a certain test, treatment or procedure is one made between the physician and his/her patient. Blue Cross and Blue Shield of Alabama administers benefits based on the member’s contract and corporate medical policies. Physicians should always exercise their best medical judgment in providing the care they feel is most appropriate for their patients. Needed care should not be delayed or refused because of a coverage determination.

Key Points:
Approximately six million fractures occur annually in the United States. It is estimated that the healing process of almost 10% of these fractures is delayed. Delayed in this situation is defined as healing not completed by three months. A significant number of this sub-population will not heal by nine months would be characterized as non-unions. The biological, anatomical and chemical factors are recognized as contributing to the occurrence of delayed union and non-union.

When a bone breaks, blood vessels also break resulting in bleeding around the injury site. Cells in neighboring tissue send out chemical messages that encourage the growth of small blood vessels. Within days, a large number of these small vessels grow into the fracture area. Eventually, the cells divide and form different connective tissues such as cartilage, bone and fibrous tissue; however, if this process is delayed or if it fails to occur at all, a nonunion results.

Noninvasive Bone Growth Stimulation
Nonunion
There is not a consensus for the definition of nonunions. One proposed definition is failure of progression of fracture-healing for at least three consecutive months (and at least six months following the fracture) accompanied by clinical symptoms of delayed/nonunion (pain, difficulty weight bearing).

The policy regarding electrical bone stimulation as a treatment of nonunion of fractures of the appendicular skeleton is based on the labeled indications by the U.S. Food and Drug Administration (FDA). The FDA approval was based on a number of case series in which patients with nonunions, primarily of the tibia, served as their own control. These studies suggest that electrical stimulation results in subsequent unions in a significant percentage of patients.

A 2008 systematic review of electromagnetic bone growth stimulation by Griffin and colleagues included 49 studies, three of which were randomized controlled trials (RCTs).
Described below are the two RCTs that included patients with nonunion and the single RCT that included patients with delayed union.

A 1994 RCT by Scott and King compared capacitive coupled electric fields with sham treatment (dummy unit) in 23 patients with nonunion (fracture at least nine months old and without clinical or radiographic sign of progression to union within the last three months) of a long bone. Patients with systemic bone disorders, synovial pseudoarthrosis, or fracture gap of greater than half the width of the bone were excluded. In this trial, electrodes were passed onto the skin surface through holes in the plaster cast. Twenty-one patients completed the protocol (10 treatment and 11 controls). Six months after beginning treatment, an orthopedic surgeon and a radiologist, neither of them involved in the patients’ management, examined radiographs and determined that six of 10 in the treatment group healed, while none of those in the control group healed (p=0.004).

In 2003, Simonis et al. compared pulsed electromagnetic field stimulation and placebo treatment for tibial shaft fractures ununited at least one year after fracture, no metal implant bridging the fracture gap, and no radiologic progression of healing in the three months before treatment. All 34 patients received operative treatment with osteotomy and unilateral external fixator prior to randomization. Treatment was delivered by external coils. Patients were assessed monthly for six months, and clinical and radiographic assessments were conducted at six months. Treatment was considered a failure if union was not achieved at six months. In the treatment group, 89% of fractures healed compared with 50% in the control group (p=0.02). While a larger percentage of smokers in the treatment group healed than compared with those in the control group, the number of smokers in each group was not comparable, and the difference in healing rates between groups was not statistically significant. The authors conclude that the available evidence supports the use of pulsed electromagnetic field therapy (PEMF) in the treatment of nonunion of the tibia and suggest that future trials should consider which modality of electromagnetic stimulation and in which anatomical sites the treatment is most effective.

Delayed Union
Delayed union is defined as a decelerating healing process as determined by serial x-rays, together with a lack of clinical and radiologic evidence of union, bony continuity, or bone reaction at the fracture site for no less than three months from the index injury or the most recent intervention.

Shi et al reported a randomized sham-controlled trial that included 58 patients with delayed union of surgically-reduced long-bone fractures (femur, tibia, humerus, radius or ulna). Delayed union was defined as a failure to heal after at least 16 weeks and not more than nine months following surgical reduction and fixation of the fracture. Patients with fracture nonunion, defined as failure to heal after more than nine months, were excluded from the study. Treatment with eight hours of PEMF per day was stopped when no radiographic progression was observed over three months or when union was achieved, with union defined as no pain during joint stressing or during motion at the fracture site and callus bridging for three out of four cortices on blinded assessment. Three months of treatment resulted in a slight, but not statistically significant, improvement in the rate of union between PEMF-treated patients and controls.
(38.7% vs. 22.2%). The success rate was significantly greater with PEMF (77.4% vs. 48.1%) after an average of 4.8 months of treatment. The time to union was not significantly different between PEMF (4.8 months, range, 2 to 12) and sham controls (4.4 months, range 2 to 7).

In a double-blind RCT by Sharrard from 1990, PEMF stimulation was compared with a sham procedure using a dummy device in 45 patients with delayed union of the tibia. Stimulators were positioned on the surface of the plaster cast. Treatment began 16 to 32 weeks after injury. Patients with fracture gaps greater than 0.5 cm after reduction, systemic disease, or taking steroids were excluded, as well as patients with marked bony atrophy or hypertrophy. Fifty-one patients were recruited, and 45 completed the protocol (20 treatment and 25 control). In the treatment group, three patients achieved union, two achieved probable union, five showed progression to union, and 10 showed no progress after 12 weeks. In the control group, none had united, one had probably united, three progressed toward union, and 17 showed no progress.

The policy regarding electrical stimulation of delayed unions is based on a 1992 TEC Assessment of the RCT by Sharrard, which offered the following conclusions. Sharrard reported radiographic evidence of healing at the end of the 12-week treatment period. Radiographs were rated separately by a radiologist and an orthopedic surgeon. Their inconsistent rating methods and uncertain comparability in their findings make the radiographic evidence difficult to interpret. In addition, it is uncertain whether radiographic evidence of healing after 12 weeks of treatment, an intermediate outcome, predicts health outcomes such as healing and need for subsequent surgery. In this study, there were no statistically significant differences between the active and sham groups on clinical outcomes such as movement at the fracture site, pain, and tenderness. Thus, Sharrard’s health outcome data do not show that noninvasive electrical bone growth stimulation delivers an advantage over placebo.

In 2011, Griffin et al published a Cochrane review of electromagnetic field stimulation for treating delayed union or non-union of long bone fractures in adults. In addition to the three RCTs reviewed above, the systematic review included a 1984 study by Barker et al that randomized 17 participants with tibial non-union to electromagnetic field stimulation or sham treatment. Thus, four studies with a total of 125 participants were included for analysis. The primary outcome measure was the proportion of participants whose fractures had united at a fixed time point. For this outcome, the overall pooled effect size was small and not statistically significant (risk ratio [RR]: 1.96; 95% confidence interval [CI]: 0.86 to 4.48). Interpretation is limited due to the substantial clinical and statistical heterogeneity in the pooled analysis. In addition, there was no reduction in pain found in two trials, and none of the studies reported functional outcomes. The authors concluded that electromagnetic stimulation may offer some benefit in the treatment of delayed union and non-union, but the evidence is inconclusive and insufficient to inform current practice.

Section Summary:
Two randomized sham-controlled trials have been identified on the treatment of delayed union with PEMF. In the Sharrard study, radiographic healing was improved at 12 weeks, but there were no statistically significant differences between groups for clinical outcomes. In the study by Shi et al, only the rate of healing at an average of 4.8 months was statistically significant, and it is not clear if this is a prespecified endpoint. The time to healing was not reduced by
PEMF. Additional study is needed to permit greater certainty regarding the effect of this technology on delayed unions.

Appendicular Skeletal Surgery
A comprehensive search found two small randomized controlled trials on non-invasive electrical bone growth stimulation after orthopedic surgery. In 1988, Borsalino et al. reported a randomized double-blind sham-controlled trial of pulsed electromagnetic field stimulation (eight hours a day) in 32 patients who underwent femoral intertrochanteric osteotomy for osteoarthritis of the hip. Radiographic measurements at 90 days revealed significant increases in the periosteal bone callus and in trabecular bone bridging at the lateral, but not the medial cortex. The study is limited by the small sample size and the lack of clinical outcomes.

A 2004 trial randomized 64 patients (144 joints with triple arthrodesis or subtalar arthrodesis) to pulsed electromagnetic field stimulation for 12 hours a day or to an untreated control condition. Patients at high risk of non-fusion (rheumatoid arthritis, diabetes mellitus, or on oral corticosteroids) were excluded from the study. Blinded radiographic evaluation found a significant decrease in the time to union (12.2 weeks for talonavicular arthrodesis vs. 17.6 weeks in the control group; 13.1 weeks for calcaneocuboid fusion vs. 17.7 weeks for the control group). Clinical outcomes were not assessed.

Fresh Fractures
A multicenter, double-blind, randomized sham-controlled trial evaluated 12 weeks of pulsed electromagnetic field stimulation for acute tibial shaft fractures. The endpoints examined were secondary surgical interventions, radiographic union, and patient-reported functional outcomes. Approximately 45% of patients were compliant with treatment (>6 hours daily use), and 218 patients (84% of 259) completed the 12-month follow-up. The primary outcome, the proportion of participants requiring a secondary surgical intervention because of delayed union or nonunion within 12 months after the injury, was similar for the two groups (15% active; 13% sham). Per protocol analysis comparing patients who actually received the prescribed dose of pulsed electromagnetic field stimulation versus sham treatment also showed no significant difference between groups. Secondary outcomes, which included surgical intervention for any reason (29% active; 27% sham), radiographic union at six months (66% active; 71% sham), and the SF-36 (Short Form) Physical Component Summary (44.9 active; 48.0 sham) and Lower Extremity Functional Scales at 12 months (48.9 active; 54.3 sham), also did not differ significantly between the groups. This sham-controlled RCT does not support a benefit for electromagnetic stimulation as an adjunctive treatment for acute tibial shaft fractures.

Another smaller (n=53) multicenter double-blind, randomized sham-controlled trial found no advantage of PEMF for the conservative treatment of fresh (<5 days from injury) scaphoid fractures. Outcomes included the time to clinical and radiologic union and functional outcome.

Stress Fractures
In 2008, Beck et al reported a well-conducted randomized controlled trial (n=44) of capacitively coupled electric fields (OrthoPak) for healing acute tibial stress fractures. Patients were instructed to use the device for 15 hours each day and usage was monitored electronically. Healing was confirmed when hopping 10 cm high for 30 seconds was accomplished without
pain. Although an increase in the hours of use per day was associated with a reduction in the time to healing, there was no difference in the rate of healing between treatment and placebo. Power analysis indicated that this number of patients was sufficient to detect a difference in healing time of three weeks, which was considered to be a clinically significant effect. Other analyses, which suggested that electrical stimulation might be effective for the radiologic healing of more severe stress fractures, were preliminary and a beneficial effect was not observed for clinical healing.

Invasive Bone Growth Stimulation
A comprehensive search for implantable bone stimulators identified a small number of case series, all of which focused on foot and ankle arthrodesis in patients at high risk for nonunion (summarized in reference. Risk factors for nonunion included smoking, diabetes mellitus, Charcot (diabetic) neuroarthropathy, steroid use, and previous nonunion. The largest case series described outcomes of foot or ankle arthrodesis in 38 high-risk patients. Union was observed in 65% of cases by follow-up evaluation (n=18) or chart review (n=20). Complications were reported in 16 (40%) cases, including six cases of deep infection and five cases of painful or prominent bone stimulators necessitating stimulator removal. A multicenter retrospective review described outcomes from 28 high-risk patients with arthrodesis of the foot and ankle. Union was reported for 24 (86%) cases at an average of 10 weeks; complications included breakage of the stimulator cables in two patients and hardware failure in one patient. Five patients required additional surgery. Prospective controlled trials are needed to evaluate this procedure.

The 1992 TEC Assessment indicated that semi-invasive bone growth stimulators are no longer in wide use.

Clinical Input Received through Physician Specialty Societies and Academic Medical Centers
While the various physician specialty societies and academic medical centers may collaborate with and make recommendations during this process through the provision of appropriate reviewers, input received does not represent an endorsement or position statement by the physician specialty societies or academic medical centers, unless otherwise noted.

In response to requests, input was received from five academic medical centers while this policy was under review in 2012. The input supported use of noninvasive electrical bone growth stimulation for the treatment of fracture nonunions or congenital pseudoarthroses of the appendicular skeleton. Input agreed that noninvasive electrical bone growth stimulation is investigational for immediate post-surgical treatment after appendicular skeletal surgery and treatment of fresh fractures. A majority of reviewers considered the use of noninvasive electrical bone growth stimulation to be investigational for the treatment of delayed union, for arthrodesis, or for the treatment of failed arthrodesis.

Summary
There is evidence from randomized controlled trials (RCTs) and systematic reviews of clinical trials that noninvasive electrical stimulators improve fracture healing for patients with fracture non-union. This evidence is not from high-quality RCTs; however, and systematic reviews
provide qualified support for this conclusion. Based on the available evidence and the lack of other options for patients with non-union, electrical stimulation may be considered medically necessary for the U.S. Food and Drug Administration (FDA)-approved indications of fracture nonunions or congenital pseudoarthroses in the appendicular skeleton when specific criteria are met.

There is insufficient evidence to evaluate the efficacy of noninvasive electrical bone growth stimulation following surgery of the appendicular skeleton or for the treatment of delayed union. In addition, a recent randomized trial found no benefit of electrical bone growth stimulation for fresh fractures. Use of noninvasive electrical bone growth stimulation for these conditions is considered investigational.

The literature for implantable bone stimulators of the appendicular skeleton consists of a small number of case series. In addition, no semi-invasive devices have FDA clearance or approval. The use of invasive or semi-invasive electrical bone growth stimulators is considered investigational.

**Key Words:**
Fracture, nonunion, delayed union, bone growth stimulator, electrical bone growth stimulator, osteogenesis stimulator, invasive, semi-invasive, non invasive, electrical current, percutaneous, pseudarthrosis, pseudoarthrosis, Exogen 2000™, Exogen 3000, SAFHS® Model 2A, SAFHS® Model 2000, EBI Bone Healing System®, EBI OsteoGen OrthoPak®, Physio-Stim Lite®, Dynatron STS, Zimmer Direct Bone Growth Stimulator, Orthofix, OsteoStim®,

**Approved by Governing Bodies:**
The noninvasive OrthoPak® Bone Growth Stimulator (BioElectron) received U.S. Food and Drug Administration (FDA) premarket approval in 1984 for treatment of fracture nonunion. Pulsed electromagnetic field systems with FDA premarket approval (all noninvasive devices) include Physio-Stim® from Orthofix Inc., first approved in 1986, and OrthoLogic® 1000, approved in 1997, both indicated for treatment of established nonunion secondary to trauma, excluding vertebrae and all flat bones, in which the width of the nonunion defect is less than one-half the width of the bone to be treated; and the EBI Bone Healing System® from Electrobiology, Inc., which was first approved in 1979 and indicated for nonunions, failed fusions, and congenital pseudoarthroses. No distinction was made between long and short bones. The FDA has approved labeling changes for electrical bone growth stimulators that remove any timeframe for the diagnosis.

No semi-invasive electrical bone growth stimulator devices with FDA approval or clearance were identified.

**Benefit Application:**
Coverage is subject to member’s specific benefits. Group specific policy will supersede this policy when applicable.
ITS: Home Policy provisions apply
FEP contracts: Special benefit consideration may apply. Refer to member’s benefit plan.
FEP does not consider investigational if FDA approved and will be reviewed for medical necessity.

**Current Coding:**

**CPT Codes:**
- **20974** Electrical stimulation to aid bone healing; non-invasive (non-operative)
- **20975** Electrical stimulation to aid bone healing; invasive (operative)

**HCPCS Codes:**
- **E0747** Osteogenesis stimulator, electrical, noninvasive, other than spinal application
- **E0749** Osteogenesis stimulator, electrical (surgically implanted)

**References:**

Policy History:
Medical Policy Group, October 2008 (4)
Medical Policy Administration Committee, November 2008
Available for comment November 20, 2008-January 5, 2009
Medical Policy Group, February 2009 (4)
Medical Policy Administration Committee, March 2009
Available for comment February 27-April 13, 2009
Medical Policy Group, October 2009 (1)
Medical Policy Administration Committee, October 2009
Available for comment October 20-December 3, 2009
Medical Policy Group, November 2009 (1)
Medical Policy Administration Committee, December 2009
Available for comment December 4, 2009-January 19, 2010
Medical Policy Group, February 2010 (1)
Medical Policy Administration Committee, April 2010
Available for comment April 7-May 21, 2010
Medical Policy Group, February 2010; Regular update (1)
Medical Policy Group, November 2011 (1): Electrical bone growth stimulators separated from policy #331; Update to Key Points and References; no change in policy statement
Medical Policy Administration Committee, January 2012
Available for comment January 11 – February 27, 2012
Medical Policy Panel, October 2012
Medical Policy Group, March 2013 (1): Electrical Stimulation of the Spine separated from this policy and moved to new policy #524, information box added to direct to new policy; Title change to reflect Appendicular Skeleton; Update to Key Points and Reference; no change in policy statement
Medical Policy Panel, January 2014
Medical Policy Group, January 2014 (1): Update to Key Points and References; no change to policy statement

This medical policy is not an authorization, certification, explanation of benefits, or a contract. Eligibility and benefits are determined on a case-by-case basis according to the terms of the member’s plan in effect as of the date services are rendered. All medical policies are based on (i) research of current medical literature and (ii) review of common medical practices in the treatment and diagnosis of disease as of the date hereof. Physicians and other providers are solely responsible for all aspects of medical care and treatment, including the type, quality, and levels of care and treatment.

This policy is intended to be used for adjudication of claims (including pre-admission certification, pre-determinations, and pre-procedure review) in Blue Cross and Blue Shield’s administration of plans contracts.