Genetic Testing for Facioscapulohumeral Muscular Dystrophy

Policy # 00392
Original Effective Date: 12/18/2013
Current Effective Date: 12/21/2016

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 genetic testing for facioscapulohumeral muscular dystrophy (FSHD) to confirm a diagnosis in a patient with clinical signs of the disease to be eligible for coverage.

Note: Facioscapulohumeral muscular dystrophy (FSHD) is typically suspected in an individual with the following: weakness that predominantly involves the facial, scapular stabilizer, and foot dorsiflexor muscles without associated ocular or bulbar muscle weakness, and age of onset usually by 20 years of age (although mildly affected individuals show signs at a later age and some remain asymptomatic).

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 genetic testing for facioscapulohumeral muscular dystrophy (FSHD) for all other indications to be investigational.*

Background/Overview

Description of the Disease
Facioscapulohumeral muscular dystrophy is the third most common muscular dystrophy and involves progressive weakness and wasting of the facial muscles (facio), and shoulder and upper arm (scapulohumeral) muscles. The weakness is often most evident in the muscles of the face, resulting in difficulty smiling and whistling, and reduced facial expression. The weakness in the shoulder muscles causes the scapula to protrude from the back (“wringing of the scapula”). The muscles are typically affected asymmetrically, and with progression, the lower extremities, both proximal and distal, become involved. The severity of the disease is highly variable, ranging from mildly affected, asymptomatic individuals to severely affected individuals, with approximately 20% of patients eventually requiring a wheelchair. Nonmuscular manifestations include retinal vascular abnormalities that can result in significant loss of vision; however, only about 1% of patients with FSHD experience visual acuity loss. Most people with FSHD will eventually develop high-frequency hearing loss, which is usually not noticeable and only detected by audiogram. FSHD usually presents between the ages of 6 and 20 years, and life expectancy is not shortened. It is estimated that 4 to 5 people per 100,000 populations have FSHD. FSHD affects males and females equally.
Clinical Diagnosis of FSHD
Facioscapulohumeral muscular dystrophy has a characteristic distribution of muscle involvement that often can lead to targeted genetic testing without the need for a muscle biopsy. However, atypical presentations have been reported, which include scapulohumeral dystrophy with facial sparing. A retrospective review of an academic center database of the period 1996 to 2011 determined that, of 139 genetically confirmed FSHD cases, 7 had atypical disease, including late age of onset of disease, focal weakness and dyspnea.

Electromyography (EMG) and muscle biopsy to confirm the clinical diagnosis of FSHD has largely been supplanted by genetic testing. EMG usually shows mild myopathic changes, and muscle biopsy most often shows nonspecific chronic myopathic changes.

Genetics of FSHD
Facioscapulohumeral muscular dystrophy is likely to be caused by inappropriate expression of the gene DUX4 in muscle cells. DUX4 is a double homeobox-containing gene (a homeobox gene being one in a large family of genes that direct the formation of many body structures during early embryonic development). DUX4 lies in the macrosatellite repeat D4Z4, which is on chromosome 4q35. D4Z4 has a length of 11 to 100 repeat units on normal alleles. The most common form of FSHD (95%) is designated FSHD1, and these individuals have a D4Z4 allele of between 1 and 10 repeat units. There is no absolute linear and inverse correlation between residual repeat size and disease severity and onset; however, patients with repeat arrays of 1 to 3 units usually have an infantile onset and rapid progression.

The remaining 5% of patients who do not have FSHD1 are designated as FSHD2, which is clinically indistinguishable from FSHD1. Patients with FSHD2 show loss of DNA methylation and heterochromatin markers at the D4Z4 repeat that are similar to patients with D4Z4 contractions (FSHD1), suggesting that a change in D4Z4 chromatin structure unifies FSHD1 and FSHD2. Mutations in the SMCHD1 gene on chromosome 18, which encodes a protein known as structural maintenance of chromosomes flexible hinge domain containing 1, have been associated with FSHD2. Reductions in SMCHD1 gene product levels have been associated with D4Z4 contraction-independent DUX4 expression, suggesting that SMCHD1 acts as an epigenetic modifier of the D4Z4 allele. SMCHD1 has also been identified as a possible modifier of disease severity in patients with FSHD1.

Facioscapulohumeral muscular dystrophy is inherited in an autosomal dominant manner. Approximately 70% to 90% of individuals inherit the disease-causing deletion from a parent, and 10% to 30% have FSHD as a result of a de novo deletion.

Treatment of FSHD
There is currently no treatment or prevention of symptoms of FSHD, and clinical management is directed at surveillance to identify possible FSHD-related complications, such as hearing loss, and to improve quality of life (eg, assist devices, physical therapy, orthoses to improve mobility and prevent falls).

Commercially Available Testing for FSHD
The methodology for testing for FSHD1 uses pulsed field gel electrophoresis and Southern blot to detect deletions on chromosome 4q35.
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Laboratories that offer FSHD1 testing include Athena Diagnostics and the University of Iowa Diagnostic Laboratories.

At least one commercial laboratory was identified that offers testing for FSHD2 through sequencing of the SMCHD1 gene via bidirectional Sanger sequencing (Prevention Genetics, Marshfield, WI). Prevention Genetics also offers testing for FSHD2 through sequencing of the SMCHD1 gene by next generation sequencing as part of a panel test for limb-girdle muscular dystrophy.

FDA or Other Governmental Regulatory Approval

U.S. Food and Drug Administration (FDA)
Clinical laboratories may develop and validate tests in-house and market them as a laboratory service; laboratory-developed tests (LDTs) must meet the general standards of the Clinical Improvement Act (CLIA). Genetic testing for FSHD is available under the auspices of CLIA. Laboratories that offer LDTs must be licensed by CLIA for high-complexity testing. To date, the U.S. FDA has chosen not to require any regulatory review of these tests.

Centers for Medicare and Medicaid Services (CMS)
No coverage determination is identified.

Rationale/Source

Analytic Validity
Technical accuracy of the test in detecting a mutation that is present or in excluding a mutation that is absent.

According to 1 laboratory, Southern blotting diagnostic methods enable the identification of FSHD1 in about 95% of cases.

No studies that assessed the analytic validity of SMCHD1 gene testing were identified.

Clinical Validity
Clinical validity is the diagnostic performance of the test (sensitivity, specificity, positive and negative predictive values) in detecting clinical disease.

According to a large reference laboratory, the identification of a characteristic 4q35 deletion is more than 90% specific for the disease. However, several studies have identified patients with no clinical signs of FSHD who have characteristic D4Z4 contractures, which has prompted the hypothesis that FSHD occurs only when the D4Z4 contracture occurs in a characteristic “permissive” background.

There are reports of a correlation between the degree of the mutation of the D4Z4 locus and the age at onset of symptoms, age at loss of ambulation, and muscle strength, as measured by quantitative isometric myometry. Some reports in the literature describe individuals with a large contraction of the D4Z4 locus having earlier-onset disease and more rapid progression than those with smaller contractions of the D4Z4
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locus, although other reports have not been able to confirm a correlation between disease severity and degree of \(D_4Z_4\) contraction mutations.

On average, de novo mutations are associated with larger contractions of \(D_4Z_4\) compared with the degree of \(D_4Z_4\) contraction mutations observed segregating in families, and individuals with de novo mutations tend to have findings at the more severe end of the phenotypic spectrum.

No studies that assessed clinical validity of \(SMCHD1\) gene testing were identified.

Clinical Utility
How the results of the diagnostic test will be used to change management of the patient and whether these changes in management lead to clinically important improvements in health outcomes.

Testing in Individuals with Suspected FSHD
The clinical utility for patients with suspected FSHD depends on the ability of genetic testing to make a definitive diagnosis and for that diagnosis to lead to management changes that improve outcomes.

Several studies suggest that the size of the \(D_4Z_4\) repeat contraction is associated with differences in patients’ outcomes. Lutz et al conducted a retrospective analysis of 59 patients with FSHD seen at a single institution to evaluate the relationship between the \(D_4Z_4\) repeat size and progression of hearing loss. Eleven of the 59 patients evaluated had hearing loss that was not attributable to another cause.

Truncated \(D_4Z_4\) (1-10 \(D4Z4\) repeats) was evaluated by the size of EcoRI or EcoRI/BlnI fragment, with an EcoRI fragment of less than 38 kb or an EcoRI/BlnI fragment of less than 35 kg corresponding to 1 to 10 \(D_4Z_4\) repeats. There was a statistically significant negative association between hearing loss and fragment size in a simple logistic regression model \((p=0.021)\). Six of the 11 patients with hearing loss had a history of hearing loss progression.

In a retrospective analysis of a cohort of patients with FSHD1 enrolled in the National Registry of FSHD Patients and Family Members, Statland et al evaluated the association between patient characteristics, including size of the \(D_4Z_4\) contraction, and FSHD-related outcomes. Three hundred thirteen clinically affected participants with \(D_4Z_4\) contractions of 38 kb or less were included. Those with \(D_4Z_4\) contractions of 18 kg or less started using wheelchairs earlier than those with contractions from 19 to 28 kb \((24.1\) years vs \(48.1\) years, \(p<0.001)\) or those with contractions of greater than 38 kb \((58.6\) years, \(p<0.001)\).

There is no direct evidence for the clinical utility of genetic testing in these patients, as no studies were identified that described how a molecular diagnosis of FSHD changed patient management. However, for patients who are diagnosed with FSHD by identifying a \(D_4Z_4\) contraction mutation, the clinical utility of molecular genetic testing for FSHD includes:

- Establishing the diagnosis and initiating/directing treatment, such as evaluation for physical therapy and the need for assistive devices, assessment for hearing loss, ophthalmologic examination for the presence of retinal telangiectasias and continued ophthalmologic surveillance, and possible orthopedic intervention.
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- Distinguishing from other disorders that are similar clinically to FSHD, especially the limb-girdle muscular dystrophies and scapuloperoneal muscular dystrophy syndromes,
- Avoidance of a muscle biopsy in most cases.

Treatment after a confirmed diagnosis of FSHD includes physical therapy and rehabilitation, exercise, pain management, ventilator support for those with hypoventilation, therapy for hearing loss, orthopedic intervention (ankle/foot orthoses; surgical fixation of the scapula to the chest wall to improve range of motion) and ophthalmologic management including lubricants or taping the eyes shut at night for exposure keratitis.

For those with a confirmed diagnosis of FSHD, the following surveillance applies:
- Regular assessment of pain
- Routine screening for hypoventilation in those with moderate to severe disease, and yearly forced vital capacity measurements for all affected individuals who are wheelchair bound, have pelvic girdle weakness and superimposed pulmonary disease, and/or have moderate to severe kyphoscoliosis, lumbar hyperlordosis, or chest wall deformities.
- Hearing loss assessment in children as routinely performed as part of school-based testing. In severe infantile onset forms of FSHD, hearing screens are important as hearing loss can result in delayed language acquisition. Adults should have a formal hearing evaluation based on symptoms.
- Annual dilated ophthalmoscopy in childhood is indicated. In adults, a dilated retinal exam should be performed at the time of diagnosis, and if vascular disease is absent, follow-up exams are only necessary if visual symptoms develop.

Testing of Family Members with Individuals with FSHD
Most individuals diagnosed with FSHD have a parent with clinical findings of FSHD and one D4Z4 allele with a contraction mutation (70%-90% of individuals with FSHD), although 10% to 30% of probands with FSHD have the disorder as a result of a D4Z4 de novo contraction mutation. Evaluation of at-risk relatives may determine that they may be affected but escaped previous diagnosis because of a milder phenotypic presentation. In 2013, Ricci et al evaluated the D4Z4 site in 367 relatives of 163 FSHD index cases who carried D4Z4 “alleles of reduced size” of 8 or less repeating units. Among relatives, a D4Z4 “alleles of reduced size” with 1 to 3 repeating units and 4 to 6 repeating units was identified in 42 and 133 subjects respectively. Of those relatives with 1 to 3 repeating units, about 40% demonstrated severe muscle symptoms by age 30, while none of those with 4 or more repeating units had severe symptoms in that age range.

However, for this population, no evidence was identified that compared outcomes in family members tested for genetic mutations with family members not tested for genetic mutations, and conclusions cannot be made on whether genetic testing of asymptomatic family members of a patient with known FSHD improves outcomes. In contrast to patients with diagnosed FSHD, there are no established treatment guidelines or follow-up guidelines for at-risk relatives.
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Section Summary

D4Z4 contractions are associated with FSHD, and the size of the contracture is associated with more severe symptoms. Although there is no direct evidence for the clinical utility of genetic testing for patients with suspected FSHD, as no studies were identified that described how a molecular diagnosis of FSHD changed patient management, a chain of evidence supports the use of D4Z4 contraction mutation testing for suspected FSHD to establish a diagnosis and initiate therapies consistent with appropriate guidelines and avoid a muscle biopsy in most cases.

Ongoing and Unpublished Clinical Trials

Some currently unpublished trials that might influence this review are listed in Table 1.

Table 1. Summary of Key Trials

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<th>Trial Name</th>
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<th>Completion Date</th>
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<td>A Multicenter Collaborative Study on the Clinical Features, Expression Profiling, and Quality of Life of Infantile Onset Facioscapulohumeral Muscular Dystrophy</td>
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NCT: national clinical trial.

Summary of Evidence

The evidence for genetic testing in patients who have clinical signs of FSHD syndrome is generally lacking. Relevant outcomes are test accuracy, test validity, morbid events, functional outcomes, quality of life, and resource utilization. Test accuracy and validity have been reported to be high. A definitive diagnosis may end the need for additional testing in the etiologic workup, avoid the need for a muscle biopsy, and initiate and direct clinical management changes that can result in improved health outcomes. Therefore, the evidence is sufficient to determine qualitatively that the technology results in a meaningful improvement in the net health outcome.

References

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12/12/2013 Medical Policy Committee review
12/18/2013 Medical Policy Implementation Committee approval. New policy.
12/04/2014 Medical Policy Committee review
12/17/2014 Medical Policy Implementation Committee approval. No change to coverage.
12/03/2015 Medical Policy Committee review
12/16/2015 Medical Policy Implementation Committee approval. No change to coverage.
12/01/2016 Medical Policy Committee review
12/21/2016 Medical Policy Implementation Committee approval. No change to coverage.
01/01/2017 Coding update: Removing ICD-9 Diagnosis Codes

Next Scheduled Review Date: 12/2017

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

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*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 technology assessment program (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.

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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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