

Genetic Testing for Lactase Insufficiency

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Line(s) of Business: HMO; PPO; QUEST Integration; Medicare; FEP	Precertification: Refer to the GTM Utilization Review Matrix

I. Policy Description

Lactose intolerance (LI) is a common clinical syndrome defined by abdominal pain, flatulence, bloating, borborygmus and osmotic diarrhea; LI is caused by the breakdown of nondigested lactose by the gut microflora (Ponte et al., 2016a).

Lactose malabsorption (LM) is the non-digestion of lactose caused by low expression of the enzyme lactase and is a physiologic feature occurring in most mammals after infancy (Di Rienzo et al., 2013; Ponte et al., 2016b).

II. Indications and/or Limitations of Coverage

Application of coverage criteria is dependent upon an individual's benefit coverage at the time of the request. Specifications pertaining to Medicare and Medicaid can be found in the "Applicable State and Federal Regulations" section of this policy document.

The following does not meet coverage criteria due to a lack of available published scientific literature confirming that the test(s) is/are required and beneficial for the diagnosis and treatment of an individual's illness.

- 1) For the prediction of lactase insufficiency, targeted mutation analysis of *LCT* -13910 C>T **DOES NOT MEET COVERAGE CRITERIA.**
- 2) For individuals with lactose intolerance and/or lactase insufficiency, genetic testing of *LCT* and/or *MCM6* **DOES NOT MEET COVERAGE CRITERIA.**

III. Table of Terminology

Term	Definition
AAP	American Academy of Pediatrics
ACG	American College of Gastroenterology
BSACI	British Society for Allergy & Clinical Immunology
C/T-13910	Eurasian lactase persistence variant
CLIA	Clinical Laboratory Improvement Amendments

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CMS	Centers for Medicare and Medicaid Services
FODMAP	Fermentable oligo-, di- and monosaccharides and polyols
FGID	Functional gastrointestinal disorders
HBT	Hydrogen breath test
IBD	Inflammatory bowel disease
LBT	Lactose breath test
LCT	Lactase/lactase-phlorizin hydrolase
LD	Lactase deficiency
LDTs	Laboratory developed tests
LI	Lactose intolerance
LIP	Lactose-intolerant phenotype
LM	Lactose malabsorption
LNP	Lactase non-persistence
LTT	Lactose tolerance test
MCM6	<i>Minichromosome maintenance complex component 6</i>
NIH	National Institutes of Health
PCR	Polymerase chain reaction
RNA	Ribonucleic acid
RT-PCR	Real-time polymerase chain reaction
SNPs	Single nucleotide polymorphisms

IV. Scientific Background

Lactose is a disaccharide, which is a class of sugars comprised of two monosaccharides or simple sugars. Lactose consists of galactose bound to glucose and is the main source of carbohydrates from mammalian milk. Intestinal absorption of lactose requires initial hydrolysis by the enzyme lactase. Low lactase activity results in undigested lactose and colonic bacterial fermentation of that lactose. This leads to the characteristic symptoms of lactose intolerance, such as bloating and flatulence (Luyt et al., 2014).

Lactase expression decreases as consequence of the normal maturational down-regulation after weaning, ultimately to undetectable levels in most populations (Swallow, 2003). Lactase expression persists, however, in descendants of populations that traditionally practice cattle domestication who maintain the ability to digest milk and other dairy products into adulthood (Deng et al., 2015). Adult expression of the gene encoding lactase (LCT), located on chromosome two at 2q21 appears to be regulated by *cis*-acting elements (Wang et al., 1995) and is inherited as an autosomal recessive trait (Enattah et al., 2002). The LCT gene is regulated by the nearby *MCM6* gene (minichromosome maintenance complex component 6), which encodes a helicase complex. A few different *MCM6* variants have been identified in affecting LCT gene expression (NIH, 2024). Single nucleotide polymorphisms (SNPs) associated with the lactase persistence vary by region. In European populations it is associated with C/T-13910 and G/A-22018 mutations of the LCT gene (Enattah et al., 2002; Hogenauer et al., 2005; Poulter et al., 2003; Ridefelt & Hakansson, 2005). Additional mutations have been identified in Saudi

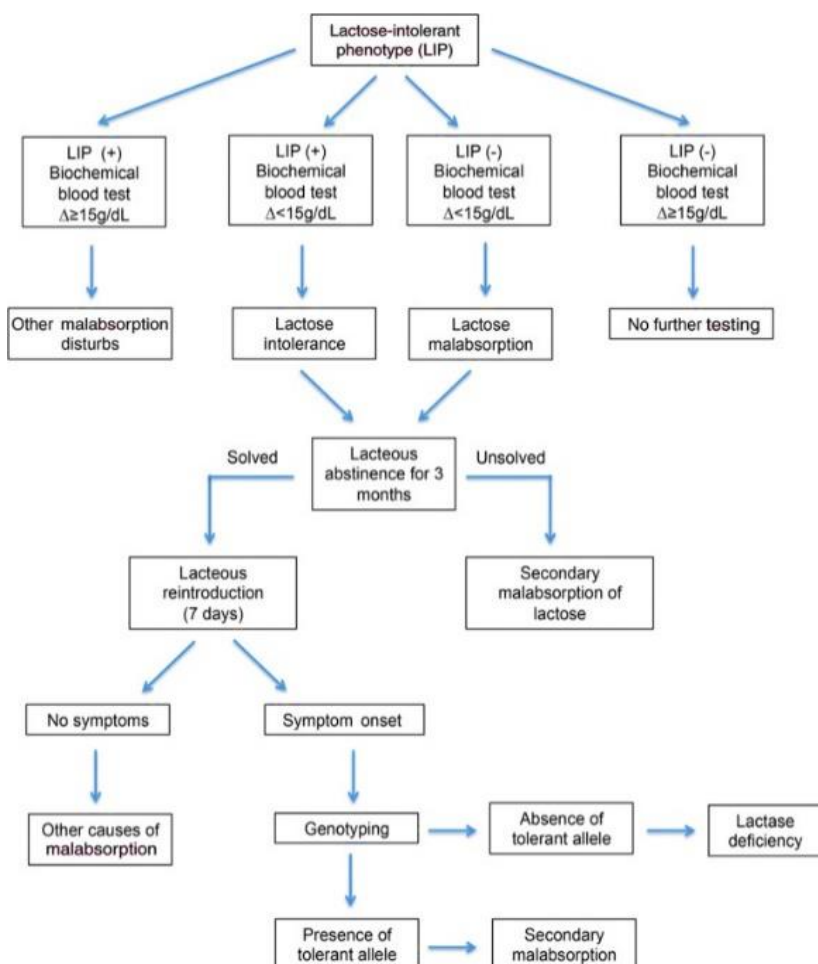
Arabia populations with G-13915 (Imtiaz et al., 2007), and in African tribes with the G-14010, G-13915, and G-13907 polymorphisms (Ingram et al., 2007; Tishkoff et al., 2007). No SNP associated with lactase persistence has been identified in the lactase gene regulatory sequence in Chinese populations (Zheng et al., 2016). In adult patients with homozygous lactase persistence, enzyme levels are 10-times higher than for patients with homozygous non-persistence, and heterozygous individuals (Deng et al., 2015; Enattah et al., 2007).

Lactase deficiency Baffour-Awuah et al. (2015) is defined as markedly reduced brush-border lactase activity relative to the activity observed in infants (Deng et al., 2015). Continued dairy consumption despite low expression of lactase results in unabsorbed lactose being present in the intestinal tract (lactose malabsorption [LM]), which can lead to symptoms of lactose intolerance (LI) in susceptible individuals (Hammer & Hogenauer, 2024).

Lactose intolerance is defined by patient reports of abdominal pain, bloating, borborygmi, and diarrhea induced by dairy consumption. Unabsorbed lactose increases the osmotic load thus increasing the intestinal water content, resulting in osmotic diarrhea. Additionally, lactose and other poorly-absorbed oligosaccharides, disaccharides, monosaccharides, and polyols ubiquitous in the diet are readily fermented by the colonic microbiome, leading to production of short-chain fatty acids and gas (mainly hydrogen [H₂], carbon dioxide [CO₂], and methane [CH₄]) (Magge & Lembo, 2012; Shepherd et al., 2013). LI may be associated with nonspecific symptoms, abdominal pain, bloating, flatulence, diarrhea, or vomiting (Hammer & Hogenauer, 2024); however, it is unclear whether these symptoms are directly due to lactose ingestion. Although LM is nearly always attributable to LD, it is not possible to make a definitive diagnosis on clinical presentation alone because double-blind trials have shown that the reliability of self-reported LI is very poor (Deng et al., 2015; Suarez et al., 1995; Zheng et al., 2016).

Determining if reported symptoms of LI are resultant from LD can be approached through several different methods. The gold standard is the measurement of lactase, sucrase, and maltase activity through intestinal biopsies. However, this method is not commonly used due to its invasive nature (Di Rienzo et al., 2013). Other tests, such as the lactose breath test or biochemical blood tests are more frequently used (Furnari et al., 2013; Mattar et al., 2013; Ponte et al., 2016b). In addition to biochemical blood tests, genetic markers may be useful for LI diagnosis; however, a positive genetic test indicates whether lactase activity decline may represent a clinical problem for the patient, but the test does not give information on actual patient symptoms, making it inappropriate as an initial screening as not all patients with LM will develop symptoms of LI (Ponte et al., 2016a).

On the contrary, this information is more readily accessible by combining the lactose breath test with intolerance symptom evaluation (Di Stefano et al., 2009). Usual LI management involves excluding milk and milk products from the diet, while ensuring adequate calcium intake (Misselwitz, 2014; Ponte et al., 2016b; Usai-Satta et al., 2012). The use of genetic tests has been proposed as an adjunct to LI diagnosis to differentiate primary LD from secondary causes (Bodlaj et al., 2006) as depicted below in the figure taken from Ponte et al. (2016b).



Clinical Utility and Validity

Marton et al. (2012) compared the common polymorphism C/T 13910 with the lactase breath test and lactose tolerance test to assess each test's ability to predict genotype/phenotype relationships. The agreement of the breath test and genotype was 0.88 sensitivity and 0.85 specificity whereas the agreement between genotype and tolerance test was 0.94 sensitivity and 0.90 specificity (Marton et al., 2012).

Baffour-Awuah et al. (2015) studied the association of genotypes at the -13910 and -22018 SNPs with clinical characteristics, RNA quantification, and enzymatic phenotypes among a range of European ethnicities within the U.S. population. The authors concluded that "13910T/T genotype will frequently, but not perfectly, predict lactase persistence in this mixed European-ancestry population; a -13910T/C genotype will not predict the phenotype" (Baffour-Awuah et al., 2015).

Misselwitz et al. (2013) stated that genetic testing for the -13910*T genotype in certain African, Arabic, or Asian subpopulations has limited value because lactase persistence may be linked to different polymorphisms. The authors also stated that genetic tests will be negative in patients with secondary

causes of lactase deficiency and that no information about clinical symptoms lactose intolerance will be obtained during testing (Misselwitz et al., 2013).

Brasen et al. (2017) genotyped 3395 routine samples using real-time polymerase chain reaction (PCR) for the -13910C > T-variant to determine the prevalence of the variants in a Danish cohort examined for lactose intolerance as well as to improve the real-time PCR analysis for detection of the different variants. The researchers found that “Using real-time PCR resulted in 100% successful genotyping of the -13910C > T variant. By using a quality value of 99% and sequencing the undetermined samples we improved the ability of the assay to identify variants other than -13910C > T. This resulted in a reduction of the diagnostic error rate by a factor of 2.4 while increasing the expenses only 3%” (Brasen et al., 2017).

Coluccia et al. (2019) compared results from a lactose breath test and a lactase-gene polymorphism test in a total of 158 symptomatic adults to identify lactose intolerance. Whole blood samples were used for genetic testing purposes. Lactose breath testing resulted in positive results in 75.9% of participants, while genetic testing identified lactase-gene polymorphisms in 82.3% of participants. In conclusion, the authors state, “We suggest considering the use of the genetic test after LBT [lactose breath test] administration, when secondary hypolactasia is suspected, for completion of diagnostic procedures” (Coluccia et al., 2019).

Muendlein et al. (2019) developed a real-time PCR protocol for the detection of the LCT-13910C>T variant from whole blood samples. Lactose tolerance in adults is known to be strongly associated with the genetic variant LCT-13910C>T, which lies near the lactose encoding gene. Results from real-time PCR were compared to those from Sanger sequencing. A total of 105 whole blood samples were analyzed. When compared to Sanger sequencing, the real-time PCR protocol was determined to be a reliable method for the detection of the LCT-13910C>T (Muendlein et al., 2019).

In a cross-sectional study by Couce et al. (2020), 493 children suspected of functional gastrointestinal disorders (FGID) were studied using the exhaled H₂ test, gastrointestinal symptoms, and SNP C/T-13910 genetic testing to observe the correlation between the genotype and phenotype of the C/T-13910 lactase non-persistence (LNP) gene. “The C/T-13910 genotype distribution was as follows: CC, 46.0%; CT, 39.5%; TT 14.4%. The frequency of the LP allele was 34.1%.” A significant increase in LNP genotype, H₂ test, and gastrointestinal symptoms were observed with increasing age. According to phenotype, CC carriers were mainly lactose non-absorbers (75.4%), TT carriers were lactose-absorbers (91.6%), and CT heterozygotes were predominantly lactose absorbers (90.7%) and lactose tolerant (74.3%). According to these results and its prevalence in older age, the authors state that the C/T-13910 polymorphism is significantly correlated with the phenotype and the authors suggest that the practical value of genetic testing is greater in older children (Couce et al., 2020).

Nardone et al. (2021) studied the prevalence of lactose intolerance assessed by hydrogen breath test (H-BT) and investigated the prevalence of three single genetic polymorphisms of the lactase gene. A total of 54 IBD patients were recruited, and H-BT was positive in 64.8% of IBD patients and 62.3% control patients. The genetic analysis revealed that 46 IBD patients (85.2%) had the wild-type genotype (LCT-13910 CC) while the other polymorphisms (CT-22018, AG-13910, and CT-22018/AG-13910) were less common in IBD patients. In the control group, the wild genotype was found in 87% of the patients. Therefore, the prevalence of polymorphisms did not differ between the IBD group and the control group.

The correlation between positive H-BT and genetic analysis showed that the "wild-type genotype was associated with higher rate of lactose intolerance in the total population" (Nardone et al., 2021).

Usai-Satta et al. (2021) reviewed the usefulness of hydrogen breath testing in the nutritional management of carbohydrate digestive disorders, including lactose malabsorption and intolerance, using the online databases PubMed, Medline, and Cochrane. According to the authors, the literature search yielded that though lactose breath testing is an indirect test for lactose malabsorption, "Lactose BT showed good sensitivity and optimal specificity for lactose malabsorption", leading them to conclude that "Before starting a low FODMAP [fermentable oligo-, di- and monosaccharides and polyols] diet, lactose BT should be suggested in a population with low prevalence of hypolactasia," helped in part by its non-invasiveness and inexpensiveness (Usai-Satta et al., 2021).

Cavichio et al. (2024) studied the agreement between C/T-13910 polymorphism genotyping results and lactose tolerance test (LTT) results in Brazil. LTT is the most commonly used LI diagnostic test in Brazil. The C/T-13910 polymorphism has mostly been studied in Caucasian populations; therefore, the authors of this study aimed to investigate the accuracy of C/T-13910 polymorphism genotyping in Brazil's "highly mixed" population. The authors included 404 patients who had undergone both C/T-13910 polymorphism genotyping and an LTT. Overall, "there was agreement between the genotyping and LTT results in 325 (80.4%) patients and discordance in 79 (19.6%) patients." The authors classified these results as "moderate agreement" and recommend additional studies to further investigate (Cavichio et al., 2024).

V. Guidelines and Recommendations

American Academy of Pediatrics (AAP)

The AAP published guidelines (Heyman, 2006) on the evaluation of Lactose Intolerance in Infants, Children and Adolescents which recommend:

"Children with suspected lactose intolerance can be assessed clinically by dietary lactose elimination or by tests including noninvasive hydrogen breath testing or invasive intestinal biopsy determination of lactase (and other disaccharidase) concentrations. Treatment consists of use of lactase-treated dairy products or oral lactase supplementation, limitation of lactose-containing foods, or dairy elimination... If dairy products are eliminated, other dietary sources of calcium or calcium supplements need to be provided."

The AAP also reported that "Recent studies suggest that in the future, genetic testing may be useful for identifying individuals at increased risk of lactase deficiency and consequent diminished bone mineral density, potentially allowing early intervention with dietary manipulation or nutrient supplementation" (Heyman, 2006).

This statement was reaffirmed in 2012.

American College of Gastroenterology (ACG)

The ACG has a webpage focused on lactose intolerance in children. Regarding diagnoses, the ACG

states that “Lactose intolerance is diagnosed by a simple test called a hydrogen breath test” (ACG, 2024). Genetic testing was not mentioned.

The 1st Rome Consensus Conference

The 1st Rome Consensus Conference issued their opinion on H₂-breath testing for sugar malabsorption. They found that “The determination of lactase activity in jejunal biopsy is currently considered the gold standard for lactose malabsorption. However, its results can be influenced by the irregular dissemination of lactase activity throughout the small intestine mucosa. On the basis of literature review, the lactose breath test is a reliable, non-invasive technique, which is provided with good sensitivity and optimal specificity.”

Though it is acknowledged that there is no unequivocal reference test available for lactose malabsorption testing, the Conference graded the quality of evidence for the above as Class I (“Conditions with evidence or general accord that a particular procedure or treatment is useful or effective”) of Strength A (“Data derived from multiple large and intermediate RCT”) (Gasbarrini et al., 2009).

VI. Applicable State and Federal Regulations

DISCLAIMER: If there is a conflict between this Policy and any relevant, applicable government policy for a particular member [e.g., Local Coverage Determinations (LCDs) or National Coverage Determinations (NCDs) for Medicare and/or state coverage for Medicaid], then the government policy will be used to make the determination. For the most up-to-date Medicare policies and coverage, please visit the [Medicare search website](#). For the most up-to-date Medicaid policies and coverage, visit the applicable state Medicaid website.

Food and Drug Administration (FDA)

Many labs have developed specific tests that they must validate and perform in house. These laboratory-developed tests (LDTs) are regulated by the Centers for Medicare and Medicaid (CMS) as high-complexity tests under the Clinical Laboratory Improvement Amendments of 1988 (CLIA '88). LDTs are not approved or cleared by the U. S. Food and Drug Administration; however, FDA clearance or approval is not currently required for clinical use.

VII. Important Reminder

The purpose of this Medical Policy is to provide a guide to coverage. This Medical Policy is not intended to dictate to providers how to practice medicine. Nothing in this Medical Policy is intended to discourage or prohibit providing other medical advice or treatment deemed appropriate by the treating physician.

Benefit determinations are subject to applicable member contract language. To the extent there are any conflicts between these guidelines and the contract language, the contract language will control.

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This Medical Policy has been developed through consideration of the medical necessity criteria under Hawaii's Patients' Bill of Rights and Responsibilities Act (Hawaii Revised Statutes §432E-1.4) or for QUEST members, under Hawaii Administrative Rules (HAR 1700.1-42), generally accepted standards of medical practice and review of medical literature and government approval status.

HMSA has determined that services not covered under this Medical Policy will not be medically necessary under Hawaii law in most cases. If a treating physician disagrees with HMSA's determination as to medical necessity in a given case, the physician may request that HMSA reconsider the application of the medical necessity criteria to the case at issue in light of any supporting documentation.

Genetic testing is covered for level 1 or 2A recommendations of the National Comprehensive Cancer Network (NCCN and in accordance with Hawaii's Patients' Bill of Rights and Responsibilities Act (Hawaii Revised Statutes §432E-1.4) or for QUEST members, the Hawaii Administrative Rules (HAR 1700.1-42).

VIII. Evidence-based Scientific References

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IX. Policy History

Action Date	Action
June 01, 2023	Policy created
December 03, 2024	Policy approved by Medical Directors
December 20, 2024	Policy approved at UMC
February 01, 2025	Policy effective date following notification period