Reimbursement Policy:

Intracellular Micronutrient Analysis - Lab Benefit Program (LBM)

POLICY NUMBER	EFFECTIVE DATE:	APPROVED BY
AHS-G2099	3/01/2023	RPC (Reimbursement Policy Committee)

Policy Description:

Micronutrients are dietary components, often referred to as vitamins and minerals, which although only required by the body in small amounts, are vital to development, disease prevention, and wellbeing. Micronutrients are not produced in the body and must be derived from the diet (CDC, 2015; Life, 2012). Micronutrients include essential trace elements such as boron, iron, zinc, selenium, manganese, iodine, copper, molybdenum, cobalt, and chromium (Frieden, 1985; WHO, 1973), and essential vitamins such as vitamins A, B, C, D, and K (organic) (Gidden & Shenkin, 2000).

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 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 a patient's illness.

Intracellular micronutrient panel testing, including but not limited to SpectraCell, Cell Science Systems cell micronutrient assay, and ExaTest, **DOES NOT MEET COVERAGE CRITERIA**

Definitions:

Term	Definition
ASEM	Analytical scanning electron microscopy
CDC	The Centers for Disease Control
CLIA	Clinical laboratories improvement amendments
CLIA ’88	Clinical laboratory improvement amendments of 1988
CMA	Cellular micronutrient assay
CMS	Centers for Medicare and Medicaid
CSS	Cell Science Systems
EXA	Energy dispersive x-ray analysis
FDA	Food and Drug Administration
HPLC	High-performance liquid chromatography
LDTs	Laboratory-developed tests
SI	Stimulation index
WHO	World Health Organization

Scientific Background:

Micronutrients, such as zinc, selenium, and copper, are involved in metabolic processes, either as catalysts or facilitators for various enzymatic functions. Micronutrient deficiency can result from general malnutrition, a current illness, or side effects of medications or procedures. Nutritional loss may exacerbate severe illness and side effects of medications as the inflammatory response draws micronutrients to the damaged organs, causing an increase in oxidative stress, and normal defense mechanisms to fail (Preiser et al., 2015). For example, oxidative damage in copper deficiency results in muscle weakness and edema, and impaired oxidative status in iodine deficiency leads to a decrease in thyroid hormone synthesis and mental retardation (Pazirandeh, 2020; Pearce, Lazarus, Moreno-Reyes, & Zimmermann, 2016).

The measurement of serum vitamin and mineral levels is widely available from numerous commercial testing companies. Normal serum nutrient concentration varies based on its function in the body. Serum concentrations of nutrients involved in regulatory mechanisms, such as calcium and zinc, are maintained within narrow ranges regardless of body stores and any changes only occur with severe nutrient deficiency. Other nutrients, such as carotenoids, vary in the body depending on recent intake or half-life length. Environmental factors, such as infections or stress, can also influence serum nutrient concentrations. Vitamin C, Vitamin B, selenium, and magnesium play a role in reducing the levels of cortisol and adrenalin in the body (McCabe, Lisy, Lockwood, & Colbeck, 2017). Nutrient concentrations may also vary based on the tissue. Nutrient concentrations in cell membranes or bone fluctuate less, but these measurements are more difficult to obtain (Elmadfa & Meyer, 2014). Serum nutrient testing is promoted to the public as a nutrient deficiency screening and supplement personalization, but these tests are usually unwarranted. There is not enough information available regarding the optimal blood levels of vitamins. Moreover, there is a lack of evidence that vitamin supplements prevent disease in healthy adults with low blood levels of vitamins, apart from those with specific diets or conditions. Vitamin deficiencies typically occur in special populations such as the elderly or those with gastric bypass surgery, and not the general public (Fairfield, 2021).

Another possible method of measuring nutrient deficiency is to assess the intracellular concentration (as opposed to the typical serum measurement). Intracellular micronutrient lymphocyte analysis was developed based on the premise that a peripheral blood lymphocyte reflects the genetic and biochemical state of the person at the time it was formed (Shive et al., 1986). A study was performed to validate the measurement of lymphocytes as an indicator of an individual's nutrient state. Lymphocytes were hypothesized to provide a superior history of nutritional status rather than a "snapshot" from typical serum testing as proclaimed by the authors. Lymphocytes were grown in various chemically defined serum-free media, and their growth responses were measured. This lymphocyte growth response was used as an indicator of nutritional status. The authors concluded that lymphocytes provide an accurate method of determining nutrient needs, requirements, or deficiencies (Bucci, 1993, 1994).

Proprietary Testing

Lymphocyte measurement is the basis of SpectraCell's micronutrient testing procedure. Lymphocytes are isolated from the blood sample and placed in a culture medium containing the optimal levels of nutrients for sustained growth. A given micronutrient is removed, and then growth is measured and compared against the 100% level of growth. For example, Vitamin B6 may be removed from the medium. The growth rate of the cell is theoretically only dependent on vitamin B6 as all other micronutrients are at optimal levels; therefore, any deficiency in cell growth would be caused by issues with intracellular Vitamin B6. This is done for all 31 micronutrients in the panel and results are reported. The micronutrients included in SpectraCell's panels are as follows: Vitamins A, B1, B2, B3, B6, B12, C, D, E, and K, as well as biotin, folate, pantothenate, calcium, magnesium, manganese, zinc, copper, asparagine, glutamine, serine, oleic acid, alpha-lipoic acid, coenzyme Q10, cysteine, glutathione, selenium, chromium, choline, inositol, and carnitine. SpectraCell also provides an assessment of "Total Antioxidant Function," an "Immune Response Score," and measures of fructose sensitivity and glucose-insulin metabolism (SpectraCell, 2021b).

Another test analyzing intracellular concentration is ExaTest by IntraCellular Diagnostics. From their laboratory website, this test uses "rapidly metabolizing sublingual epithelial cells under Analytical Scanning Electron Microscopy, (ASEM) an Energy Dispersive X-Ray Analysis, (EXA) to reflect fast tissue changes of vital mineral electrolytes." This test is primarily for aid with the management of heart disease and provides tissue evaluations of magnesium, sodium, calcium, phosphorus, potassium, and chloride. ExaTest proclaims its ability to follow a patient's metabolic status and assess electrolyte imbalance easily. First, the buccal, epithelial cells are swabbed from the patient. Then the sample is analyzed by the proprietary energy dispersive x-ray analysis and bombarded with X-Rays. Energy is released by wavelengths (unique to each element), and the element composition is analyzed and reported. ExaTest states that the serum or urine of some minerals do not correlate with intracellular levels and that these deficiencies are common in patients with various health issues, particularly heart disease. Buccal cells are used as they are easily accessible and have an easily analyzed structure for electrolytes (Exatest, 2014).

Vibrant America has also developed a test that gives both extracellular and intracellular information on approximately 40 vitamins, minerals, amino acids, fatty acids and antioxidants in the body (Vibrant, 2017). Vibrant America states that the benefits of intracellular testing include the identification of potential functional deficiencies in the cellular nutrient absorption process (which may increase the risk of certain diseases), and the identification of an individual's nutritional status in the previous four to six months (Vibrant, 2017).

Another possible method of analyzing nutrient deficiency is by measuring lymphocyte proliferation in response to micronutrient concentration. Cell Science Systems (CSS) released a cellular micronutrient assay (CMA) which measures the effect of micronutrients on lymphocyte proliferation when stimulated with a mitogen. According to their protocol, lymphocytes are primarily separated from the patient's whole blood and the patient's own serum is added back to the lymphocytes. The cells are stimulated with a mitogen and baseline lymphocyte proliferation rates (without the addition of micronutrients) are recorded. Next, micronutrients are added to the lymphocyte culture and proliferation rates are compared to the baseline rate. If the addition of micronutrients to the lymphocyte culture enhances lymphocyte proliferation, a nutrient insufficiency is reported. If the lymphocyte proliferation rate with the addition of micronutrients does not exceed the baseline rate, it likely indicates sufficient stores of that nutrient. The CMA measures vitamins, amino acids, minerals, and other nutrients such as carnitine, alpha-ketoglutarate, choline, glutathione, and inositol. By measuring intracellular levels of micronutrients, the test is intended to provide insight into the long-term nutritional status (6 months) versus the short term variability of serum nutrient levels, which is prone to daily fluctuations (Cell_Science_Systems, 2020). In 2020, the FDA approved the Baze blood testing kit for at-home use to assess nutrient status by analyzing 10 micronutrients. Through a small sample of whole blood, the testing device determines levels of choline, chromium, copper, magnesium, omega-3, selenium, vitamins B12, D, E, and zinc. The sample is mailed to a certified laboratory and analyzed using mass-spectrometry (Baze, 2020).

Genova Diagnostics released NutrEval FMV® a comprehensive blood and urine test that evaluates over 125 biomarkers and 40 antioxidants, vitamins, minerals, essential fatty acids, and amino acids in patients 2 years and older. These levels provide insight into digestive function, toxic exposure, mitochondrial function, and oxidative stress. According to their website, The NutrEval is not meant to be a substitute for other conventional nutritional panels (complete blood count, comprehensive metabolic panel), but rather a complement by providing additional information (Genova_Diagnostics, 2021).

Analytical Validity

In a randomized observational analysis, the Cell Science Systems (CSS) cellular micronutrient assay (CMA) was used to examine nutritional status in 845 American individuals aged 13 years and older. Results were expressed as the stimulation index (SI), which is the percentage of lymphocyte stimulation in response to the mitogen. All subjects were divided into two groups based on their diet. The first group had a healthy diet, consisting of whole fresh foods including fruits, vegetables, nuts, while the poor diet group reported high consumption of sweets, fried, frozen, and starchy foods. CMA analysis indicated that the "mean values for micronutrient deficiency were significantly higher in the poor diet group as compared to the healthy diet group with p-values of 0.0017 and 0.0395, respectively." According to the authors, "the adequate functioning of this defensive system is critically impacted by intracellular nutritional status, and its interaction with the host' cells. Lacking adequate nutrition, the immune system is clearly deprived of the components needed to generate an effective immune response" (Steele, Allright, & Deutsch, 2020).

Clinical Utility and Validity

While limited research has been completed regarding intracellular micronutrient lymphocyte analysis, Yamada, Yamada, Waki, and Umegaki (2004) did complete a study with 41 type 2 diabetes patients and 50 healthy controls. No participants were taking vitamin supplements at the time of the study. Blood samples were taken from all participants during a fasting state; the researchers determined that the lymphocyte vitamin C level was significantly lower in the type 2 diabetes patients than in controls (Yamada et al., 2004). This study may support the above theory that lymphocytes can be used as an indicator of an individual's nutrient state.

Houston (2010) published a small study stating that treating the intracellular micronutrient deficiencies in combination with optimal diet, exercise and other weight management resulted in reaching blood pressure goals for 62% of a hypertensive population (Houston, 2010). Another small study of 10 patients found that both genders showed overall improvement in their vitamin and mineral cellular storage balance after being tested with SpectraCell's assessment (Frye, 2010). However, the authors of each of the aforementioned studies (Houston, Bucci, Frye, and Shive) are associated with SpectraCell Laboratories. SpectraCell has listed several studies on their website discussing serum versus intracellular deficiencies; from discussing the effect of the inflammatory response on serum micronutrient levels to Vitamin B12's difficult serum profile to micronutrient deficiencies in special populations (SpectraCell, 2021a). However, none of these studies reported use SpectraCell's actual method as of 2018, nor did the studies cover the healthy population for which the test is marketed. Most of these studies listed used other methods such as HPLC to measure micronutrient levels instead of the proprietary method provided by SpectraCell. Few other studies listed on SpectraCell's website used lymphocytes as the analyte as well.

In an observational study, Coelho studied the association between serum and dietary antioxidant micronutrients and advanced liver fibrosis in non-alcoholic fatty liver disease (NAFLD). 72 NAFLD patients were evaluated for levels of retinol, alpha-tocopherol, ascorbic acid, beta-carotene, serum zinc, and selenium. "A high proportion of inadequate serum retinol (20.8%), vitamin C (27%), and selenium (73.6%) was observed in the patients with NAFLD, in addition to a significant inadequacy of vitamin A (98.3%) and vitamin E (100%) intake." Those with advanced liver fibrosis had reduced levels of serum retinol. Overall, "NAFLD patients showed an important serum deficiency and insufficient dietary intake of the evaluated micronutrients (Coelho et al., 2020)."

Guidelines and Recommendations:

No studies evaluating the accuracy or clinical utility of intracellular micronutrient testing compared to standard testing for vitamin or mineral levels were identified. In addition, no controlled studies that evaluated changes to patient management or health impact of intracellular micronutrient testing were identified. Limited data are available on correlations between serum and intracellular micronutrient levels. Intracellular micronutrient analysis was not included in reviews on micronutrient analysis (Elmadfa & Meyer, 2014; Raghavan, Ashour, & Bailey, 2016).

No recommendations or practice guidelines recommending intracellular micronutrient testing were identified in a literature search.

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: http://www.cms.gov/medicare-coverage-database/overview-and-quick-search.aspx. For the most up-to-date Medicaid policies and coverage, visit the applicable state Medicaid website.

Food and Drug Administration (FDA)

Intracellular micronutrient testing is offered by companies SpectraCell, IntraCellular Diagnostics, and Cell Science Systems Corporation which have Clinical Laboratories Improvement Amendments (CLIA) accredited laboratories. SpectraCell's micronutrient panel test, the IntraCellular Diagnostics ExaTest, Genova Diagnostic's NutrEval FMV, and the Cell Science Systems Cellular Micronutrient Assay (CMA) have not been through the FDA approval process. Additionally, 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). As an LDT, the U. S. Food and Drug Administration has not approved or cleared this test; however,

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FDA clearance or approval is not currently required for clinical use.

Applicable CPT/HCPCS Procedure Codes:

CPT	Code Description
82128	Amino acids; multiple, qualitative, each specimen
82136	Amino acids, 2 to 5 amino acids, quantitative, each specimen
82180	Ascorbic acid (vitamin c), blood
82310	Calcium; total
82379	Carnitine (total and free), quantitative each specimen
82495	Chromium
82525	Copper
82607	Cyanocobalamin (Vitamin B-12);
82652	Vitamin D; 1, 25 dihydroxy, includes fraction(s), if performed
82725	Fatty acids, nonesterified
82746	Folic acid; serum
82978	Glutathione
83735	Magnesium
83785	Manganese
84207	Pyridoxal phosphate (vitamin b-6)
84252	Riboflavin (vitamin b-2)
84255	Selenium
84425	Thiamine (vitamin b-1)
84446	Tocopherol alpha (Vitamin E)
84590	Vitamin A
84591	Vitamin, not otherwise specified
84597	Vitamin K
84630	Zinc
86353	Lymphocyte transformation, mitogen (phytomitogen) or antigen induced blastogenesis
88348	Electron microscopy, diagnostic

Procedure codes appearing in Medical Policy documents are included only as a general reference tool for each policy. They may not be all-inclusive.

Evidence-based Scientific References:

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Revision History

Company(ies)	DATE	REVISION
EmblemHealth ConnectiCare	11/2022	• Reformatted and reorganized policy, transferred content to new template with new Reimbursement Policy Number