

## Acetyl-L-carnitine

ALC has become one of the most studied compounds for its anti-aging effects, particularly with regard to degeneration of the brain and nervous system.

Acetyl-L-Carnitine is an amino acid the body uses to turn fat into energy. It is not normally considered an essential nutrient because the body can manufacture all it needs. However, supplemental carnitine may improve the ability of certain tissues to produce energy. This effect has led to the use of carnitine in various muscle diseases as well as heart conditions. Acetyl-L-carnitine is a natural substance found in the body. Acetyl-L-carnitine is an amino acid produced by every cell in the body. L-carnitine is a vitamin-like nutrient that is found in the heart, brain and skeletal muscles. Acetyl-L-Carnitine is a derivative of the amino acid, carnitine. Its primary job is to transport fatty acids across the cell wall to the mitochondria, the powerhouse of the cell, providing heart and skeletal cells with energy. It helps with neurotransmitter metabolism, and is necessary for normal neuron and brain function. Acetyl-L-carnitine crosses the blood brain barrier and provides the brain with more energy. It too can act as an antioxidant in the brain and protect the cell's energy factories, the mitochondria.

ALC is composed of acetic acid and L-carnitine bound together. The acetyl component of acetyl-L-carnitine provides for the formation of the neurotransmitter acetylcholine.

Some people have dietary deficiencies of carnitine or cannot properly absorb this nutrient from foods that they eat. Carnitine deficiencies may be caused by genetic disorders, liver or kidney problems, high-fat diets, certain medications, and low dietary levels of the amino acids lysine and methionine (substances needed to make carnitine). Carnitine deficiencies may cause symptoms such as fatigue, chest pain, muscle pain, weakness, low blood pressure, and/or confusion. A healthcare provider may recommend use of the supplement

levocarnitine (L-carnitine) for individuals who have a suspected or confirmed deficiency of this nutrient.

According to European studies, it appears to slow down the mental deterioration that accompanies Alzheimer's. In other words, perhaps the reason why ALC supplementation is so beneficial to Alzheimer's patients is because they are deficient in L-carnitine in the first place.

Acetyl-L-carnitine may offer unprecedented hope for people suffering from Alzheimer's disease or the aftereffects of a stroke. The human brain is uniquely powerful and complex, but it is sometimes difficult for it to fully recover from damage. People who have been affected by stroke, traumatic brain damage or age-associated dementia know this all too well. Fortunately, research studies suggest that the vitamin-like nutrient L-carnitine may be able to slow down, or even reverse, brain deterioration. Plus, it may give people the ability to think clearer and remember things like, "Where did I put my keys?"

If you are worried about developing Alzheimer's disease, Parkinson's disease or age-associated dementia, studies suggest that acetyl-L-carnitine (ALC) may delay the onset of the disease. Acetyl-L-carnitine is unique in its ability to provide a number of important protective functions. It has been shown to reduce the amount of an age pigment in the brain called lipofuscin.

Furthermore, if you have already been diagnosed with Alzheimer's, ALC can help slow down its progression and improve your mental functioning. In fact, experimental and clinical studies demonstrate that ALC may have a "significant capacity to slow and even reverse, the effects of aging on the brain," writes Dr. Russell L. Blaylock in *Health and Nutrition Secrets*. Results of this study showed that acetyl-L-carnitine may be effective in ameliorating receptor functionality in the aging brain due to its ability to preserve the receptor-mediated functional ACH release response.

Other examples of pro-drugs are alpha-lipoic acid and acetyl-L-carnitine. Research shows it can augment the body's healing mechanisms, as well as prevent and improve symptoms and disease for a wide range of conditions, including diabetes, neuropathy (nerve damage), liver disease, hypertension, hearing loss, and nerve damage in the brain associated with conditions such as Parkinson's disease. Elderly subjects with the highest depression scores are usually the ones who benefit the most from acetyl-L-carnitine. Results of this double-blind, placebo-controlled study showed that acetyl-L-carnitine had significant positive effects on memory and cognitive performance tasks in elderly patients with cerebrovascular insufficiency.

### **How exactly does ALC work?**

Dr. Ray Sahelia believes that Alzheimer's patients may benefit from ALC in three ways:

- It is able to travel through the blood-brain barrier, where it then helps form the brain chemical acetylcholine;
- It keeps mitochondria working efficiently by clearing them of toxic fatty-acid metabolites;
- It helps regenerate neurons damaged by free radicals.

The results of numerous research studies support Dr. Sahelia's theory, including electron microscope analysis of the hippocampus region of the brain, which demonstrated ALC's ability to reverse the age-related deterioration of mitochondria. Electron microscopic studies in the hippocampus region of the brain showed that acetyl-L-carnitine and lipoic acid reversed age-associated mitochondrial structural decay. L-carnitine was able to reverse much of the damage inflicted to brain cells by free radicals, which is typical of the kind of damage seen in the brains of Alzheimer's patients. Furthermore,

according to Professor Gary Null, autopsies show that people who had Alzheimer's experienced 25 to 40 percent less ALC transferase activity than people without Alzheimer's. Acetyl-L-carnitine also may stave off the protein deposits that develop in the brains of early-stage Alzheimer's patients. Scientists theorize that it boosts energy production in the brain, improves function in the brain's glutamate receptors, which are responsible for learning, and may stop the formation of lipofuscin, a kind of "age spot" of the neurons that can interfere with memory.

Of course, the benefits of ALC's ability to regenerate lost brain function extend far beyond Alzheimer's disease, making it a promising treatment for victims of stroke as well. If it is administered to stroke victims soon after the stroke occurs, ALC may actually reduce the level of brain damage caused by the interrupted blood flow, according to an Italian animal study reported in Dr. Russell L. Blaylock's Health and Nutrition Secrets. But even if it was not possible to give a patient ALC soon after the stroke first occurred, ALC supplementation may help the patient improve memory, task performance and cognition during the road to recovery. Furthermore, ALC may even be able to help people with Down's syndrome, even though it is a congenital disease, rather than an age- or trauma-related one. Results of this study showed significant improvement in visual memory and attention in Down's Syndrome patients relative to controls following treatment with acetyl-L-carnitine for 90 days. Acetyl-L-carnitine has also been shown to regenerate nerves (Fernandez et al. 1997); provide protection against glutamate and ammonia-induced toxicity to the brain (Rao et al. 1999); and to reverse the effects of heart aging in animals (Paradies et al. 1999). Carnitine is primarily used for heart-related conditions. Some evidence suggests that it can be used along with conventional treatment for angina, to improve symptoms and reduce medication needs. When combined with conventional therapy, it may also reduce mortality rates after a heart attack as well as congestive heart failure.

In addition, a few studies suggest that carnitine may be useful for cardiomyopathy.

### **Can Acetyl-L-Carnitine boost brain function?**

If ALC supplements can help normalize the mental activity of people with neurological damage or deterioration, can it boost the brainpower of anyone? Many experts have asked the same question. In *Mind Boosters*, Dr. Sahelia writes: “Acetyl-L-carnitine is an antioxidant involved in energy utilization within cells. A dose of 500 mg in the morning before breakfast works within two to three hours to induce a pleasant visual and mental clarity.” Similarly ALC can “jump-start” the brain, and Dr. Blaylock believes that ALC improves spatial learning, long-term memory and discriminatory learning. Given the fact that the acetyl component of ALC is an important neurotransmitter and L-carnitine itself helps increase cell energy, it is not illogical to believe that ALC may offer mental-boosting effects, but experts’ opinions are not unanimous. For example, *Textbook of Natural Medicine* authors Joseph E. Pizzorno and Michael T. Murray report that ALC supplementation may only be beneficial to people who are actually deficient in L-carnitine, such as people with age-associated mental deterioration. Study showed that acetyl-L-carnitine administered at high levels can have positive effects on the release of amino acids as well as neurotransmitters such as dopamine and acetylcholine in the brain. This amino acid (protein building block) enhances brain energy, helping to improve mood and reduce the effects of age-associated memory impairment. With L-carnitine, people have a resource that helps them fight fatigue and improve mental performance.

### **How much ALC should be taken?**

There is no dietary dosage requirement for L-carnitine. However, a few individuals have a genetic defect that hinders the body’s ability to make L-carnitine. In addition, diseases of the liver, kidneys, or brain

may inhibit carnitine production. Heart muscle tissue, because of its high energy requirements, is particularly vulnerable to carnitine deficiency. Certain medications, especially the antiseizure drugs valproic acid and phenytoin, may also reduce carnitine levels in the body.

A natural substance acetyl-L-carnitine, which resembles amino acids are found in **dairy foods, kidney beans, eggs, and red meats** (particularly lamb) and dairy products are the primary sources of carnitine. Carnitine can also be found in fish, poultry, fermented soybeans, wheat, asparagus, avocados, and peanut butter. Cereals, fruits, and vegetables contain little or no carnitine.

Because scientists do not know the long-term health effects of taking ALC in large doses, Dr. Elson Haas cautions, “This is basically safe and can be taken over an extended period, although it probably should be stopped for one week each month, until its long-term safety as a supplement is more clearly established.”

According to the PDR for Nutritional Supplements, a typical dose is 500 milligrams to two grams, taken daily in two divided doses. If you currently suffer from age-associated mental impairment, such as poor memory, Professor Null recommends that you take one to two grams of ALC daily for no more than 90 days in order to see improvement without any possible long-term health risks. When taken in these controlled doses, ALC supplementation may prove helpful, especially if you are currently experiencing dementia or even just “brain fog.” Always be sure that the form being used is L-carnitine alone or bound to either acetic or propionic acid. For Alzheimer's disease and brain defects, it appears that Acetyl-L-carnitine (LAC) may provide the greatest benefit. Studies suggest that mental deterioration in Alzheimer's patients can be slowed by supplementation of **Iron, vitamins B6 and B12, coenzyme Q10, acetyl-L-carnitine, Alpha-lipoic acid, Niacin amide, and Creatine monohydrate.**

## **Pediatric**

If laboratory tests reveal that a child has an amino acid imbalance requiring treatment, a healthcare provider may recommend a complete amino acid supplement containing carnitine. For children on valproate for epilepsy, which can lead to a deficiency of carnitine, the doctor will likely prescribe a dose of 100 mg/kg of body weight per day, not to exceed 2,000 mg per day.

## **Adult**

Recommended doses of L-carnitine supplements vary depending on the health condition being treated. The following list provides guidelines for some of the most common uses, based largely on doses used in studies for these conditions:

- Fat metabolism (conversion of fat to energy) and muscular performance: 1,000 to 2,000 mg usually divided into two doses.
- Heart disease: 600 to 1,200 mg three times daily, or 750 mg twice daily
- Alcohol-related carnitine deficiency: 300 mg three times daily
- Male infertility: 300 to 1,000 mg three times daily
- Chronic fatigue syndrome: 500 to 1,000 mg three to four times per day
- Overactive thyroid: 2,000 to 4,000 mg per day in two to four divided doses

Acetyl-L-carnitine can aid in the formation of the neurotransmitter acetylcholine, which we know plays a vital role in memory. Use of Acetyl-L-carnitine and alpha-lipoic acid in testing memory it was found that both nutrients improved memory, but the combination of both was the most effective.

Although acetyl-L-carnitine generally has only few or mild side effects, it can interfere with several medications, including **anticoagulants, anticonvulsants, cephalosporins, penicillin derivatives, zidovudine and valproic acid.**

Carnitine is taken in three forms: L-carnitine (for heart and other conditions), propionyl-L-carnitine (for heart conditions), and acetyl-L-carnitine (for Alzheimer's disease). The dosage is the same for all three forms.

A massive body of published scientific research indicates that one can take steps to boost cognitive function today, while simultaneously reducing the risk of Alzheimer's disease, stroke, and other degenerative brain diseases. When used properly, nutrients enhance mental function. Anything that increases brain energy production will reduce toxicity.

## **Angina**

Carnitine might be a good addition to standard therapy for angina. In one controlled study, 200 individuals with angina (the exercise-induced variety) took either 2 g daily of L-carnitine or were left untreated. All the study participants continued to take their usual medication for angina. Those taking carnitine showed improvement in several measures of heart function, including a significantly greater ability to exercise without chest pain.<sup>70</sup> They were also able to reduce the dosage of some of their heart medications (under medical supervision) as their symptoms decreased. Another trial that did use a double-blind, placebo-controlled design tested L-carnitine in 52 individuals with angina, and found evidence of benefit. In addition, several small studies (some of them double-blind) tested propionyl-L-carnitine for the treatment of angina, and also found evidence of benefit.

## **High Cholesterol**

In several studies, people who took L-carnitine supplements had a significant lowering of their total cholesterol and triglycerides, and an increase in their HDL ("good") cholesterol levels.

## **Diabetics**



## Acetyl-L-Carnitine Improves Pain, Nerve Regeneration, and Vibratory Perception in Patients with Chronic Diabetic Neuropathy.

**OBJECTIVE**—Evaluated frozen databases from two 52-week randomized placebo-controlled clinical diabetic neuropathy trials testing two doses of acetyl-L-carnitine (ALC): 500 and 1,000 mg/day.

**RESEARCH DESIGN AND METHODS**— Intention-to-treat patients amounted to 1,257 or 93% of enrolled patients. Efficacy end points were sural nerve morphometry, nerve conduction velocities, vibration perception thresholds, clinical symptom scores, and a visual analogue scale for most bothersome symptom, most notably pain. The two studies were evaluated separately and combined.

**RESULTS**—Data showed significant improvements in sural nerve fiber numbers and regenerating nerve fiber clusters. Nerve conduction velocities and amplitudes **did not improve**, whereas vibration perception improved in both studies. Pain as the most bothersome symptom showed significant improvement in one study and in the combined cohort taking 1,000 mg ALC.

**CONCLUSIONS**—These studies demonstrate that ALC treatment is efficacious in alleviating symptoms, particularly pain, and improves nerve fiber regeneration and vibration perception in patients with established diabetic neuropathy.

### Multiple Sclerosis

Some research suggests that acetyl-L-carnitine may improve fatigue associated with multiple sclerosis (MS).

Acetyl-L-carnitine is a form of L-carnitine, an amino acid that is found in nearly all cells of the body. L-carnitine plays a critical role in the production of energy from long chain fatty acids. In addition, it increases the activity of certain nerve cells in the central nervous system.

Fatigue is a common symptom in people with multiple sclerosis. The cause is not well understood. A study published in 2006 evaluated the benefit of supplementation with L-carnitine in people with MS-related fatigue who had low blood levels of L-carnitine. Study

participants were given 3 to 6 grams of oral L-carnitine daily. Researchers reported a decrease in fatigue intensity in 63 percent of participants treated with immunosuppressive drugs, especially in those treated with cyclophosphamide and interferon beta.

### **Chronic Obstructive Pulmonary Disease (COPD)**

Evidence from three double-blind placebo-controlled studies enrolling a total of 49 individuals suggests that L-carnitine can improve exercise tolerance in COPD, presumably by improving muscular efficiency in the lungs and other muscles.

### **Hyperthyroidism**

Enlargement of the thyroid (goiter) can be due to many causes, including cancer and iodine deficiency. In some cases, thyroid enlargement occurs without any known cause, so-called benign goiter.

Treatment of benign goiter generally consists of taking thyroid hormone pills. This causes the thyroid gland to become less active, and the goiter shrinks. However, there may be undesirable effects as well. Symptoms of hyperthyroidism (too much thyroid hormone) can develop, including heart palpitations, nervousness, weight loss, and bone breakdown.

A double-blind, placebo-controlled trial found evidence that use of L-carnitine could alleviate many of these symptoms. This 6-month study evaluated the effects of L-carnitine in 50 women who were taking thyroid hormone for benign goiter. The results showed that a dose of 2 or 4 g of carnitine daily protected participants' bones and reduced other symptoms of hyperthyroidism.

Carnitine is thought to affect thyroid hormone by blocking its action in cells. This suggests a potential concern: Carnitine might be harmful for people who have low or borderline thyroid levels to begin with. This possibility has not been well explored as yet.

## **Weight Loss**

Although L-carnitine has been marketed as a weight loss supplement, there is no scientific evidence to date to show that it improves weight loss. A recent study of moderately overweight women found that L-carnitine did not significantly alter body weight, body fat, or lean body mass. Based on the results of one small study, claims that L-carnitine helps reduce weight are not supported at this time.

## **Eating Disorders**

Several studies suggest that amino acid levels, including carnitine, are diminished in people with anorexia nervosa. Some experts believe that low levels of carnitine contribute to muscle weakness frequently seen in people with this eating disorder. However, one study of severely underweight women with anorexia found that carnitine supplements did not raise levels of this amino acid in the blood nor did it improve muscle weakness.

## **Alcohol-related Liver Disease**

Some researchers speculate that alcohol consumption reduces the ability of carnitine to function properly in the body. This can lead to a buildup of fat in the liver. Supplementation with carnitine has been shown to prevent and reverse the damage caused by alcohol-induced fatty buildup in the liver of animals.

## **Down's Syndrome**

In a study of individuals with Down syndrome, L-acetylcarnitine (LAC) supplementation significantly improved visual memory and attention.

## **Kidney Disease and Hemodialysis**

Given that the kidney is a major site of carnitine production, damage to this organ can cause a significant carnitine deficiency. Many patients undergoing hemodialysis also experience carnitine

deficiencies. For these reasons, individuals with kidney disease (with or without the need for hemodialysis) may benefit from carnitine supplementation.

### **Male Infertility**

Low sperm counts have been linked to low carnitine levels in men. Several studies suggest that L-carnitine supplementation may increase sperm count and mobility.

### **Chronic Fatigue Syndrome (CFS)**

Some researchers speculate that chronic fatigue syndrome may be caused by deficiencies in a variety of nutrients, including carnitine. L-carnitine has been compared to a medication for fatigue in a study of 30 people with CFS. Those who took L-carnitine did much better than those who took the medication, particularly after receiving the supplement for 4 to 8 weeks.

### **Shock**

Carnitine (administered intravenously in the hospital) may be helpful in treating shock from loss of blood, a sizeable heart attack, or a severe infection of the bloodstream known as sepsis. In one study, acetyl-L-carnitine helped improve the condition of 115 people with septic, cardiac, or traumatic shock.

Shock is a failure of the circulatory system and is a life-threatening medical emergency. Its key feature is inadequate blood flow to vital organs in the body. Therefore, if carnitine were used for this condition, it would, again, be administered in the hospital along with many other essential conventional therapies.

### **Other Diseases**

Lesser evidence suggests that it may be helpful for a condition called intermittent claudication (pain in the legs after walking due to narrowing of the arteries), Carnitine may also be helpful for

improving exercise tolerance in people with chronic pulmonary obstruction disease (COPD), more commonly known as emphysema.

One study found evidence that acetyl-L-carnitine is helpful for Peyronie's disease, a condition affecting the penis.

A genetic condition called fragile X syndrome can cause behavioral disturbances such as hyperactivity, along with mental retardation, autism, and alterations in appearance. A preliminary study of 17 boys found that acetyl-L-carnitine might help to reduce hyperactive behavior associated with this condition.

Additionally, a preliminary study suggests that carnitine may be useful for improving blood sugar control in individuals with type 2 diabetes. It also might help prevent diabetic cardiac autonomic neuropathy (injury to the nerves of the heart caused by diabetes). Weak evidence suggests that carnitine may be able to improve cholesterol and triglyceride levels, and also help individuals with degeneration of the cerebellum (the structure of the brain responsible for voluntary muscular movement). One very small study suggests carnitine may be helpful for reducing symptoms of chronic fatigue syndrome. One study suggests that carnitine may be of value for treating hyperthyroidism.

Uncontrolled studies suggest that L-carnitine or acetyl-L-carnitine may be helpful for improving sperm function. Weak evidence also suggests that carnitine may be helpful for decreasing the toxicity of AZT (a drug used to treat AIDS).

Carnitine is widely touted as a physical performance enhancer, but there is no real evidence that it is effective and some research indicates that it does not work. Little to no evidence supports other claimed benefits such as treating irregular heartbeat, Down's syndrome, muscular dystrophy, and alcoholic fatty liver disease.

**Warning:**

You should not attempt to self-treat any of the serious medical conditions, nor should you use carnitine as a substitute for standard drugs. Take the advice of a qualified physician, preferably one who is familiar with orthomolecular approach to treatment.

Although L-carnitine does not appear to cause significant side effects, high doses (5 or more grams per day) may cause diarrhea. Other rare side effects include increased appetite, body odor, and rash.

D-carnitine supplements should be avoided as they interfere with the natural form of L-carnitine and may produce undesirable side effects. L-carnitine in its three forms appears to be quite safe. However, individuals with low or borderline-low thyroid levels should avoid carnitine because it might impair the action of thyroid hormone.

Individuals on dialysis should not receive this (or any other supplement) without a physician's supervision. The maximum safe dosages for young children, pregnant or nursing women, or those with severe liver or kidney disease have not been established.

### **Possible Interactions**

If you are currently being treated with any of the following medications, you should not use carnitine without first talking to your healthcare provider.

#### **AZT**

In a laboratory study, L-carnitine supplements protected muscle tissue against toxic side effects from treatment with AZT, a medication used to treat human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS). Additional studies are needed to confirm whether L-carnitine would also have this effect in people.

#### **Doxorubicin**

Treatment with L-carnitine may protect heart cells against the toxic

side effects of doxorubicin, a medication used to treat cancer, without reducing the effectiveness of this chemotherapy agent.

### **Isotretinoin**

Isotretinoin, a strong medication used for severe acne, can cause abnormalities in liver function, measured by a blood test, as well as elevations in cholesterol and muscle pain and weakness. These symptoms are similar to those seen with carnitine deficiency. Researchers in Greece showed that a large group of people who had side effects from isotretinoin got better when taking L-carnitine compared to those who took a placebo.

### **Valproic Acid**

The anticonvulsant medication valproic acid may lower blood levels of carnitine and can cause carnitine deficiency. Taking L-carnitine supplements may prevent deficiency and may also reduce the side effects of valproic acid.

Further research into this scope of ALC's benefits should be promising.