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FEB/MARCH 2017

ISSUE #403/404 | \$8.25



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# Optimizing Metabolism

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## Carnitine Supplementation in Clinical Practice

This month is *Townsend Letter's* biannual "Best of Naturopathic Medicine." Prompted by this theme, I asked myself, "What nutrient could be more fully utilized to improve clinical outcomes?" Here I present my rationale for selecting the nutrient L-carnitine. I begin by describing a rare heritable condition and why it is relevant to integrative medicine. Then I interview two practitioners, one who has expanded the carnitine-responsive disease conditions and another who has expanded the therapeutic options.

### Brief Background on L-carnitine

L-carnitine's primary metabolic role is to transport long-chain fatty acids across cells' inner mitochondrial membrane for ATP synthesis. Also called carnitine or levocarnitine, this nutrient, concentrated in animal protein, derives its name from the Latin word for meat, *carne*. Since the human body can make carnitine, it is not considered an essential nutrient even though diet is a primary source. However, in some clinical circumstances, carnitine is insufficient for the body's needs.

### Primary Carnitine Deficiency

Allopathic medicine unanimously agrees that carnitine is insufficient for the body's needs for at least one medical condition, primary carnitine deficiency. It is genetic, inherited as an autosomal-recessive mutation of the transport protein that shuttles carnitine into cells. Plasma levels of carnitine are low, and carnitine wasting elevates concentration in the urine. Clinical manifestations include muscle weakness, especially cardiac muscle leading to cardiomyopathies; hypoglycemia without ketone production; and, sometimes, encephalopathy from buildup of fatty acids. The treatment is high-dose supplemental carnitine, lifelong, or until gene therapy is available.

I came to appreciate the clinical significance of this inborn error of metabolism when asked to review the hospital record of a child with primary carnitine deficiency. The admitting diagnosis for the three-day hospitalization had been gastroenteritis. A closer chart review demonstrated that the hospitalization was for parenteral carnitine and the intravenous fluids with dextrose. The patient was closely observed for signs of hypoglycemia, cardiac arrhythmias, and encephalopathy. The diagnosis was therefore revised to reflect treatment of a heritable metabolic condition.

Primary carnitine deficiency was identified relatively recently in the 1980s. While now the condition is included in the newborn genetic screening, some teens and adults remain undiagnosed even when symptomatic. This implies that clinicians aware of primary carnitine deficiency could make a life-saving diagnosis.

### Symptoms with Carrier State, More Information Needed

Primary carnitine deficiency prompts another question. Since the trait is autosomal recessive, both parents would have a mutation. Do carriers have lower than average plasma carnitine levels; and if so, do they also benefit from carnitine supplementation? I believe these questions merit public health consideration, discourse which I have not been able to locate in scientific publications.

### Secondary Carnitine Deficiency

A genetic mutation is not required to have low plasma carnitine or to benefit from carnitine supplementation. While, in primary carnitine deficiency, low levels of plasma carnitine cause disease, in many clinical conditions carnitine deficiency has been demonstrated to result from disease. Secondary

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causes include medications such as valproate; kidney and liver diseases; and dietary insufficiency from carnitine-lacking TPN and some soy infant formulas.

One of my patients in an orthopedics' clinic had high triglyceride levels and adverse effects from lipid-lowering drug therapies. When she began taking L-carnitine to help lower triglycerides her pain reduced notably, and she needed less medication. At the time her physical medicine doctor and I were not able to identify the biochemical mechanism by which carnitine would reduce pain.

A PubMed search today would provide several mechanisms by which carnitine can reduce pain, especially neuropathic pain. Dr. Michael Gonzalez explains carnitine's role in mitochondrial function. He described this process of metabolic correction in the July 2016 *Townsend Letter*.

## Dr. Mark Houston on Secondary Carnitine Deficiency

I asked integrative cardiologist Mark C. Houston, MD, MS, about the clinical use of L-carnitine. His immediate reply was "It's very important for heart muscle!" Recently a number of his patients with severe congestive heart failure improved to the point that they went off the cardiac transplant list. He attributes this profound clinical result largely to the combined use of L-carnitine, D-ribose, L-aurine and coenzyme Q 10. These combined nutrients maximize ATP production and, in this way, treat the cardiomyopathy underlying some causes of congestive heart failure. Less well-described is their antiarrhythmic potential. Heart rate variability is influenced by the balance and function of the sympathetic and parasympathetic nervous systems. L-carnitine and taurine as well as other nutrients such as magnesium help support the parasympathetic response, thereby reducing the likelihood of fatal arrhythmias and heart attacks.

## Safety Considerations for L-carnitine

The safety profile of nutrient supplements can be found on Daily Med, a website of the federal government (<https://dailymed.nlm.nih.gov/dailymed/>). When I searched "carnitine" on Daily Med in November 2016, 46 carnitine-containing products were listed.

Formulations of L-carnitine include those with FDA-approved prescription drug labels. These are prescription supplements and injections for the indication of primary carnitine deficiency. Also listed on Daily Med are homeopathic products, topical skin care products, and various dietary supplements.

I urge practitioners recommending levocarnitine oral supplements to their patients to refer to the FDA drug label found on Daily Med. While there are no warnings or known contraindications, carnitine may interact with other medications such as warfarin. A precaution is listed for patients with renal insufficiency since toxic amine metabolites of carnitine are excreted in the urine. The list of reported adverse

effects is strikingly short but, as always, is important to note: <https://dailymed.nlm.nih.gov/dailymed/>.

## A Personal Journey: Lorri Franckle on Pioneering a Carnitine-Containing Functional Beverage

### Q: Why L-carnitine?

Franckle: I benefitted from using L-carnitine personally nineteen years ago when I developed a serious medical condition and mainstream medicine didn't have much to offer. I was prescribed antibiotics indefinitely and was recommended a diet of bread and meat. Dissatisfied with this plan for my personal health, in the back of my mind I wondered what alternatives might be available. Then between cases in the operating room, I flipped through a medical journal. A nutritional products company was hiring health professionals, a career I chose largely to benefit my personal health. With carnitine supplementation as part of my personalized nutrition program, the medical condition didn't recur.

### Q: Why choose a beverage to administer carnitine?

Franckle: The feedback I received from doctors in my capacity with nutritional product and diagnostic companies sparked the idea. I consistently heard that their patients want fewer pills and more therapeutic foods (and beverages). And athletes like to vary their sports beverages without introducing extra calories. Hydration is important especially in Florida where I live, especially during a workout; and exercise utilizes carnitine to metabolize fat.

### Q: What were the challenges in developing a drink with carnitine and ribose as active ingredients?

Franckle: Good taste without sugar, artificial sweeteners, or excess calories is the food and beverage industry's big challenge. Here, there was good synergy: Carnitine is tart like lemons and ribose (the other active ingredient) is sweet. So I suppose I took the advice literally about lemons and turned carnitine and ribose into a beverage that tastes similar to lemonade. Foremost I wanted to make sure the product was true to the science and medical research. The citations which most influenced the product development are available on [www.FatToEnergy.com/Science](http://www.FatToEnergy.com/Science).

## In Summary

Even though carnitine is a dietary supplement rather than a pharmaceutical drug, some formulations of carnitine are approved by the FDA as a medication for the indication of primary carnitine deficiency. Scientific research accompanied by the clinical experience of leading integrative physicians suggests an expanding number of clinical conditions associated with secondary carnitine deficiency. New formulations of carnitine, including a functional beverage, are now available to integrative physicians and their patients. ♦