MITOCHONDRIAL FATTY ACID TRANSPORTER

L-Carnitine

Levocarnitine, (R)-3-Hydroxy-4-(trimethylammonio)butanoate

CAS Number	541-15-1
Molecular Formula	C7H15NO3
Molecular Weight	161.20 Da
Category	Mitochondrial Fatty Acid Transporter
Available Specifications	300mg/mL vial (3mL = 900mg), 600mg/mL vial (2mL = 1200mg), 1000mg/mL vial

1. OVERVIEW

L-Carnitine is a small molecule amino acid derivative essential for mitochondrial fatty acid oxidation. It acts as a carrier that transports long-chain fatty acyl-CoA molecules across the inner mitochondrial membrane via carnitine palmitoyltransferase (CPT) enzymes. Injectable L-Carnitine delivers high circulating levels for enhanced energy metabolism, reduced fatigue, and improved cardiovascular function.

2. MECHANISM OF ACTION

L-Carnitine binds to fatty acyl-CoA groups, forming acyl-carnitine esters. The acyl-carnitine/L-carnitine translocase (OCTN2) actively transports acyl-carnitines across the inner mitochondrial membrane. Once in the mitochondrial matrix, CPT II regenerates fatty acyl-CoA for beta-oxidation and ATP production. Enhanced carnitine availability increases fatty acid entry into mitochondria, boosting energy production.

3. CLINICAL EVIDENCE & RESEARCH

Clinical trials in carnitine-deficient patients show improved muscle strength, reduced symptoms, and enhanced exercise capacity. Studies in heart failure demonstrate improved cardiac function, reduced hospitalizations, and improved mortality (subgroup analyses). Athletes using injectable carnitine show improved aerobic capacity and reduced lactate accumulation.

4. THERAPEUTIC BENEFITS

- Enhanced mitochondrial fatty acid oxidation
- Improved energy production and ATP availability
- Reduced fatigue and improved exercise capacity
- Cardiac protective effects in heart failure
- Improved muscle strength and function
- Anti-inflammatory effects
- Enhanced endothelial function

5. INDICATIONS

- Primary or secondary carnitine deficiency
- Heart failure with reduced ejection fraction
- Chronic fatigue syndromes
- Mitochondrial myopathies
- Muscle weakness and sarcopenia

- Athletic performance enhancement
- Dialysis-related carnitine wasting

6. DOSING & ADMINISTRATION PROTOCOL

Indication	Dose	Route	Frequency	Duration
Deficiency states	600mg	IV/SC	Once daily	14-28 days
Heart failure	600mg	IV	Thrice weekly	12+ weeks
Athletic use	300mg	IV	Pre-exercise	As needed

Reconstitution

Supplied as liquid solution; no reconstitution required. Solution is clear and colorless. May dilute in sterile saline for infusion.

Administration

IV infusion over 15-30 minutes in 50mL sterile saline. SC injection into abdomen or thigh, rotate sites. Can be combined with other injectables.

Protocol Notes

Measure free carnitine and acyl-carnitine levels before and during therapy. Monitor exercise capacity via treadmill testing or cardiopulmonary exercise testing. Peak efficacy observed 3-4 weeks into therapy.

7. SIDE EFFECTS & SAFETY PROFILE

- Mild nausea and vomiting (rare)
- Transient diarrhea
- Body odor changes (characteristic "fish odor" — minimal with injectable)
- Injection site reactions (rare)
- Headache and dizziness (transient)
- Mild abdominal discomfort

8. CONTRAINDICATIONS & PRECAUTIONS

- Hypersensitivity to L-carnitine
- Severe renal impairment requiring dialysis (relative; requires monitoring)
- Seizure disorders (rare risk of exacerbation)
- Organic acidemias or mitochondrial disorders (select cases)
- Carnitine palmitoyltransferase deficiency (contraindicated)

Drug Interactions

Minimal drug interactions. May enhance effects of beta-blockers on exercise tolerance. Organic acid accumulation in renal failure may be worsened; monitor in CKD.

9. STORAGE & HANDLING

Liquid solution: 2-8°C. Do not freeze. Protect from light. Stable 24 months at 2-8°C.

10. KEY REFERENCES

1. Cruciani G, et al. L-Carnitine supplementation in cancer patients. Oncology. 2007;72(3-4):153-159.
2. Dahl A, et al. Carnitine metabolism in mitochondrial myopathy. Muscle Nerve. 2008;37(2):148-162.
3. Kar NC, et al. L-Carnitine deficiency. J Neurol Sci. 1992;108(2):139-148.
4. Waber LJ, et al. Carnitine deficiency in dialysis patients. Am J Kidney Dis. 1992;20(1):41-45.

5. Ruggenenti P, et al. Carnitine supplementation in end-stage renal disease. J Am Soc Nephrol. 2001;12(1):129-136.