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Intravenous longevity therapy: a critical review of evidence, mechanisms, and clinical utility

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Abstract

Intravenous administration of high-dose vitamins, minerals, amino acids, coenzyme Q_{10}, α-lipoic acid, glutathione, and nicotinamide adenine dinucleotide has emerged as a popular longevity therapy, targeting key molecular processes, oxidative stress, mitochondrial decline, chronic inflammation, and genomic instability, which drive and accelerate aging. The rationale is that intravenous administration facilitates supraphysiological plasma concentrations, bypassing gastrointestinal absorption limitations to more effectively target these age-promoting mechanisms. Evidence from preclinical models and small clinical series reports transient reductions in oxidative biomarkers, modest improvements in fatigue syndromes, and anecdotal enhancements in skin elasticity. However, these findings are predominantly derived from disease-specific or aesthetic contexts rather than studies involving healthy aging populations. Crucially, few studies incorporate validated biomarkers of aging such as epigenetic age or telomere length, and placebo-controlled trials are scarce and underpowered or they yield conflicting results. Additional challenges include pharmacokinetic limitations, procedural risks, and substantial heterogeneity of infusion protocols, all of which hinder reliable interpretation. Until rigorously designed, adequately powered randomized controlled trials demonstrate reproducible long-term efficacy and safety, intravenous longevity therapy should be regarded as an experimental intervention rather than an evidence-based dermatological or anti-aging practice.

Keywords: dermatology, glutathione infusion, intravenous longevity therapy, NAD^+ therapy, quality of life

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Introduction

The pursuit of interventions that attenuate physiological aging and extend lifespan has led to the rise of intravenous (IV) longevity therapy within clinical and aesthetic settings (1, 2). These formulations typically combine high-dose vitamin C, vitamin B complex, coenzyme Q_{10}, alpha-lipoic acid (ALA), reduced nicotinamide adenine dinucleotide (NADH), and glutathione (3–5). Advocates posit that IV delivery circumvents gastrointestinal barriers, achieving supraphysiological plasma concentrations and enhanced cellular uptake to counteract oxidative stress, mitochondrial dysfunction, and chronic inflammation, which are central mechanisms of cellular senescence (6, 7).

Aging is characterized by cumulative macromolecular damage, disrupted redox homeostasis, and declining mitochondrial bioenergetics (8, 9). In theory, rapid systemic administration of antioxidants and metabolic cofactors could restore intracellular pools, support sirtuin-mediated repair pathways, and rebalance redox status. Clinical data for IV vitamins and common antioxidants (e.g., vitamin C) demonstrate some short-term improvements in oxidative biomarkers and subjective wellbeing, but rigorous evidence remains sparse (10). Moreover, the purported benefits of NADH and glutathione IV therapy are supported primarily by small, uncontrolled studies or anecdotal reports, with no large-scale randomized trials confirming their efficacy in modifying validated aging biomarkers or improving long-term patient-centered outcomes (11).

The most common components in commercially available IV drips contain NADH and glutathione because they have a powerful anti-aging effect. NADH drives adenosine triphosphate (ATP) production via oxidative phosphorylation and regulates aging pathways through sirtuins and polymerase (PARP) enzymes, but IV use shows no proven benefits for longevity (12–14). Glutathione maintains redox balance, regenerates antioxidants, and aids detoxification, but clinical evidence for anti-aging effects of IV therapy remains weak (11, 15, 16).

This review provides a comprehensive analysis of the composition, molecular rationale, dosing strategies, and clinical outcomes of commercially available IV longevity formulations in the context of anti-aging efficacy and safety interventions. It assesses evidence from preclinical models and human studies, with particular attention to surrogates of redox balance, mitochondrial function, and subjective wellbeing, while critically appraising study design, sample size, and endpoint validity. Key limitations, such as heterogeneous infusion protocols, pharmacokinetic constraints, reliance on disease-specific or aesthetic cohorts, and the paucity of placebo-controlled trials using validated aging biomarkers, are highlighted (Table 1). Finally, priorities for rigorous, adequately powered randomly controlled trials (RCTs) in healthy aging populations are outlined to determine the true safety, efficacy, and clinical utility of IV longevity therapies.

Discussion

The increasing popularity of IV longevity therapy, typically comprising high-dose vitamins, antioxidants, NADH, glutathione, and other substances, reflects a growing interest in anti-aging medicine and personalized wellness interventions. Marketed as tools for enhancing energy, detoxification, and cellular repair, these infusions are widely used in aesthetic clinics and wellness practices. However, when evaluated through the lens of evidence-based medicine (EBM), the scientific foundation underpinning many of these

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claims is limited and, in several instances, speculative. The theoretical rationale for IV longevity therapy draws from well-established biological mechanisms. Aging is associated with oxidative stress, mitochondrial dysfunction, chronic inflammation, and genomic instability (6).

Nicotinamide adenine dinucleotide (NAD$^+$)

NADH functions as a critical coenzyme in mitochondrial oxidative phosphorylation, where it donates electrons to Complex I of the electron transport chain, driving ATP production (12). Beyond energy metabolism, NAD$^+$/NADH levels also regulate key cellular pathways linked to aging, including sirtuins and poly (ADP-ribose) PARP enzymes, which are involved in DNA repair, genomic stability, and metabolic signaling (13, 14).

An IV drip commonly used at longevity clinics is NAD$^+$. It is a key coenzyme in redox metabolism, DNA repair, and mitochondrial function, and its levels decline significantly during aging. This depletion has been linked to impaired cellular energy production and increased oxidative damage (14). IV NAD$^+$ therapy available at longevity drip centers in the United Kingdom (UK) ranges from 250 to 750 mg per infusion, and it is marketed as a way to restore systemic NAD$^+$ levels and improve vitality. Unlike oral precursors, IV administration bypasses hepatic metabolism, potentially achieving higher bioavailability. However, evidence for its anti-aging effects in healthy individuals remains limited.

Most studies to date have been conducted in disease-specific populations. For example, Castro-Marrero et al. reported that oral NADH combined with coenzyme Q$_{10}$ (CoQ$_{10}$) improved fatigue and quality of life in 73 patients with chronic fatigue syndrome in a randomized, placebo-controlled trial (17). Even though this suggests therapeutic potential in fatigued populations, it cannot be generalized to healthy individuals seeking longevity benefits. Observational data from lifestyle clinics indicate subjective improvements following IV NAD$^+$, but controlled trials are lacking, and findings from small cohorts remain inconsistent. Overall, although NAD$^+$ replenishment is biologically plausible as an anti-aging intervention and current evidence supports some benefit in fatigue-related conditions, there is insufficient evidence for routine use in healthy aging populations.

Glutathione

Glutathione, often referred to as the "master antioxidant," plays a central role in cellular redox balance by directly neutralizing reactive oxygen species (ROS), regenerating other antioxidants such as vitamins C and E, and supporting detoxification processes via glutathione peroxidase (15, 16). It is a critical intracellular antioxidant involved in detoxification, immune function, and protection against oxidative stress. It exists as reduced glutathione (GSH) and as oxidized glutathione (GSSG), maintaining redox balance in cells and neutralizing reactive oxygen species. Aging and chronic illness are associated with reduced glutathione levels, contributing to mitochondrial dysfunction and accelerated cellular damage. Intravenous glutathione, available at UK longevity centers in doses typically ranging from 600 to 1,200 mg per infusion, is used to rapidly elevate plasma glutathione levels, bypassing the degradation seen with oral supplementation.

Clinical evidence for IV glutathione use in anti-aging and dermatological therapy is modest. In a review by Weschawalit et al., a small clinical trial showed some improvement in skin elasticity and pigmentation reduction with oral glutathione (250 mg/day) use, particularly among Asian populations(18), but most studies involved oral or intramuscular administration (19). Furthermore,

Table 1 | Commercially available IV longevity formulations (online data from treatment centers across the United Kingdom).

Product name and recommended doses	Physiology	Supra-physiology	Efficacy	Side effects
NAD$^+$ (250–500 mg)	Central to redox reactions, DNA repair, sirtuin activation, mitochondrial function (14)	IV NAD$^+$ aims to raise systemic levels beyond oral precursors (13)	Some evidence in fatigue, aging, and cognitive support; limited RCTs (17)	Nausea, flushing, chest tightness during infusion (13)
Glutathione (1,200 mg)	Master antioxidant; detoxification, immune regulation (11)	IV use bypasses GI breakdown to increase plasma GSH levels (21)	Antioxidant support, skin lightening (controversial), mild evidence in dermatology and liver disease (18)	Rare: rash, abdominal cramps, bronchospasm in asthmatics, renal dysfunction, thyroid disease (20)
Amino acids (10 ml × 15%)	Protein synthesis, neurotransmitter and enzyme precursors (21)	IV mixes (e.g., BCAAs, glutamine, arginine) exceed dietary intake for anabolic recovery purposes (22)	Supportive in cachexia, wound healing, muscle loss; limited anti-aging evidence (22)	Nausea, metabolic imbalance if overused
Vitamin C (2 g)	Antioxidant, cofactor in collagen synthesis, immunity (3)	IV doses can reach plasma concentrations > 100 × oral route (3)	Some efficacy in cancer adjuvant therapy, fatigue, antioxidant support (3)	Osmotic diarrhea (oral), rare oxalate nephropathy (IV), hemolysis in G6PD deficiency (10)
Other vitamins (vitamin B complexes, vitamins D and E)	B: energy metabolism; D: immune modulation; E: antioxidant (6)	Supra-physiological doses given IV for synergistic effects	Evidence limited in healthy aging; some benefit in deficiencies or stress states	Hypervitaminosis risk (especially D, A); headache, GI upset
Minerals (magnesium 1,000 mg, zinc 6 mg, and selenium)	Electrolyte balance, enzyme function, antioxidant roles	IV use to bypass gut limits or correct deficiencies	Used in fatigue, stress, immune function; evidence varies by mineral	Risk of overload (e.g., magnesium → hypotension, zinc → copper deficiency)
Other agents (e.g., alpha-lipoic acid 300–600 mg, CoQ10, L-carnitine, taurine, bicarbonate)	Mitochondrial support, fatty acid transport, antioxidant effects (5)	Doses exceed normal dietary intake; often combined in IV cocktails (5)	Some support for mitochondrial dysfunction, fatigue, metabolic syndromes (4)	Mild: nausea, dizziness; rare allergic reaction (4,5)

NAD$^+$ = nicotinamide adenine dinucleotide, IV = intravenous, RCTs = randomized controlled trials, GI = gastrointestinal, GSH = reduced glutathione, BCAAs = branched-chain amino acids, G6PD = glucose-6-phosphate dehydrogenase, CoQ10 = coenzyme Q10.

Dilokthornsakul et al.'s systematic review highlighted evidence suggesting that glutathione contributes to improved skin hydration and elasticity, which improves the skin's health and explains the anti-aging properties of glutathione (19).

In terms of anti-aging, there is a biological rationale due to its antioxidant properties, but placebo-controlled trials in healthy aging populations are lacking. Some small studies and observational reports suggest benefit in liver detoxification and skin brightening, but these often lack rigorous controls. Even though IV glutathione is generally well tolerated and is widely promoted for skin lightening and wellness, clinical trials remain few, small in scale, and methodologically limited (11, 16, 20). Mild side effects of glutathione are flushing of the skin or gastrointestinal upset, and the overall evidence supports limited but possible benefits in specific cosmetic or oxidative stress-related contexts, with insufficient evidence for broad anti-aging efficacy in healthy individuals (19).

Amino acids

Amino acids are essential for protein synthesis, immune regulation, neurotransmitter production, and cellular metabolism. In the context of aging, specific amino acids, such as glutamine, arginine, and branched-chain amino acids (BCAAs), are linked to muscle preservation, wound healing, and modulation of mechanism target of rapamycin (mTOR) and immune signaling pathways (21). Age-related sarcopenia and catabolic states are often characterized by reduced amino acid bioavailability, suggesting a potential therapeutic role for supplementation.

Intravenous amino acid infusions are commonly included in UK-based anti-aging IV therapies, often in doses ranging from 5 to 10 g of mixed amino acids per treatment, typically combined with BCAAs, taurine, or carnitine. Despite widespread clinical use, robust evidence for anti-aging efficacy is limited. Most available studies assess amino acid infusions in acute or disease-specific settings. For instance, in a randomized controlled trial of 32 participants Wernerman et al. demonstrated improved nitrogen balance in critically ill patients receiving IV BCAAs compared to standard parenteral nutrition (22). In contrast, Gariballa et al. found no significant difference in muscle strength or recovery among 40 elderly hospitalized patients receiving amino acid supplementation versus controls (23).

Similarly, glutamine has been studied extensively in surgical and trauma patients, with some evidence of reduced infection rates and shorter hospital stays; however, results vary widely depending on baseline nutritional status and clinical context. In healthy aging populations, there are currently no published RCTs evaluating IV amino acid therapy for longevity, cognitive performance, or skin health. Even though IV amino acids show some clinical efficacy in catabolic or malnourished patients, there is no high-quality evidence to support their use as an anti-aging intervention in otherwise healthy individuals.

Vitamin C

Vitamin C (ascorbic acid) is a potent water-soluble antioxidant, a cofactor in collagen synthesis and catecholamine production, and a modulator of immune function. Physiologically, it scavenges reactive oxygen species and regenerates other antioxidants, helping maintain redox homeostasis (3). In the UK, IV formulations are typically administered at 5 to 25 g per infusion to achieve plasma concentrations unattainable by oral dosing. Carr and Maggini's review reports that high-dose IV vitamin C substantially reduces biomarkers of oxidative stress (e.g., malondialdehyde and 8-isoprostanes) and inflammatory cytokines in both animal models (e.g., experimental acute pancreatitis and myocardial ischemia) and small human trials, although impact on hard clinical outcomes (mortality and organ failure) remains inconsistent (24). For example, in a rat model of cerulean-induced pancreatitis, IV ascorbate reduced pancreatic necrosis and serum amylase more effectively than saline controls. In contrast, an observational cohort of 20 sepsis patients receiving 10 g IV vitamin C twice daily showed no significant difference in length of intensive care unit stay compared to matched controls, despite lower oxidative markers (24). Overall, IV vitamin C demonstrates some efficacy in mitigating oxidative injury, but evidence for routine anti-aging benefit in healthy adults is lacking.

Other vitamins

Beyond ascorbate, IV multi-vitamin infusions at UK anti-aging clinics commonly include B complex (thiamine, riboflavin, niacin, B6, and B12), vitamin D3, and vitamin E. Physiologically, B vitamins act as enzyme cofactors in energy metabolism and homocysteine regulation, vitamin D modulates immune and inflammatory responses, and vitamin E is a lipid-soluble antioxidant protecting cell membranes (6). The European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines recommend routine IV micronutrient supplementation perioperatively to correct deficiencies and support recovery, citing level II evidence for reduced postoperative infection rates and length of stay with combined IV vitamins / trace elements in surgical patients (25). However, these findings derive from malnourished or critically ill cohorts and cannot be extrapolated to healthy aging. No randomized trials have specifically tested IV vitamins B, D, or E for anti-aging endpoints (e.g., skin elasticity and cognitive function) in healthy populations. Thus, even though IV multi-vitamin infusions may correct subclinical deficiencies and aid recovery in disease states, their efficacy as longevity therapies in healthy adults remains unproven.

Minerals

Magnesium, zinc, and selenium act as essential cofactors in many enzymatic reactions, stabilize membrane potentials, and support antioxidant defenses. Magnesium in particular is critical for ATPase activity, mitochondrial function, and ion channel regulation, and it also scavenges free radicals. UK anti-aging clinics typically infuse magnesium sulfate at doses of 2 to 10 g (8 to 40 mmol) per session to rapidly correct subclinical deficiencies and bolster cellular energetics.

Clinical evidence for IV magnesium's benefits primarily comes from acute cardiovascular settings. In an overview of seven randomized trials enrolling 1,266 suspected acute myocardial infarction (AMI) patients, Teo et al. reported a 55% reduction in the odds of in-hospital mortality with magnesium versus control ($p < 0.001$) and a 36% reduction in serious ventricular arrhythmias (27). The LIMIT-2 trial ($n = 2{,}316$) demonstrated that a 4 g loading dose followed by a 16 g infusion over 24 hours reduced 28-day mortality by 24% (95% CI, 1–43, $p = 0.04$) compared to saline placebo (27). In contrast, the larger MAGIC trial ($n = 6{,}213$) found no significant difference in 30-day all-cause mortality with a 2 g bolus plus 17 g infusion regimen (relative risk [RR] 1.00; 95% CI, 0.91–1.09) (28).

Data on IV zinc and selenium in aging contexts are scarce and limited to small, uncontrolled cohorts. Thus, although IV magnesium demonstrates some efficacy in specific disease-related settings, there is insufficient high-quality evidence to support routine IV mineral supplementation as an anti-aging intervention in healthy populations.

Other agents (e.g., alpha-lipoic acid, CoQ$_{10}$, L-carnitine, taurine, and bicarbonate)

ALA functions as a thiol antioxidant and a cofactor in mitochondrial dehydrogenases, scavenging reactive oxygen species and regenerating glutathione and vitamins C and E in vivo. UK anti-aging infusions commonly deliver 300 to 600 mg ALA per infusion. In a rodent model of myocardial ischemia–reperfusion, IV ALA (100 mg/kg) reduced infarct size by 35% compared to saline controls (5). Conversely, a small, double-blind RCT of 40 diabetic patients undergoing coronary artery bypass grafting found that pre-operative IV ALA (600 mg) did not significantly alter postoperative oxidative stress markers (malondialdehyde and protein carbonyls) compared to placebo highlighting RCT limitations in wellness IV research (5).

CoQ$_{10}$ acts within the electron transport chain to facilitate ATP production and quench lipid peroxyl radicals. IV formulations at UK clinics typically provide 100 to 200 mg CoQ$_{10}$ per infusion. In a 12-patient case series of chronic heart failure, daily IV CoQ$_{10}$ (150 mg) for 7 days improved left ventricular ejection fraction by an average 4% over baseline, but the study lacked a control arm (4). Subsequent observational data in 30 similar patients showed no significant change in ejection fraction after 10 days, indicating inconsistent efficacy.

L-carnitine facilitates mitochondrial fatty acid transport and supports β-oxidation, and typical IV doses are 2 to 4 g. Small RCTs in acute myocardial infarction report reductions in peak creatine kinase release but no improvement in short-term mortality, and sample sizes rarely exceed 50 subjects per arm.

Taurine (1–2 g IV) and bicarbonate (50–100 mEq IV) are included for osmoregulation and acid–base buffering, respectively, but are supported only by anecdotal reports. Overall, even though these agents demonstrate some efficacy in disease-specific or animal models, high-quality evidence, especially from adequately powered, placebo-controlled RCTs in healthy aging cohorts is lacking, and many published trials suffer from small sample sizes, heterogeneous dosing regimens, and limited clinical endpoints (3).

Conclusions

IV longevity therapy is a theoretically sound strategy to influence key biological processes involved in aging, such as oxidative stress, declining mitochondrial function, chronic low-grade inflammation, and genomic instability. The aim is to decelerate aging and improve longevity. Intravenous delivery of supraphysiological concentrations of vitamins, antioxidants, amino acids, and metabolic cofactors, while circumventing gastrointestinal absorption constraints, provides a compelling pharmacokinetic rationale. However, the extant evidence base is constrained by methodological limitations: studies are predominantly small-scale, heterogeneous in formulation and dosing, and largely confined to disease-specific or aesthetic cohorts. Only a few trials measure validated biomarkers of biological aging or assess long-term, patient-centered benefits, making it difficult to draw firm conclusions about clinical efficacy or safety.

Until well-designed, adequately powered clinical trials in healthy aging populations are carried out, intravenous longevity therapy should be considered experimental. Its use should be reserved for settings in which patients understand that its benefits remain unproven and that potential risks are not fully characterized.

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