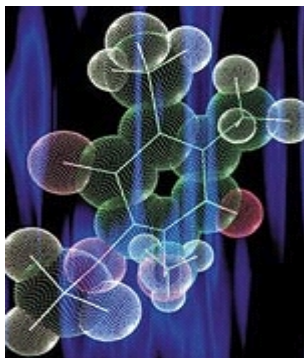


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REPORT

Coenzyme Q10 New Applications for Cancer Therapy

By Christie Yerby, ND



Computer graphic of a coenzyme Q10 molecule. The green spheres represent carbon, the red spheres are oxygen, and the white spheres are hydrogen.

Promising new research suggests that coenzyme Q10 may be an important adjuvant therapy for cancer patients. Scientists have discovered that CoQ10 can program cancer cells to self-destruct before multiplying at their customary, lethal rates. For millions of cancer patients, the implications of this discovery are nothing short of profound.

This finding was one of several from recent studies conducted by researchers at the University of Miami (FL), using CoQ10 as their test agent.¹ In a telephone interview in July 2005, principal investigator Dr. S.L. Hsia told *Life Extension*, "This is the first time in history we have been able to selectively teach a cancer cell to kill itself with CoQ10, via a mitochondrial mechanism, without harming the healthy cells."

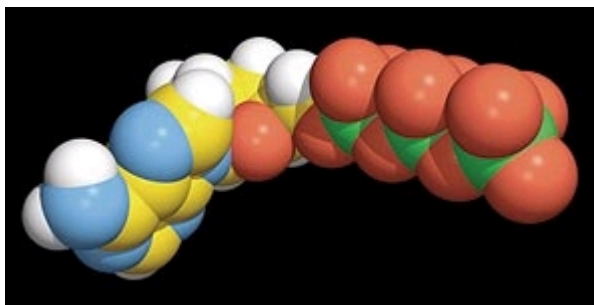
According to team researcher Niven R. Narain, cancer cells lose their apoptotic potential, or ability to respond to programmed cell death. "What CoQ10 does is to restore apoptosis to cancer cells," Narain told *Life Extension*. "The data suggest that CoQ10 significantly reduces expression of the bcl-2 gene family, which is responsible for conferring resistance to cell death. In essence, CoQ10 modulates bcl-2 in a manner that allows the cancer cell to kill itself without adversely affecting normal cells. This is why we say it is 'selective,' because the bcl-2 family is not affected in normal cells."

COQ10 RESEARCH: PAST AND PRESENT

CoQ10, a fat-soluble, vitamin-like nutrient that is also called "ubiquinone" because it is found in every human cell, boosts energy, is a powerful antioxidant, and can bolster immune health. Growing research indicates that CoQ10 is valuable for fighting fatigue, preventing and managing heart disease and some cancers, and possibly reversing some of the toxic effects of chemotherapy.² As a coenzyme, it supports many important biochemical reactions in the body.

Interest in CoQ10's therapeutic uses can be traced as far back as 1957, when it was first identified by Frederick Crane, PhD. In the 1960s, Peter D. Mitchell, PhD, discovered that CoQ10 produces energy at the cellular level, work that would eventually earn him a Nobel Prize in Chemistry in 1978. In the early 1980s, Karl Folkers, PhD, director of the Institute for Biochemical Research at the University of Texas, and Peter H. Langsjoen, MD, FACC, began studying CoQ10. In 1983, seven years before Folkers received the National Medal of Science in recognition of his work, the Life Extension Foundation announced CoQ10's potential benefits for health disorders ranging from neurological aging to heart disease, and drew attention to numerous clinical studies demonstrating its safety.²

The recent findings about CoQ10 may mean that in the near future, a diagnosis of cancer may carry with it more hope for being able to continue living a long and healthy life. But does this mean we are closer to finding a cure for cancer?



Computer artwork of a molecule of adenosine triphosphate (ATP). The atoms are shown as spheres and are color-

"We encourage cancer patients to continue the traditional treatment their doctors recommend," says Dr. Hsia. He feels, however, that adjuvant, or integrative, therapy with CoQ10 may be advisable. "It might be advantageous to give cancer patients CoQ10," he says, "given that it will help healthy cells produce more ATP [adenosine triphosphate], the energy molecule."

Dr. Hsia notes that CoQ10 is concentrated in the mitochondria, the energy-generating "power plants" contained in each human cell. CoQ10 is an important cofactor, or contributing ingredient, in the production of ATP, the molecule that serves as the cell's major energy source and is central to many life-sustaining biological processes.³ Some health experts believe

coded: carbon (yellow), oxygen (red), nitrogen (blue), hydrogen (white), and phosphorus (green).

that diminished ATP levels may lead to the development of chronic illnesses, including cancer.

COQ10-DEPLETING AGENTS

The body's natural stores of CoQ10 can be depleted in numerous ways, including inadequate biosynthesis due to gene mutation, inhibited production caused by cholesterol-lowering statin drugs, normal aging, strenuous exercise, and cancer.³ Correcting these deficiencies often requires supplementing with greater amounts of CoQ10 than can be obtained through dietary sources.³

Studies show that patients treated with statin drugs have lower plasma levels of CoQ10, since these medications block mevalonic acid, which is a precursor of both cholesterol and CoQ10.⁴⁻⁸ CoQ10 supplementation may prevent plasma depletion without affecting the statins' cholesterol-lowering effects.⁹

Normal aging can also affect CoQ10 levels. "By age 20," says Narain, "CoQ10 diminishes in our bodies. It has been suggested that low levels of CoQ10 may lead to a number of diminished states of health, playing a part in many degenerative illnesses."

The increased metabolic rates seen in athletes during strenuous competition or endurance exercise may accelerate the body's utilization of CoQ10. Unless these increased demands are met through supplementation, the body's CoQ10 levels may remain in a depleted state.¹⁰

Decreased CoQ10 bioavailability may cause cellular damage resulting in altered DNA and consequently leading to poor health.⁸ Studies have noted diminished CoQ10 levels in cancer patients and others with chronic illnesses.¹¹⁻¹⁴ Results from assay studies accumulated over 25 years reveal that viral infection may deplete CoQ10 levels and that AIDS patients show a "striking" beneficial response to CoQ10 supplementation.¹⁵

FREE RADICALS AND ANTIOXIDANTS

Free radicals, which alter cell membranes and DNA, have been implicated in the aging process and the development and progression of many chronic and degenerative illnesses, including cancer.¹⁶ Some researchers believe that free radical damage may contribute to the pathogenesis of cancer and that antioxidant supplements may help aging adults counter the effects of environmental toxins.^{11,17,18}

Antioxidants inhibit free radical formation or quench existing radicals, thus halting the progression of free radical damage. Many nutrients act as antioxidants, with CoQ10 being one of the more powerful.¹⁹ CoQ10 deficiencies thus may contribute to greater cellular damage from free radicals.



Some conventional cancer therapies and radiation treatments kill cancer cells, in part by spurring free radical formation.¹⁶ Although it may seem illogical to supply a source of antioxidants during conventional cancer treatment, the value of using antioxidants to treat cancer remains a topic of great debate, despite the known adverse effects of chemotherapy drugs.¹⁸

Recent data, however, suggest that antioxidants can help counter the toxic side effects of chemotherapeutic agents without affecting their anti-cancer actions. Results from a study investigating the combined efficacy of tamoxifen citrate (Nolvadex®) and CoQ10 were reported in May 2005. Tamoxifen is commonly used to prevent and treat breast cancer. While known to be an antioxidant as well as a non-steroidal anti-estrogenic drug, it can produce adverse side effects with extended use. Researchers sought to determine whether CoQ10 could help to minimize tamoxifen's side effects while maintaining or increasing its antioxidant actions.¹⁸

In this study, rats with chemically induced mammary carcinoma exhibited lowered levels of antioxidant activity, suggesting a possible increase in free radicals and the resultant peroxidative damage often implicated in cancer development. Rats that received 28 days of tamoxifen and CoQ10 had significantly increased glutathione-related antioxidant enzymes. The researchers concluded that the combination of CoQ10 and tamoxifen restores antioxidant activity that is diminished by chemotherapeutic agents, and increases antioxidant actions that may prevent cancer cell proliferation and protect cells from free radical damage.¹⁸



Another chemotherapy drug, Adriamycin® (doxorubicin), can damage the heart. In 1996, scientists noted that CoQ10 helped prevent Adriamycin®-induced cardiotoxicity. Again in 2005, researchers reported that CoQ10 appears to prevent Adriamycin®-induced damage to the mitochondria of the heart.²⁰

People with cancer affirm their belief in the benefits of nutritional supplements by adding them to their health-restoration programs. A recent study showed that 63% of 453 oncology patients used vitamins and herbs, leading the researchers to call for further studies. "Use of CAM (Complementary and Alternative Medicine) will likely increase," the study reported.²¹

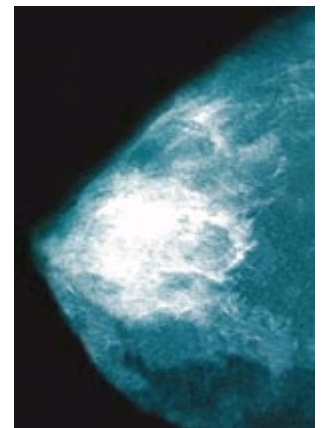
According to scientists at the University of Colorado, high-dose antioxidants inhibit the growth of different rodent and human cancer cells both in vivo and in vitro. Because each antioxidant may have a different mechanism of action on tumor cells, cancer cells may respond uniquely to different antioxidants. While antioxidant treatment for a short time (a few hours) may not inhibit cancer cell growth, treatment over a longer period of time (24 hours or more) with the same dose may inhibit tumor growth. Thus, the efficacy of antioxidants may depend on the cellular environment.²²

Chemotherapy drugs can have toxic side effects.^{20,23} By reducing cellular damage, antioxidants may help to minimize these side effects and improve outcomes for patients with cancer. Emerging evidence suggests that CoQ10 may be a valuable adjuvant therapy for individuals undergoing conventional cancer therapy.

CANCER-PREVENTIVE EFFECTS

As early as 1961, low levels of CoQ10 were noted in patients with myeloma, lymphoma, and cancers of the breast, lung, prostate, pancreas, colon, kidney, head, and neck.¹⁶ However, CoQ10's potential value in preventing breast cancer did not become apparent until more than three decades later, in studies conducted by Knud Lockwood, MD, a cancer specialist in Copenhagen, Denmark.²⁴

Lockwood's treatment of 32 "high-risk" breast cancer patients with antioxidants and other nutrients, including a daily dose of 90 mg of CoQ10, produced remarkable results. Although four deaths were expected, no deaths occurred. The subjects also reported decreased use of painkillers, an absence of weight loss, and an improved sense of well-being. Of the 32 participants, six showed partial tumor remission and two benefited from an even higher dose of CoQ10. One woman experienced a stabilized tumor when taking 90 mg of CoQ10; after her daily dose was increased to 390 mg, the tumor disappeared, a finding confirmed by mammography.²⁴ Another patient who had a small tumor removed from her right breast refused to undergo a second operation to remove another. Instead, she began taking 390 mg of CoQ10 daily. Three months later, mammography confirmed an absence of tumors or metastasis in her breast.²⁵



In a follow-up study more than one year later, three other subjects in the original study who had combined conventional cancer therapy with CoQ10 supplementation of 390 mg a day also saw their tumors disappear with no evidence of metastasis.²⁶ CoQ10 thus appears to be the dominant nutrient contributing to breast cancer regression and prevention of its recurrence.²⁵

Correcting a CoQ10 deficiency may be essential for good health. According to Stephen Sinatra in his book *The CoQ10 Phenomenon*, "Without CoQ10, the body cannot survive."¹⁰ Sinatra recommends CoQ10 supplementation, especially for those undergoing breast cancer therapy and others who are at risk of having depleted stores of CoQ10, including aging adults and users of cholesterol-lowering statin drugs.¹⁰

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IMPORTANCE OF DIET AND NUTRITION

In 2004, breast cancer accounted for about 30% of all newly diagnosed cancer cases in US women and was the second leading cause of cancer death, surpassed only by lung cancer.²⁷ Diet may contribute to 30-50% of these newly diagnosed cases.²⁷ Very little CoQ10 is derived from the standard American diet, so attention to nutrient-rich food is important for cancer prevention. Foods that contain the most CoQ10 include oily fish such as sardines and mackerel, liver, peanuts, and whole grains. A well-balanced diet may provide adequate amounts of CoQ10 for an already healthy person, but those with depleted levels or chronic illness may require supplemental CoQ10.

CoQ10 is synthesized in the body from the amino acids tyrosine and phenylalanine, in a multi-step cascade of events that requires several vitamins, including vitamin C, vitamins B2, B3, B5, B6, and B12, and folic acid. Vitamin B6 is the first cofactor required for this conversion process, as B6 deficiencies cause dysfunctions in CoQ10 formation.²⁸ Data on cancer patients' blood levels have shown deficiencies of both CoQ10 and vitamin B6.²⁸

Red meat supplies an abundance of B vitamins, but since meat consumption may be associated with an increased risk for some cancers,²⁹ supplementing with a good multi-vitamin and vitamin B complex is important for CoQ10 synthesis in those who choose to avoid eating red meat.

CoQ10 not only has been shown to have anti-cancer properties, but also appears to boost immune health.^{15,16,30} In one study, administration of CoQ10 and vitamin B6 together and separately boosted blood levels of both CoQ10 and CD4 T lymphocytes (helper T-cells), a type of disease-fighting immune system cell.³¹ Blood levels of immunoglobulin G increased when CoQ10 and vitamin B6 were administered together and when CoQ10 was given alone.³¹

Because of its potential as an immune system stimulant, CoQ10 has been used as an adjuvant therapy in patients with various types of cancer. With new research findings demonstrating that it is able to restore susceptibility to apoptosis in cancer cells, CoQ10 may be of critical importance in an integrated cancer treatment protocol.

HELP FOR OTHER CANCERS

In recent studies, University of Miami researchers examined breast and prostate cells, but other studies suggest that CoQ10 may also inhibit cervical cancer cells,³² illustrating how its antioxidant and other effects may be valuable in fighting other cancers.

During their presentation at a recent meeting of the American Association for Cancer Research in Anaheim, CA, the Miami team showed that adding CoQ10 to the most common prostate cancer cell line, PC3, inhibited cell growth by 70% over 48 hours. Similarly, they found that CoQ10 greatly inhibited the growth of breast cancer cells, while providing a stabilizing effect to normal mammary cells.¹



The University of Miami scientists are now focusing on applications of CoQ10 for skin cancer. "We are studying CoQ10 with skin cancer, given that our interests are dermatologic in nature," says Narain. "But certainly there will be expansion into studies that target other organs as well."

"We are in the process of developing an IV delivery system for other organs," adds Indushekhar Persaud, chief bioengineer for drug delivery therapeutics at the University of Miami. "For prostate and breast cancer, IV delivery may be more advantageous."

For their dermatological application of CoQ10, the Miami team is using liposomes made of phospholipids as a molecular delivery vehicle into targeted cells.

The Miami researchers have investigated a therapeutic dose of up to 500 mg daily of orally ingested CoQ10 for conditions such as cancer. Applied topically, however, smaller doses may be effective. However, as with all health issues, a thorough discussion with your physician regarding your supplement program is advised.

The research team is planning further clinical trials with Dr. Keyvan Nouri at the Mohs Center in the Sylvester Comprehensive Cancer Center in Miami. According to Dr. Nouri, "Mohs microscopic surgery is the gold standard of treatment for basal cell carcinoma, squamous cell carcinoma, and other rare cutaneous neoplasms."³³

CONCLUSION

For years, researchers have suspected that antioxidants may have properties that can aid in the prevention and treatment of cancer. However, answers as to how, why, and which antioxidants work best have continued to challenge them. Every new scientific discovery plays an important part in helping to unravel this ongoing mystery.

As recent studies demonstrate, often-overlooked nutritional therapeutics are gaining ground as essential aspects of cancer management.³⁴ As more is understood about the biochemical mechanisms of nutrients such as CoQ10, research may continue to elucidate their medical applications for managing cancer.

Exciting new research findings from the University of Miami, describing CoQ10 as an anti-cancer agent, may be an important piece of the cancer-cure puzzle. For people diagnosed with cancer—a disease once labeled "incurable"—new research suggests that CoQ10 may well enhance their prospects for living a long and healthy life when incorporated in a daily treatment regimen.

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