

OBJECTIVES:

To review what constitutes optimal nutrition for the cancer patient.

DATA SOURCES:

Conventional nutrition, botanical and biomedical journals and texts, electronic media, databases, and abstracts.

CONCLUSION:

Optimal nutrition is neither a complementary nor alternative treatment, but is the fundamental groundwork for the creation of the most favorable cancer treatment outcomes as presented in numerous study findings and journal articles. The two main topics of this article are (1) general food choices and decisions that can affect treatment outcomes; and (2) a brief look at the specific scientific application of individual nutrients to affect a positive impact on treatment, protection of healthy cells and tissues, side-effect mitigation, and quality of life for cancer patients.

IMPLICATIONS FOR NURSING**PRACTICE:**

It is critical for health care providers to both acknowledge and apply the principles of nutrition for cancer patients both in general and as part of a therapeutic regimen. It is important for nursing staff to understand that nutritional elements can promote or detract from cancer treatment and recovery.

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REINTRODUCTION TO NUTRITION AND CANCER TREATMENT

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IT HAS BEEN suggested that 50% to 70% of all cancers could be prevented by correcting diet and lifestyle issues.¹⁻⁴ It is a stunning revelation to think we might have that much control over our future health on a daily basis. With simple changes in the way we eat, how we move, and the cessation of detrimental health habits such as smoking, we can dramatically improve our health in both the short and the long term. The information presented here is a reintroduction to nutrition and how it can promote or detract from cancer treatment and recovery. There are two main foci of this article: (1) a discussion of cancer and nutrition in general, and (2) a brief look at the specific scientific application of individual nutrients for a positive impact on treatment, side-effect mitigation, and increased quality of life.

CARCINOGENESIS AND INFLAMMATION

In the mid 1800s, pathologist Rudolf Virchow postulated that cancer forms in areas of chronic inflammation.⁵ Modern research has shown the connection between inflammation and the development of some cancers. Researchers are looking at the possibility that mutation and inflammation work together to transform normal cells into cancer cells.⁵ Phagocytes, key cells of the immune system, produce radical oxygen species and nitrogen intermediates that damage and/or destroy other cells and bacteria. This is wonderful when there is genuine need of their services. However, in the case of chronic inflammation (which can be caused by many factors including *H. Pylori* infection, cigarette smoke, asbestosis, Epstein-Barr virus, food allergies, and so on), this regular release of radical oxygen species and nitrogen intermediates may damage healthy cells and their DNA leading to mutagenesis, oncogene activation, and angiogenesis.⁵ The damaged cell stimulates the formation of growth factors and other

elements designed to heal the damage. Unfortunately, this can mean that, rather than healing, there are proliferations stimulated by the attempts to heal the site.⁶ Chronic inflammation creates the ideal environment for radical oxygen species and other free radicals, which, in turn, stimulate continuation of inflammation.

Elevated levels of pro-inflammatory leukocytes, prostaglandins (especially PGE₂), chemokines and cytokines, as well as interleukins (such as IL-6), are found in cancer patients. For example, monocytes, macrophages, and (interestingly) adipose cells produce IL-6. This interleukin is the primary initiator of the inflammatory response and induces synthesis of all of the liver's inflammatory proteins (ie, C-reactive protein and fibrinogen).⁷

Overweight and obesity are risk factors for the development of some cancers. In fact, people who are overweight or obese, or are struggling with metabolic syndrome, secrete enough IL-6 to qualify as having low-grade systemic inflammatory disorders.⁷ By the year 2000, 64.5% of adults in the United States were overweight and 30.5% were obese.⁸ Dietary and lifestyle interventions can reduce chronic inflammation along with attaining a healthy body mass.

DIET IN GENERAL

Most people in the United States consume high amounts of sugar, damaged fats, and protein, and very few vegetables and fruits with their nutrient value intact. We can start by making adjustments on a larger scale that will benefit the patient. There are things we can do, and *not* do, to reduce inflammation and increase optimal metabolism for healthy cells.

SUGAR

All cells burn glucose and the cancer cells burn it faster than normal cells.⁹ Positron emission tomography technology takes advantage of this by using radiolabeled glucose to “light-up” tumors during the scanning process.¹⁰ It has been suggested that eliminating dietary sugar and components of the diet that break down quickly to glucose may deprive cancer cells of their favorite fuel.

Insulin, and insulin-like growth factors, are key determinants of cancer cell proliferation. It has

been shown that diets that cause insulin resistance or hypersecretion (including increased consumption of sucrose, high glycemic index carbohydrates, and saturated fatty acids) are risk factors for the development of colon and other cancers.¹¹

When evaluating a patient's diet, the elimination of obvious sources of sugar and highly processed carbohydrates (pasta, white bread, muffins, cookies, crackers, candy, sodas, and so on) should be encouraged. High-fructose corn syrup is not a naturally occurring substance; it is a sweetener created from highly processed corn and is readily converted to glucose. High-fructose corn syrup has been implicated as one of the key factors in the epidemic of overweight and obesity in the United States.

Unfortunately, one of the most commonly used meal replacements in the hospital setting is the product Ensure (Abbott Laboratories, Abbott Park, IL). The first ingredient after water is sucrose followed immediately by corn syrup. There are healthier alternatives for patients having difficulty with solid foods, or for those who need to keep their weight up. Ensure should be used as a last resort. A prime example of a healthy option is a smoothie made with organic berries, organic coconut milk, and whey protein as a base. The smoothie can act as a vehicle for delivery of other nutrients or supplements as needed, such as cod liver oil (vitamin D and omega-3 fatty acids), enzymes to aid digestion, healthy fats and proteins to maintain body weight, as well as vitamins and minerals as deemed necessary. Another more savory option is a slowly simmered meat and vegetable-based broth that can be sipped throughout the day.

WATER

Water is vital to all systems of the body, especially the detoxification and waste removal systems. It has been estimated that most Americans are chronically dehydrated and that all body systems suffer as a result. Chronic dehydration may be one of the key contributing factors to the development of many of the major diseases we face today (Table 1). Cancer treatments are highly toxic and the process of tumor degradation creates high concentrations of waste products. To minimize damage to healthy tissues, the elimination systems need to be maintained at their high-

TABLE 1.
Some Effects of Chronic Dehydration

Fatigue	Disorientation
Depression	Constipation
Joint pain	Gastroesophageal reflux disease
Headache	Asthma and allergies
Confusion	Hypertension or hypotension

est possible operating levels. Water is essential for the movement of toxins and waste products from the tissues into the blood and lymph and on to the kidneys. It is also important to keep the bowel moving and eliminating. Often chemotherapy and/or pain medications such as morphine cause a slowing of intestinal movement and accompanying constipation. Water and fiber work together to keep intestinal function in balance.

FIBER

Fiber is an important component of the diet for cancer patients and indeed may help prevent intestinal cancers in all people (Table 2). Unfortunately, fiber can aggravate mucositis caused by treatment if nothing is done to prevent and protect against its onset. For healthy protected mucosa, both soluble and insoluble fiber is important for healthy bowel maintenance. Soluble fiber binds fats and moves them through the system faster so less are absorbed. These fibers also bind with toxins generated by normal metabolic processes (and those found in foods) and carry them out of the body before they can do much additional harm. Fiber also contributes to the sensation of fullness. The use of supplemental fiber, such as powdered psyllium before a meal, can be beneficial for maintaining regularity. It is important to take supplemental fiber separate from any supplemental beneficial fatty acids or it will bind with them and they will be unavailable for absorption.

It is also important for the patient to drink plenty of water with increased fiber intake.

ORGANIC FOODS

In general, cancer patients are dealing with enough challenges to their overall health as they battle cancer and endure its treatment. If organic produce, meats, dairy, eggs, and nuts are options,

those options should be exercised. If not, merely the consumption of real foods is a huge step in the right direction.

Conventional dairy products are produced from cows injected with bovine growth hormone, which may or may not be present in the end product (depending on the study examined). Ingesting additional growth factors is not worth the risk for cancer patients. In addition, pesticides, herbicides, and fungicides mimic many actions of endogenous hormones, and when out of balance, can have a negative impact on the health of the cancer patient.¹²⁻¹⁶ In a healthy human, an intact toxin removal system can handle a certain amount of this toxicity; however, this may not be the case for the cancer patient whose toxin removal system is already working overtime.

PRODUCE

Some foods, when consumed in high amounts, have been reported to be associated with a lower incidence of some cancers; these include cruciferous vegetables, (broccoli, cauliflower, chard, bok choy), dark leafy greens (spinach, kale, beet greens), and deeply colored fruits and vegetables (yellow, orange, and red peppers; apricots; mangos; carrots; beets; berries). Generally, all Americans can and should substantially increase

TABLE 2.
Average Fiber Content of Selected Foods

Food	Serving Size	Grams of Fiber
Apple (with skin)	1 medium	3.5
Banana	1 medium	2.4
Peach (with skin)	1 medium	1.9
Celery	½ cup diced	1.1
Lettuce	1 cup	0.9
Spinach	1 cup	1.2
Green beans	1 cup	3.2
Broccoli	1 cup	4.4
Potato (without skin)	1 medium	1.4
Sweet potato	1 medium	3.4
Kidney beans (cooked)	½ cup	7.3
Lentils (cooked)	½ cup	3.7
Brown rice (cooked)	½ cup	1.0
White rice (cooked)	½ cup	0.2
All-Bran breakfast cereal	⅓ cup	8.5
Corn Flakes breakfast cereal	1¼ cup	0.3
Whole grain bread	1 slice	1.7
White bread	1 slice	0.6

consumption of vegetables. The vegetables mentioned should be blanched or steamed lightly to enhance digestion and absorption and reduce amounts of phytate and oxalate that can bind other nutrients. Fruits should be eaten whole, not as juice. Some fruits should be minimized, such as bananas, because they are high in sugar. Fruit juice is high in sugar and low in fiber and should be minimized. Legumes are a wonderful source of fiber and protein; however, soy products should be limited to the fermented types such as miso and tempeh. Unfermented soy (tofu and soy milk) has constituents that may be problematic for those battling hormone-sensitive cancers. Soy also contains phytates that bind precious nutrients and remove them from the system before they can be assimilated.

MEATS

It has been shown that farmed salmon can be as unhealthy as conventionally raised, grain-fed beef.^{17,18} Encourage the purchase of lean meats that have been raised on the types of food the animal was meant to eat (grass-fed beef, wild salmon, free-range chicken). Avoid conventionally grown meats, which are regularly injected with antibiotics and growth hormones and given feed made from heavily sprayed, genetically modified crops such as corn and soy.¹⁹ All of these toxic traits are transferred to the cow or steer and concentrated further in their fat stores. The steer and cow fat becomes high in omega-6 fatty acids. The natural ratio of omega-6 to omega-3 fatty acids in animal and human tissue is about 4:1, grain-fed beef (and farmed salmon) approaches a ratio of 20:1. It is my belief that this imbalance is the key to the cardiovascular problems associated with diets high in red meats rather than the saturated fats themselves.

GRAINS

This is a “use with caution category”: use sparingly, and only whole grains should be considered appropriate. Again, the recommendation is for organic non-genetically modified sources if possible, and minimally processed. Brown rice, whole oats, buckwheat, quinoa, amaranth, and other delicious heirloom varieties are allowable in small amounts. Encourage patients to rediscover what a “serving size” is, and to hold themselves to

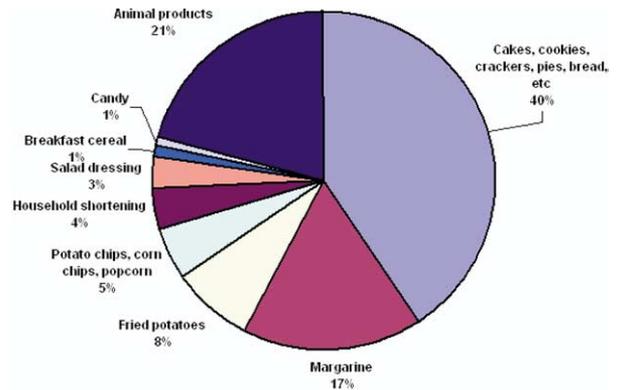


FIGURE 1. “Major Food Sources of *Trans* Fat for American Adults.” Average daily *trans* fat intake is 5.8 g or 2.6% of calories. Downloaded from the U.S. Food and Drug Administration (http://www.fda.gov/fdac/features/2003/503_fats.html) on January 18, 2005.

a single serving per meal. Whole grain and sprouted grain breads are acceptable in small amounts. Even though they are more complex, these carbohydrates will still break down to glucose; although much more slowly and controlled than their highly processed counterparts (white bread, pasta, standard breakfast cereals, muffins). This is the idea behind consuming a low-glycemic load diet. The rate at which a carbohydrate is metabolized to glucose determines where it falls on the glycemic index.

FATS

One of the most misunderstood and maligned members of our dietary menu, fats are essential energy sources and building blocks for essential components of the body. Carbohydrate is our source of “jet fuel” for sprinting away from danger, but it is the fats that store the energy to keep us chugging along all day.

Essential fatty acids include the omega-3s, omega-6s, and omega-9s. Americans tend to have diets far in excess of the appropriate and healthy amounts of omega-6, due in large part to overconsumption of grain-fed meats and vegetable oils. Supplementation with fish oil high in omega-3 essential fatty acids can help restore balance along with a reduction in the intake of omega-6 sources. It is worth noting here that supplementation with omega-3 essential fatty acids has been shown to help prevent and reverse cachexic wasting commonly seen in cancer patients.²⁰

Most nutrition experts recommend that *trans* fats be minimized or eliminated from the diet, but most Americans are getting an average of 2.6% of their caloric intake from *trans* fats (Fig 1). *Trans* fats are created by making oil into something that is solid at room temperature instead of its natural liquid form. This is done by forcing hydrogen ions onto an unsaturated fat molecule (making margarine, for example). The incorporation of *trans* fats, rather than their naturally occurring *cis* cousins, into a cell membrane causes the membrane to become stiff and less permeable.

Healthy fats are naturally occurring: both saturated and unsaturated. Healthy saturated fats include organic coconut oil, avocado, and grass-fed organic meats and dairy products (butter, whole milk, and cheese). Healthy unsaturated fats include organic, cold-pressed virgin olive oil and walnut oil. The only fat that should be used in high-heat cooking is coconut oil. All oils should be kept in cool, airtight, dark containers to reduce rancidity. Never use a rancid or burned oil or fat.

ADDITIVES

Artificial sweeteners and additives should be avoided. Despite industry claims to the contrary, aspartame (NutraSweet; Merisant Corp, Chicago, IL) has been shown to be neurotoxic and actually protects adipose tissue from being used for fuel.^{21,22} It also promotes an insulin response and the release of growth factors because of its phenylalanine component. Sucralose (Splenda; McNeil Nutritionals, Fort Washington, PA) is a chlorinated sucrose derivative and falls into the category of chlorocarbons. There is not enough long-term testing to be certain this sweetener is safe for healthy people, let alone people facing a cancer challenge.

For the person who just has to have something to help break the sweet cravings, the herb Stevia is acceptable. It is much sweeter to the taste than sugar and yet does not promote an insulin spike; rather it may help to normalize blood sugar and insulin secretion.²³⁻²⁵

Monosodium glutamate is also a neurotoxin and should be avoided, especially by those battling a hormone-sensitive cancer, such as with many breast cancers.^{26,27} This is difficult because it is often hidden in processed foods, under other names such as hydrolyzed vegetable protein, so-

dium caseinate, yeast extract, textured protein, and “natural flavoring.”

BEVERAGES

The best beverage option is always pure, clean water. The patient can use lemon or lime slices to flavor plain water or bubbly water. Green tea has cancer-fighting properties of its own and can be consumed hot or cold. Alcohol should be avoided.

SPECIFICS

When adding nutrition to overall cancer care, one must consider the general information outlined above and also understand as much about the individual patient as possible, including current lab work, biopsy information, scan reports and treatment(s), in order to choose the right components for a plan to help the body protect healthy cells and enhance the treatment used against the cancer cells.

One must consider the specifics of the patient and the disease. No one-size-fits-all approach will work. Questions that must be examined include: What is the age of the patient? Gender? Overall health status and health history? Mental and emotional health? Current dietary and lifestyle habits? Is there a family/friend support network? Is the patient currently overweight or obese? Does the patient have any food allergies or preferences that have to be taken into consideration (lactose intolerance? vegetarian? vegan?)? What is the stage of the disease? The answers to these questions will lead to very different conclusions for each patient and the protocol that could be considered. If the patient exhibits age-related degenerative issues such as ill-fitting dentures, achloridia, dementia, and comorbid diseases such as diabetes, heart disease, and osteoporosis, your concerns will be considerably different from those you might have about a younger and generally healthier patient with essentially the same diagnosis. For the purposes of this article, the focus is on more widely applicable recommendations, but the cancer patient should be encouraged to consult with a clinical nutritionist well-versed in integrative cancer care to be sure the patient's individual needs are addressed.

CHEMOTHERAPY AND RADIATION

The main target of any cytotoxic chemotherapy or radiation treatment is rapidly dividing cells, which include normal cells as well as cancer cells. The use of nutrition as a care protocol addresses four main points: (1) protection of healthy cells; (2) prevention and mitigation of specific toxicities related to the treatment of choice; (3) enhancement of therapeutic outcomes; and (4) prevention of the onset of long-term side effects related to treatment toxicities. Most treatments have acute and long-term side effects that nutrition can address in many ways, including the enhancement and maintenance of the lymphocytic, renal, and hepatic elimination systems. During the treatment continuum and follow-up, overall nutrition and nutritional agents are valuable tools for the cancer patient. Additionally, botanical agents concurrently with nutritional therapies is common and can be beneficial.

To discuss this more specifically, we can examine doxorubicin, an antineoplastic anthracycline antibiotic. Toxicities include acute cardiotoxicity at a total dose of about 400 mg/m².²⁸ Mucositis and myelosuppression are often seen during treatment. Dysfunctional cognitive change (“chemo brain,” “chemo fog”) has been recognized as a side effect during and after treatment.^{29,30} In the long term, doxorubicin induces cardiomyopathy, which has a silent onset and develops years after treatment.

In the interest of simplicity, we will look at only a small number of nutritional elements that could be used to address the above issues. One can use the multi-tasking coenzyme Q10 (CoQ10) to protect cardiomyocytes and their mitochondria, allowing them to continue to produce energy while enabling them to continue to detoxify their internal environment.³¹ Bone marrow may be protected during treatment and boosted post-treatment by the inclusion of organic whey protein and garlic in the diet. Whey protein also has the unique ability to increase intracellular glutathione levels in normal cells, but actually decrease glutathione level in tumor cells. Along with a regimen of combination antioxidants, the inclusion of supplemental selenium and alkylglycerols (such as those found in shark liver oil) are also beneficial in boosting blood cell counts.

Doxorubicin (and ionizing radiation) commonly causes irritation and/or damage to the

mucosal lining of the gastrointestinal tract, which can lead to mucositis, thrush, difficulty swallowing, digestive upset, malabsorption, and ulceration. Gastrointestinal enterocytes have a natural life span of 1 to 3 days, but to provide continuous maintenance of the mucosal lining they must have an adequate supply of the amino acid L-glutamine. Administration of a “swish and swallow” during the course of radiation therapy can be extremely beneficial in protecting endothelial cells. Mannapol powder (a form of aloe from Carrington Laboratories [Irving, TX]) and L-glutamine, blended together in licorice tea and/or chamomile tea, can be used as a mouth rinse and then swallowed. This simple treatment can prevent and/or mitigate the causes and symptoms of mucositis, where conventional medical treatment routinely only offers pain reduction in the form of a Novocain mouth rinse.

During treatment with doxorubicin, the use of supplemental melatonin as well as L-theanine can protect against cardiotoxicity and enhance tumor cell uptake of the drug.^{32,33} Additionally, the use of botanical agents, such as astragalus and green tea, can often enhance the mechanisms of action of the chosen chemotherapeutic agent, or radiation, as well as act to protect normal cells and prevent specific toxicities. There are often situations where the use of a botanical agent is more efficacious than an individual constituent removed and refined from an herb. As a supplement, one could use L-theanine derived from tea; or as a botanical agent, one could use the whole herb extract and gain far more synergistic value from the complete set of constituents.

The liver is the site of doxorubicin metabolism and can be assisted and protected by the administration of N-acetyl cysteine to boost hepatic glutathione levels, and the herb silymarin (Milk Thistle) to aid in the maintenance and repair of hepatocytes.

The most dangerous long-term side effect of the use of doxorubicin is the silent onset of cardiomyopathy years after treatment. Low-dose antioxidants may prevent the worst effects of doxorubicin on the cardiomyocytes. Studies have shown a positive effect of concurrent antioxidant administration with chemotherapy.³⁴ There are theoretical arguments against this, but studies have shown that the administration of the laboratory-created antioxidant compound 2,2,5,5-tetramethylpyrro-

line simultaneously with doxorubicin protects cardiomyocytes from premature apoptosis and DNA damage.³⁵ If this is the case, it may be that the use of naturally occurring substances, such as a combination antioxidant blend of vitamins A, C, E, and mixed natural carotenoids along with CoQ10 and, in certain cases N-acetyl cysteine, could be used instead with equal or better results.^{36,37} Garlic also shows promise as a prophylactic against doxorubicin-induced cardiotoxicity.³⁸ Regardless of the decision made for or against the use of antioxidants concurrently with treatment, a regular combination antioxidant regimen along with N-acetyl cysteine, acetyl-L-carnitine, taurine, and magnesium post-treatment is essential for long-term prophylaxis against cardiomyopathy.

Doxorubicin, and especially the platinum drugs (carboplatin, cisplatin, oxaliplatin), are well-documented in their neurotoxic and nephrotoxic effects. Others that fall into this category include cyclophosphamide, Doxil (Alza Corp, Mountain View, CA), ifosfamide, melphalan, procarbazine, paclitaxel, taxotere, and vincristine. Peripheral neuropathy and “chemo brain” are some of the most common side effects of these treatments, and can be permanent without intervention. The B vitamins, essential fatty acids, L-glutamine, alpha-lipoic acid, CoQ10, and vitamin E are effective in the prevention and treatment of peripheral neuropathies. The inclusion of supplemental phosphatidyl serine and phosphatidyl choline is helpful in the treatment of cognitive changes. In addition, folic acid, B-12, trimethylglycine, and S-adenosylmethionine facilitate methylation, which can be helpful in the early stages of cancer to reverse its progression.³⁹

Radiotherapy has similar effects to chemotherapy, and many of the same recommendations apply. However, there are a few additional suggestions that might be mentioned. L-arginine can significantly increase the numbers of cancer cells killed when administered before treatment.³⁹ Supplemental vitamin A may reduce inflammation of the lung after thoracic radiation and, with vitamin E, may help prevent against radiation fibrosis.³⁹ The free radical scavenger taurine is severely depleted in patients that undergo radiation treatment and thus should be supplemented to protect the heart for the long term.⁴¹ Nightly consumption of melatonin can increase both survival rate and quality of life in cancer patients treated with ra-

diation and chemotherapy by acting as a free radical scavenger, an antioxidant and a chemosensitizer.^{39,40}

EXERCISE

The importance of exercise for general health and enhanced vitality must be emphasized. Exercise improves the function of the elimination and detoxification systems, mood, and enhances well being. There are many other health benefits including regulation of blood glucose, regulation of blood lipids (including cholesterol), regulation of blood pressure, improved sleep, improved brain function, and dramatically reduced risk for heart disease, cancers, diabetes, osteoarthritis, osteoporosis, and vascular disease.^{42,43} If there were a medication that could be prescribed that would accomplish all these things, doctors would be sued for malpractice if they did not insist their patients take it.

If patients can experience some of the above benefits, not the least of which are improved mood and stress reduction,⁴⁴ before the possible onset of treatment side effects, it will be far easier to motivate them to continue with an exercise program even though they may not feel their best. If the only thing the patient can do is walk around the hospital ward or inside their home, doing something is better than nothing.

CONCLUSION

This article is meant to be an introduction to general dietary guidelines for cancer patients, and to the possibilities available for the use of nutrition as a therapy. Good nutrition is the groundwork that must be in place before and throughout cancer treatment and recovery. These principles are not optional if optimal outcomes are the objective. Through the scientific application of diet, nutritional supplements, and botanical agents, many of the side effects of conventional treatment can be prevented or ameliorated by protecting healthy cells from cytotoxic effects without interfering with the treatment. Various nutritional and botanical components may synergistically enhance the actions of chemotherapeutic agents and of radiotherapy. The development of synergistic, supportive, and protective nutritional protocols

in concert with conventional cancer treatments has been shown to enhance quality of life and

may increase quantity of life as well for those facing a cancer challenge.

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