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### Alternative Medical Treatments of Cancer

Cancer (sometimes neoplasm or malignant tumor) is a general medical term used to refer to an extensive group of ailments that can occur in almost any part of the body. According to studies, including seminal findings by the World Health Organization (WHO), cancer begins when cells grow abnormally and uncontrollably beyond their usual confines to invade cells and spread to other organs. This spread of abnormal cancerous tissues is known as metastasizing and is a leading cause of mortality from cancer. Globally, cancer is one of the primary causes of mortality among humans, claiming nearly 10 million lives every year (WHO).

In the US, recent epidemiological statistics by the National Cancer Institute reveal that about 1.8 million new cases of cancer are reported in the country, and about 606,500 people succumb to the disease every year. The socio-economic impacts of cancer are also significant. For example, as of 2018, the US federal cancer care outlay stood at about \$150.8 billion (National Cancer Institute). In future years, these costs are projected to increase as people age, and more cancer diagnoses are made. Costs are also expected to increase as novel and often more expensive treatment modalities are adopted and used as standards of care.

While treating and managing cancer is critical, common methods of treatment, such as chemotherapy, have been found to have undesirable effects. Indeed, according to studies, some of the negative impacts of chemo include reduced number of blood cells, neutropenia and anemia, increased bleeding and bruising, hair changes (thinning and hair loss), digestive problems (nausea, diarrhea, loss of appetite), and numerous other health challenges like fatigue and effects on the nervous system (American Cancer Society; Macmillan Cancer Support). This has made

herbal remedies more popular for an increasing number of patients. But do these alternative approaches really work? This ensuing analysis examines such an alternative: Vitamin C treatment.

### **Vitamin C: Cancer Treatment**

Medical insights have revealed that carcinogenesis arises from the abnormal transformation of cells into cancerous cells. This change is an intricate multi-phase process that comes from the interaction between a patient's genetics and other external cancer-causing elements such as asbestos and viral infections (WHO). Due to the health burden and socio-economic costs of cancer, the treatment of malignancies has been critical not only for the prevention of death but also for the restoration of health and day-to-day functionalities. But as noted earlier, chemotherapy has numerous undesirable side effects, and these have prompted individuals to seek alternative treatment approaches. One of these – and increasingly used alternatives – is Vitamin C.

Clinical interest in using Vitamin C in treating cancer is, however, not a new thing. Available research indicates that high doses of ascorbic acid were being used as early as the '70s in treating cancer when it was discovered that this vitamin had some properties that could make it toxic to malignant cells (Giridhar). While initial human trials showed encouraging outcomes, these reports were established to be defective, and ensuing randomized controlled trials (RCTs) have mixed outcomes. Some studies have shown positive outcomes, and despite a continued lack of concrete long-term evidence, Vitamin C has continued to be prescribed for cancer treatment. For example, in Cameron and Campbell's 1974 analysis, high-dose Vitamin C was found to have beneficial therapeutic effects on cancer patients. In this particular study, it was established that

ascorbate, a form of vitamin C, had suppressive properties that could prevent carcinogenesis by repressing hyaluronidase.

Likewise, a 1976 study of 100 patients found that terminally ill cancer patients can benefit from ascorbate calcium. Overall, the study's results established that cancer patients treated with Vitamin C exhibited better therapeutic outcomes, including increased longevity (Thom and Pauling). However, these earlier case studies have been criticized for being acceptable standards, but newer RCTs, including findings by Creagan et al., still don't show encouraging effects of this vitamin. But seemingly controversial results are emerging from more recent studies, with some showing that Vitamin C given intravenously can have different outcomes as those taken orally in pill form. This, as Van Gorkom et al. as well as Cantley and Yun state, has relit interest and encouraged further investigation into the therapeutic possibility of this vitamin.

So, recently, there has been a significant increase in the number and scale of phase RCTs testing the efficacy but also the safety of Vitamin C in the treatment of cancer. For instance, regarding in vivo studies, Roa et al. found that pharmacological ascorbate administered intraperitoneally, injected in the abdomen, decreased growth effects of various tumors such as human ovarian glioblastoma. According to the study, the cytotoxicity of vitamin C is associated with the extracellular production of hydrogen peroxide ( $H_2O_2$ ) and causes intracellular metal transition. This supports the prevention of Reactive Oxygen Species (ROS), like cancer cells, accomplished by high Vitamin C accumulations in tumors as a process of tumor cell death (apoptosis). In various human malignancies, including pancreatic tumors, mesothelioma, as well as human breast cancer it was effective.

Moreover, clinical experiments done *in vitro* to assess the compatibility and efficacy with other anti-carcinogenic substances have concluded that Vitamin A can have synergistic effects with most of them. For example, Gemcitabine, when used in combination with Vitamin A, is shown in Roa et al.'s analysis to have synergistic cytotoxic effects in about eight pancreatic tumor cell lines due to a phenomenon of ascorbate's pro-oxidant effects with increased H<sub>2</sub>O<sub>2</sub> production. A synergistic effect of Vitamin A and certain chemotherapeutic drugs such as those prescribed in ovarian cancer treatment (carboplatin and paclitaxel) have also been found to decrease the adverse effects of chemotherapeutic medications used in the treatment and management of this cancer. Similarly, in TNBC (triple-negative breast cancer), test results of a combination of Vitamin C, Auranofin, and Ivermectin have been shown to induce cytotoxicity against breast cancer by targeting TRXR (thioredoxin reductase) (Roa et al.).

For years, Vitamin C has been advanced as a potential therapeutic candidate for cancer management. Various clinical sources have revealed that the concentration of this vitamin can selectively induce the death of cancer cells *in vitro*. Also discussed, other studies have shown little to no effect of Vitamin C in tumor management. Consequently, there is still uncertainty regarding the potential therapeutic benefits of Vitamin C in this regard. Emerging clinical reports suggest that high dose administration of Vitamin C can have positive outcomes if given properly and in unison with other treatment modalities such as AUF, low-dose chemo, and an array of repurposed medicines to yield positive results. Further research is, however, needed to win the fight against cancer.

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