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High-Dose Vitamin C (PDQ®)

Patient Version

PDQ Integrative, Alternative, and Complementary Therapies Editorial Board.

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This PDQ cancer information summary has current information about the use of high-dose vitamin C in the treatment of people with cancer. It is meant to inform and help patients, families, and caregivers. It does not give formal guidelines or recommendations for making decisions about health care.

Editorial Boards write the PDQ cancer information summaries and keep them up to date. These Boards are made up of experts in cancer treatment and other specialties related to cancer. The summaries are reviewed regularly and changes are made when there is new information. The date on each summary ("Date Last Modified") is the date of the most recent change. The information in this patient summary was taken from the health professional version, which is reviewed regularly and updated as needed, by the PDQ Integrative, Alternative, and Complementary Therapies Editorial Board.

Overview

- [Vitamin C](#) is a [nutrient](#) found in food and [dietary supplements](#). It is an [antioxidant](#) and also plays a key role in making [collagen](#) (see [Question 1](#)).
- High-[dose](#) vitamin C may be given by [intravenous \(IV\) infusion](#) (through a [vein](#) into the bloodstream) or [orally](#) (taken by mouth). When taken by intravenous infusion, vitamin C can reach much higher levels in the [blood](#) than when the same amount is taken by mouth (see [Question 1](#)).
- High-[dose](#) vitamin C has been studied as a treatment for patients with [cancer](#) since the 1970s (see [Question 2](#)).
- [Laboratory studies](#) have shown that high doses of vitamin C may slow the growth and spread of [prostate](#), [pancreatic](#), [liver](#), [colon](#), and other types of cancer [cells](#) (see [Question 5](#)).
- Some laboratory and animal studies have shown that combining vitamin C with anticancer [therapies](#) may be helpful, while other studies have shown that certain forms of vitamin C may make [chemotherapy](#) less effective (see [Question 5](#)).

- [Animal studies](#) have shown that high-dose vitamin C treatment blocks [tumor](#) growth in certain [models](#) of pancreatic, liver, prostate, and [ovarian cancers](#), [sarcoma](#), and [malignant mesothelioma](#) (see [Question 5](#)).
- Some human studies of high-dose IV vitamin C in patients with cancer have shown improved [quality of life](#), as well as improvements in physical, mental, and emotional functions, [symptoms](#) of [fatigue](#), [nausea](#) and [vomiting](#), pain, and [appetite](#) loss (see [Question 6](#)).
- [Intravenous](#) high-dose [ascorbic acid](#) has caused very few [side effects](#) in [clinical trials](#) (see [Question 7](#)).
- While generally approved as a dietary supplement, the [U.S. Food and Drug Administration](#) (FDA) has not approved the use of IV high-dose vitamin C as a treatment for cancer or any other medical [condition](#) (see [Question 9](#)).

Questions and Answers About High-Dose Vitamin C

1. What is high-dose vitamin C?

[Vitamin C](#) (also called L-ascorbic acid or ascorbate) is a [nutrient](#) that humans must get from food or [dietary supplements](#) since it cannot be made in the body. Vitamin C is an [antioxidant](#) and helps prevent [oxidative stress](#). It also works with [enzymes](#) to play a key role in making [collagen](#).

When taken by [intravenous \(IV\) infusion](#), vitamin C can reach much higher levels in the [blood](#) than when it is taken by mouth. Studies suggest that these higher levels of vitamin C may cause the death of [cancer cells](#) in the laboratory.

A severe [deficiency](#) (lack) of vitamin C in the [diet](#) causes scurvy, a disease with [symptoms](#) of extreme weakness, [lethargy](#), easy bruising, and bleeding. The lack of vitamin C in patients with scurvy makes collagen thinner in texture; when vitamin C is given, collagen becomes thicker again.

2. What is the history and use of high-dose vitamin C as a complementary and alternative treatment for cancer?

High-[dose](#) vitamin C has been studied as a treatment for patients with cancer since the 1970s. A Scottish [surgeon](#) named Ewan Cameron worked with Nobel Prize-winning chemist Linus Pauling to study the possible benefits of vitamin C [therapy](#) in [clinical trials](#) of cancer patients in the late 1970s and early 1980's.

Surveys of healthcare [practitioners](#) at United States [CAM](#) conferences in recent years have shown that high-dose IV vitamin C is frequently given to patients as a treatment for [infections](#), [fatigue](#), and cancers, including [breast cancer](#).

3. What is the theory behind the claim that high-dose vitamin C is useful in treating cancer?

More than fifty years ago, a study suggested that cancer was a disease of changes in [connective tissue](#) caused by a lack of vitamin C. In the 1970's, it was proposed that high-dose [ascorbic acid](#) could help build resistance to disease or infection and possibly treat cancer.

Later studies showed that the levels of vitamin C that collect in the bloodstream depend on how it is taken.

4. **How is high-dose vitamin C administered?**

Vitamin C may be given by intravenous (IV) infusion or taken by mouth, although much higher blood levels are reached when given [intravenously](#).

5. **Have any preclinical (laboratory or animal) studies been conducted using high-dose vitamin C?**

[Laboratory studies](#) and [animal studies](#) have been done to find out if high-dose vitamin C may be useful in preventing or treating cancer.

Laboratory studies

Many laboratory studies have been done to find out how high-dose vitamin C may cause the death of cancer cells. The anticancer effect of vitamin C in different types of cancer cells involves a [chemical](#) reaction that makes [hydrogen peroxide](#), which may kill cancer cells.

Laboratory studies have shown the following:

- Treatment with high-dose vitamin C slowed the growth and spread of [prostate](#), [pancreatic](#), [liver](#), [colon](#), [malignant mesothelioma](#), [neuroblastoma](#), and other types of cancer cells.
- Combining high-dose vitamin C with certain types of [chemotherapy](#) may be more effective than chemotherapy alone:
 - Ascorbic acid with [arsenic trioxide](#) may be more effective in [ovarian cancer](#) cells.
 - Ascorbic acid with [gemcitabine](#) may be more effective in [pancreatic cancer](#) cells.
 - Ascorbic acid with [gemcitabine](#) and [epigallocatechin-3-gallate](#) (EGCG) may be more effective in malignant mesothelioma cells.
- Another laboratory study suggested that combining high-dose vitamin C with [radiation therapy](#) killed more [glioblastoma multiforme](#) cells than radiation therapy alone.

However, not all laboratory studies combining vitamin C with anticancer therapies have shown benefit. Combining dehydroascorbic acid, a particular form of vitamin C, with chemotherapy made it less effective in killing some kinds of cancer cells.

Animal studies

Studies of high-dose vitamin C have been done in [animal models](#) (animals given a disease either the same as or like a disease in humans).

Some of the studies showed the vitamin C helped kill more cancer cells:

- High-dose vitamin C blocked [tumor](#) growth in animal models of pancreatic, liver, prostate, sarcoma, and ovarian cancers and malignant mesothelioma.
- High-dose vitamin C combined with chemotherapy in a [mouse model](#) of pancreatic cancer showed that the combination treatment shrank tumors more than chemotherapy treatment alone.
- Another study showed that vitamin C made a type of [light therapy](#) more effective when used to treat mice injected with breast cancer cells.
- A study in a mouse model of ovarian cancer showed that combining intravenous high-dose vitamin C with the anticancer drugs [carboplatin](#) and [paclitaxel](#) made them more effective in treating ovarian cancer.

However, other animal studies have shown that vitamin C interferes with the anticancer action of certain [drugs](#), including the following:

- Mouse models of human [lymphoma](#) and [multiple myeloma](#) treated with combinations of vitamin C and chemotherapy or the drug [bortezomib](#) had more tumor growth than mice treated with [bortezomib](#) alone.

6. **Have any clinical trials (research studies with people) of high-dose intravenous (IV) vitamin C been conducted?**

Several studies of high-dose vitamin C in patients with cancer have been done in recent years, including the following:

Studies of vitamin C alone

- Intravenous (IV) vitamin C was studied in patients with breast cancer who were treated with [adjuvant chemotherapy](#) and radiation therapy. The study found that patients who received IV vitamin C had better [quality of life](#) and fewer [side effects](#) than those who did not.
- A study of IV vitamin C and high doses of vitamin C taken by mouth was done in patients with cancer that could not be [cured](#). Vitamin C was shown to be a safe and effective therapy to improve quality of life in these patients, including physical, mental, and emotional functions, symptoms of fatigue, [nausea](#) and [vomiting](#), pain, and [appetite](#) loss.
- Vitamin C has been shown to be safe when given to healthy volunteers and cancer patients at doses up to 1.5 g/kg, while screening out patients with certain [risk factors](#) who should avoid vitamin C. Studies have also shown that Vitamin C levels in the blood are higher when taken by IV than when taken by mouth, and last for more than 4 hours.

Studies of vitamin C combined with other drugs

Studies of vitamin C combined with other drugs have shown mixed results:

- In a small study of 14 patients with [advanced](#) pancreatic cancer, IV vitamin C was given along with chemotherapy and treatment with a [targeted therapy](#). Patients had very few bad side effects from the vitamin C treatment. The nine patients who completed the treatment had [stable disease](#) as shown by [imaging](#) studies.
- In another small study of 9 patients with advanced pancreatic cancer, patients were given chemotherapy in [treatment cycles](#) of once per week for 3 weeks along with IV vitamin C twice per week for 4 weeks. These patients had disease that did not [progress](#) for a period of months. The [combined](#) treatment was well tolerated and no serious side effects were reported.
- In a 2014 study of 27 patients with advanced ovarian cancer, treatment with chemotherapy alone was compared to chemotherapy along with IV vitamin C. Patients who received IV vitamin C along with chemotherapy had fewer serious side effects from the chemotherapy.
- Patients with [refractory metastatic colorectal cancer](#) or metastatic [melanoma](#) treated with IV vitamin C combined with other drugs had serious side effects, the disease got worse, and there was no anticancer effect. These studies were not [controlled](#) with a comparison group so it is unclear how much the IV vitamin C contributed to the side effects.

More studies of combining high-dose IV vitamin C with other drugs are in progress.

7. Have any side effects or risks been reported from high-dose vitamin C?

Intravenous high-dose ascorbic acid has caused very few side effects in clinical trials. However, high-dose vitamin C may be harmful in patients with certain risk factors.

- In patients with a [history](#) of [kidney disorders](#), [kidney failure](#) has been reported after ascorbic acid treatment. Patients with a tendency to develop kidney stones should not be treated with high-dose vitamin C.
- [Case reports](#) have shown that patients with an [inherited](#) disorder called G-6-PD deficiency should not be given high doses of vitamin C, due to the risk of [hemolysis](#) (a [condition](#) in which [red blood cells](#) are destroyed).
- Since vitamin C may make [iron](#) more easily absorbed and used by the body, high doses of the vitamin are not recommended for patients with [hemochromatosis](#) (a condition in which the body takes up and stores more iron than it needs).

8. Have any drug interactions been reported from combining high-dose vitamin C with anticancer drugs?

A [drug interaction](#) is a change in the way a [drug](#) acts in the body when taken with certain other drugs. High-dose vitamin C, when combined with some anticancer drugs, may cause them to be less effective. So far, these effects have been seen only in some

laboratory and animal studies. No clinical trials have been done to further research these drug interactions in humans.

- Combining vitamin C with an anticancer drug called [bortezomib](#) has been studied in [cell cultures](#) and in animal models. Bortezomib is a targeted therapy that blocks several [molecular pathways](#) in a cell, causing cancer cells to die. Several studies showed that vitamin C given by mouth made bortezomib less effective, including in multiple myeloma cells. A study in mice transplanted with human prostate cancer cells, however, did not show that giving the mice different doses of vitamin C by mouth made bortezomib therapy less effective.
- An [oxidized](#) form of vitamin C called dehydroascorbic acid has been studied in cell cultures and in animals with tumors. Several studies have found that high doses of dehydroascorbic acid can interfere with the anticancer effects of several chemotherapy drugs. Dehydroascorbic acid is found in only small amounts in dietary supplements and in fresh foods.

See [Question 5](#) and [Question 6](#) for more information on combining vitamin C with anticancer drugs.

9. Is high-dose vitamin C approved by the U.S. Food and Drug Administration for use as a cancer treatment in the United States?

The [U.S. Food and Drug Administration](#) (FDA) has not approved the use of high-dose vitamin C as a treatment for cancer or any other medical condition.

About This PDQ Summary

About PDQ

Physician Data Query (PDQ) is the National Cancer Institute's (NCI's) comprehensive cancer information database. The PDQ database contains summaries of the latest published information on cancer prevention, detection, genetics, treatment, supportive care, and complementary and alternative medicine. Most summaries come in two versions. The health professional versions have detailed information written in technical language. The patient versions are written in easy-to-understand, nontechnical language. Both versions have cancer information that is accurate and up to date and most versions are also available in [Spanish](#).

PDQ is a service of the NCI. The NCI is part of the National Institutes of Health (NIH). NIH is the federal government's center of biomedical research. The PDQ summaries are based on an independent review of the medical literature. They are not policy statements of the NCI or the NIH.

Purpose of This Summary

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Reviewers and Updates

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Clinical Trial Information

A clinical trial is a study to answer a scientific question, such as whether one treatment is better than another. Trials are based on past studies and what has been learned in the laboratory. Each trial answers certain scientific questions in order to find new and better ways to help cancer patients. During treatment clinical trials, information is collected about the effects of a new treatment and how well it works. If a clinical trial shows that a new treatment is better than one currently being used, the new treatment may become "standard." Patients may want to think about taking part in a clinical trial. Some clinical trials are open only to patients who have not started treatment.

Clinical trials are listed in PDQ and can be found online at [NCI's website](#). Many cancer doctors who take part in clinical trials are also listed in PDQ. For more information, call the Cancer Information Service 1-800-4-CANCER (1-800-422-6237).

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The information in these summaries should not be used to make decisions about insurance reimbursement. More information on insurance coverage is available on Cancer.gov on the [Managing Cancer Care](#) page.

Contact Us

More information about contacting us or receiving help with the Cancer.gov website can be found on our [Contact Us for Help](#) page. Questions can also be submitted to Cancer.gov through the website's [E-mail Us](#).

General CAM Information

Complementary and alternative medicine (CAM)—also called integrative medicine—includes a broad range of healing philosophies, approaches, and therapies. A therapy is generally called complementary when it is used in addition to conventional treatments; it is often called alternative when it is used instead of conventional treatment. (Conventional treatments are those that are widely accepted and practiced by the mainstream medical community.) Depending on how they are used, some therapies can be considered either complementary or alternative. Complementary and alternative therapies are used in an effort to prevent illness, reduce stress, prevent or reduce side effects and symptoms, or control or cure disease.

Unlike conventional treatments for cancer, complementary and alternative therapies are often not covered by insurance companies. Patients should check with their insurance provider to find out about coverage for complementary and alternative therapies.

Cancer patients considering complementary and alternative therapies should discuss this decision with their doctor, nurse, or pharmacist as they would any type of treatment. Some complementary and alternative therapies may affect their standard treatment or may be harmful when used with conventional treatment.

Evaluation of CAM Therapies

It is important that the same scientific methods used to test conventional therapies are used to test CAM therapies. The National Cancer Institute and the National Center for Complementary and Integrative Health (NCCIH) are sponsoring a number of clinical trials (research studies) at medical centers to test CAM therapies for use in cancer.

Conventional approaches to cancer treatment have generally been studied for safety and effectiveness through a scientific process that includes clinical trials with large numbers of patients. Less is known about the safety and effectiveness of complementary and alternative methods. Few CAM therapies have been tested using demanding scientific methods. A small number of CAM therapies that were thought to be purely alternative approaches are now being used in cancer treatment—not as cures, but as complementary therapies that may help patients feel better and recover faster. One example is acupuncture. According to a panel of experts at a National Institutes of Health (NIH) meeting in November 1997, acupuncture has been found to help control nausea and vomiting caused by chemotherapy and pain related to surgery. However, some approaches, such as the use of laetrile, have been studied and found not to work and to possibly cause harm.

[The NCI Best Case Series Program](#) which was started in 1991, is one way CAM approaches that are being used in practice are being studied. The program is overseen by the NCI's Office of Cancer Complementary and Alternative Medicine (OCCAM). Health care professionals who offer alternative cancer therapies submit their patients' medical records and related materials to OCCAM. OCCAM carefully reviews these materials to see if any seem worth further research.

Questions to Ask Your Health Care Provider About CAM

When considering complementary and alternative therapies, patients should ask their health care provider the following questions:

- What side effects can be expected?
- What are the risks related to this therapy?
- What benefits can be expected from this therapy?
- Do the known benefits outweigh the risks?
- Will the therapy affect conventional treatment?
- Is this therapy part of a clinical trial?
- If so, who is the sponsor of the trial?
- Will the therapy be covered by health insurance?

To Learn More About CAM

National Center for Complementary and Integrative Health (NCCIH)

The National Center for Complementary and Integrative Health (NCCIH) at the National Institutes of Health (NIH) facilitates research and evaluation of complementary and alternative practices, and provides information about a variety of approaches to health professionals and the public.

- NCCIH Clearinghouse
- Post Office Box 7923 Gaithersburg, MD 20898-7923
- Telephone: 1-888-644-6226 (toll free)
- TTY (for deaf and hard of hearing callers): 1-866-464-3615

- E-mail: info@nccih.nih.gov
- Website: <https://nccih.nih.gov>

CAM on PubMed

NCCIH and the NIH National Library of Medicine (NLM) jointly developed [CAM on PubMed](#), a free and easy-to-use search tool for finding CAM-related journal citations. As a subset of the NLM's PubMed bibliographic database, CAM on PubMed features more than 230,000 references and abstracts for CAM-related articles from scientific journals. This database also provides links to the websites of over 1,800 journals, allowing users to view full-text articles. (A subscription or other fee may be required to access full-text articles.)

Office of Cancer Complementary and Alternative Medicine

The NCI Office of Cancer Complementary and Alternative Medicine (OCCAM) coordinates the activities of the NCI in the area of complementary and alternative medicine (CAM). OCCAM supports CAM cancer research and provides information about cancer-related CAM to health providers and the general public via the [NCI website](#).

National Cancer Institute (NCI) Cancer Information Service

U.S. residents may call the NCI Cancer Information Service toll free at 1-800-4-CANCER (1-800-422-6237) Monday through Friday from 8:00 am to 8:00 pm. A trained Cancer Information Specialist is available to answer your questions.

Food and Drug Administration

The Food and Drug Administration (FDA) regulates drugs and medical devices to ensure that they are safe and effective.

- Food and Drug Administration
- 10903 New Hampshire Avenue
- Silver Spring, MD 20993
- Telephone: 1-888-463-6332 (toll free)
- Website: <http://www.fda.gov>

Federal Trade Commission

The Federal Trade Commission (FTC) enforces consumer protection laws. Publications available from the FTC include:

- *Who Cares: Sources of Information About Health Care Products and Services*
- *Fraudulent Health Claims: Don't Be Fooled*
- Consumer Response Center
- Federal Trade Commission

- 600 Pennsylvania Avenue, NW
- Washington, DC 20580
- Telephone: 1-877-FTC-HELP (1-877-382-4357) (toll free)
- TTY (for deaf and hard of hearing callers): 202-326-2502
- Website: <http://www.ftc.gov>

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