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The Science of Vitamin C

1271 High Street, Auburn, CA 95603 • Phone (530) 823-7092 • Toll Free (800) 359-6091
E-mail: Jim@imageawareness.com web: www.ImageAwareness.com

December 2020 Volume 16: Issue 4

Introduction

Ingestion of adequate quantities of vitamin C has been of nutritional importance as a matter of life and death since before historical records began to be kept. Man, unlike most other forms of life on earth is incapable of manufacturing vitamin C from glucose within the body.

Glucose and Vitamin C

Glucose is the most important source of energy for almost all forms of life. Glucose is a form of sugar which is used in the metabolic process which leads to the body's primary source of energy called ATP. ATP is the source of energy for life in the same manner that electricity or gasoline is the source of energy for an automobile.

Humans have a strong craving for sugar. This is probably because of the strong connection between energy production and glucose. Our brains are wired for sweetness. A sweet food which is toxic is almost impossible to find. Sweet foods are almost always accompanied by generous quantities of vitamin C as well.

The association between sweet foods and vitamin C content is not a major concern for most creatures which can manufacture their own vitamin C from glucose. It is a major factor for humans and other primates as well as for the guinea pig and a species of fruit eating bat that can not manufacture vitamin C within their bodies. Humans lack an enzyme (L-gulonolactone oxidase) which is essential for converting glucose into vitamin C.

Man's uniqueness with regard to the ability to synthesize vitamin C hindered research on the vitamin resulting in its discovery after the vitamins we call A and B. It was not until 1907 that it was discovered that guinea pigs could develop scurvy, providing an animal model for the human disease.

The metabolism of vitamin C is similar to that of sugar. A molecular pump called GLUT (Glucose Transporter) moves both glucose and vitamin C into the cell.

GLUT is like a bus with limited seats. If all the seats are filled with glucose, there may be no room or insufficient room for vitamin C to hitch a ride into the cells.

One consequence of this transporter is that the body can channel insufficient intakes of vitamin C into tissues that have a critical need for the vitamin such as white blood cells and the adrenal glands.

The vitamin C requirements set by the government were based on studies of white blood cells which get preferential access to vitamin C in the body. Other tissues can be suffering deficiency of vitamin C while white blood cells appear normal leading to recommendations for inadequate intake of vitamin C to provide optimal intake of the vitamin. It is interesting that government recommendations for vitamin C intake for primates are several orders of magnitude greater than the recomendations for human beings.

In nature glucose is almost always accompanied by generous quantities of vitamin C. Unfortunately, with the industrialization of sugar production an ever increasing number of foods have become rich in content of sugars and deficient in vitamin C content.

Vitamin C and glucose compete for absorption into cells. Thus high intakes of sugar can hinder the effectiveness of vitamin C, particularly when administered as oral doses along with a high intake of sugars. Hickey and Saul suggest that glucose can serve as an "antidote" to this essential vitamin.

The result of *competitive absorption* can be cells depleted of vitamin C decreasing immune competence and increasing the likelihood of infectious disease.

Insulin moves the GLUT receptor

to the surface of the cell membrane allowing for entrance of glucose and vitamin C into the cell. This can pose a special problem for diabetics who often have both high blood glucose levels and also insulin that does not function properly. Many of the long-term complications of diabetes are earily similar to the symptoms of scurvy.

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"500-mg Vitamin C Tablets and Paprikas" published in PMID:15971944 Albert Szent-Györgyi wrote that he won a Nobel Prize after he found a way to mass produce vitamin C for research purposes when he lived in Szeged, which had become the center of the paprika (red pepper) industry.[1] ↑ (June 1963). "Lost in the Twentieth Century". *Annual Review of Biochemistry* 32 (1): 1-15.

https://commons.wikimedia.org/wiki/File:Vitamin_C_tablets_and_paprikas.png

https://commons.wikimedia.org/wiki/File:James_Lind_by_Chalmers.jpg

Dynamic Flow

In 2004 Hickey and Roberts introduced the dynamic flow model of vitamin C. The dynamic flow model is built around the understanding that the half-life of vitamin C at higher levels of intake is only about 30 minutes.

Vitamin C exists in two forms: oxidized and reduced. Oxidized vitamin C (dehydroascorbate) does not function as an antioxidant. The active form of vitamin C is the reduced form or ascorbate. Ascorbate grabs onto free radicals and becomes oxidized. Oxidized vitamin C is then either excreted or regenerated into ascorbate.

When intake of vitamin C is high, the body readily dumps the vitamin as it becomes oxidized removing large quantities of free radicals from the tissues of body.

The absorption of vitamin C from the digestive tract is limited. In addition, high levels of intake are also generously excreted by the kidneys into the urine. Absorption of a dose of 180 mg of vitamin C will be 80-90% absorbed, while the absorption of 1,000 mg (1 gram) is about 75%, 1.5 gram is 50%, 6 grams about 26%, and 12 grams about 16%.

Hickey and Roberts explain the significance of the dynamic flow model as follows: "A single megadose will provide only a fraction of the benefit of split or slow release doses." Repeated oral doses of vitamin C can result in a blood level of the vitamin at least three times greater than the average with a single large dose. Injections result in much higher levels.

Clinical trials using a single dose of the vitamin will invariably underestimate the benefit of vitamin C which applies to almost all clinical trials which have been conducted.

Hickey and Roberts also assert that "Doses below dynamic flow will not provide adequate protection against susceptibility to disease."

The researchers predict that any large single dose will produce results comparable to a single 500 mg dose due to the short half-life of the vitamin. Single doses will establish dynamic flow for only 4-6 hours.

Vitamin C in foods is released slowly as the foods are digested. To accomplish similar results with supplements one must either take multiple doses or use a slow release form of the vitamin.

Requirements for vitamin C vary with the insults with which the body must cope. Hilary and Roberts suggest that 3,000 mg. of slow release vitamin C is adequate to maintain dynamic flow and combat most challenges by bacteria, viruses, and toxins.

The greater the challenge the greater the requirement of vitamin C. In extreme cases, as will be discussed later, it may be difficult to obtain adequate blood levels of vitamin C by oral intake alone. In such situations injections of vitamin C have been used successfully by some physicians.

Ascorbate Flush

The intake of excessive vitamin C results in diarrhea or what is known as the ascorbate flush. A flush can take place with a low intake in some people. The flush is the result of reaching "bowel tolerance" for the vitamin.

Bowel tolerance is assessed by beginning with a low dose of the vitamin and repeating it each hour until bowel tolerance is reached. Bowel tolerance is reached when one experiences gas, distension, and loose stool. *There are some people that do not tolerate large quantities of vitamin C due to genetic factors or other causes.*

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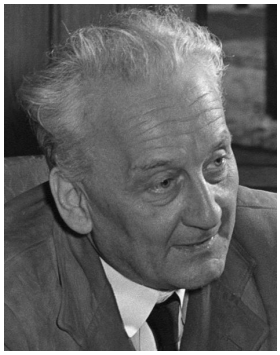
Lessons from History

James Lind

Scurvy, the disease resulting from inadequate intake of vitamin C, decimated human populations deprived of fresh foods for thousands of years. The first controlled experiment in medicine was conducted by James Lind in 1747 and demonstrated that fresh citrus could cure scurvy.

The value of Lind's work was not recognized and acted upon until after his death. The lesson to be learned here is that preconceived ideas can block or slow the acceptance of valuable insights into nutrition. Men of Lind's day had difficulty giving up their own ideas even when they were obviously untrue. One prominent fig-



ure actually allowed a friend to die rather than give a trial to citrus fruits.

Lind found that remarkably small quantities of citrus fruit were required to cure scurvy. This contributed to the idea that only small quantities of the vitamin are necessary for health, which is an entirely different issue altogether. Prevention of a deficiency disease is not a measure of the optimal intake of a vitamin.

Albert Szent-Gyorgyi

Vitamin C was first isolated from the adrenal gland of an ox by Szent-Gyorgyi in 1928. In 1931 he was able to isolate enough of the sugar-like compound from peppers to prove it was vitamin C. This resulted in a shared Nobel Prize in 1937. Gyorgyi always maintained that this nutrient was required in gram quantities for optimal health.

The Nobel Prize was shared with Sir Walter Haworth who learned how to synthesize the vitamin inexpensively. Without the inexpensive synthesis of vitamin C, the use of high doses by later researchers would have been impossible.

Claus Washington Jungeblut

Claus Jungeblut (1898-1976) was a well-known polio researcher in the 1930's. He published an important paper in 1935 concerning his discovery that vitamin C would prevent and cure polio. He would later publish research suggesting that vitamin C could inactivate not only viruses, but also bacteria and bacterial toxins.

Frederick Klenner

Frederick Klenner (1907-1984) was undoubtedly influenced by Jungeblut. He experimented upon himself with large quantities of vitamin C and concluded that is was very safe.

Klenner's specialty was diseases of the chest which led him to research on viral diseases and polio. No one had previously used the massive doses of vitamin C Klenner used to treat his patients. He would treat polio patients with up to 300 grams (300,000 milligrams) of vitamin C by injection (and orally) in divided doses.

In 1949 Klenner presented a paper to the American Medical Association detailing the complete cure of 60 patients with polio using nothing but massive doses of vitamin C. The research was ignored by other physicians. Klenner would go on to treat a wide variety of other infectious diseases with vitamin C.

Klenner was a key figure in the history of vitamin C. His work influenced Irwin Stone, Lendon Smith, Linus Pauling, and Robert Cathcart III. All of these men became giants in the continuing saga of vitamin C.

Irwin Stone

Stone was an industrial chemist. He reasoned that the intake of vitamin C for humans should mirror what was produced in the bodies of animals that manufactured the vitamin from glucose. This led him to the conclusion that the human requirement in low stress situations was 2-4 grams a day, while as much as 15 grams or more might be required in high stress situations.

Stone was involved in a head-on collision at 80 miles an hour around 1960. He credited his intake of 50-60 grams of vitamin C a day to his recovery from severe injuries after 3 months of hospitalization.

Stone published *The Healing Factor: "Vitamin C" Against Disease* in 1972. This was one of the most important books ever published on the vitamin. This was the first systematic presentation of the story of vitamin C and its value in a wide variety of health conditions. The book was a forerunner to Thomas Levy's book *Curing the Incurable: Vitamin C, Infectious Diseases, and Toxins* which extend's and updates Stone's work with over 1,200 references.

Linus Pauling

Pauling is the only person to receive two unshared Nobel Prizes. He received a great deal of opposition from the scientific community when he chose to champion the cause of increased intake of vitamin C. Pauling learned of vitamin C from Irwin Stone.

Pauling coined the word orthomolecular to identify medical treatments which use molecules normal to the body rather than toxic substances usually promoted by pharmaceutical firms. The first orthomolecular treatment for a disease was Abram Hoffer's use of vitamin C and vitamin B3 to treat schizophrenia.

Pauling teamed up with Ewan Cameron and the amazing results of their research into the use of vitamin C to treat cancer are available in a book they published in 1979.

Cameron was a surgeon with 30 years experience studying the resistance of normal tissues to infiltration by tumors. His contact with Pauling took place in 1971 and resulted in the administration of large quantities of vitamin C (10 grams) to cancer patients.

Cameron noted "an improved appetite, increased mental alertness, decreased requirement for pain-killing drugs, and other clinical criteria."

The discovery that vitamin C reduced the need for opiate drugs and that patients could withdraw from the drugs with minimum difficulty resulted in a classic paper by Irwin Stone and Alfred Libby on the use of vitamin C to treat opiate addiction.

Pauling created even more controversy with his book suggesting that the cold and flu could be pre-

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WELLNESS INSTITUTE
1271 HIGH STREET, AUBURN, CA 95603
PHONE (530) 823-7092 ORDER LINE (800) 359-6091
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vented or ameliorated by proper use of vitamin C. Pauling recommended taking vitamin C in split doses. For the flu he suggested most people would need "the regular intake of 1 gram or more per hour."

Robert Cathcart III

Robert Cathcart became interested in vitamin C after reading Pauling's book on vitamin C and the common cold. Editors of medical journals scorned the work of both Pauling and Cathcart and refused take notice of or to publish their work.

Cathcart not only experimented with large quantities of vitamin C on himself, but he also administered vitamin C to bowel tolerance to 20,000 of his patients. He found that as need for the vitamin increased it was better tolerated. No one since Klenner had used such quantities of vitamin C. Cathcart administered up to 200 grams of vitamin C orally or by injection. Cathcart felt that these kinds of dosages could be used to treat virtually any kind of viral disease including the flu. Due to opposition Cathcart's work is not well published.

Archie Kalokerinos

Kalokerinos was a physician working with the aboriginal people in Australia. He learned that vaccination of a child who was deficient in vitamin C could result in death. He began administering vitamin C prior to vaccination to avoid complications such as Sudden Infant Death Syndrome (SIDS).

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Conclusion

There has been little formal study of the forms of administration of vitamin C these pioneers found most effective. This is unfortunate, but pharmaceutical firms have no incentive to study clinical uses of vitamin C because it is a cheap compound which can not be patented. Don't look for any serious studies soon.

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