The Science of Vitamin C Research on O
Blood and Cellular Levels

An Interview with Steve Hickey, Ph.D.

By Richard A. Passwater, Ph.D. - June 27, 2018

Recent columns have focused on our expanded knowledge of vitamin C's health be
message has been, "Vitamin C is helpful, in higher doses it is highly effective." This r
consulting with Dr. Steve Hickey on maintaining desired blood and immune systen
This is primarily for those individuals wishing to increase their protection against vi
threats or wishing to maintain increased blood levels of vitamin C between courses
Vitamin C medical treatments. However, it applies to general nutrition as well. It's n
in your mouth, but how much gets into your blood and to your cells. What should y
good health? For optimal health? For adjunct therapy for disease states?

We will also discuss the misleading "information" being widely quoted and dissemi

and/or body reaches a vitamin C saturation with doses under a gram (1,000 mg). N
that this misconception encourages the use of low doses and hinders the research
as an adjunct therapy that could save many lives. Just as important, it also serves t
on the subject. This misconception must be corrected. The aim of scientific researc

We will also discuss the advantages of taking vitamin C supplements in split doses
once. Ever wonder why different organs in the body hold different amounts of vita
these amounts change when the body is under attack or stress?
Does research suggest that there is a minimum blood level of vitamin C that must
the cancer-cell killing process? Or does research suggest that any level of vitamin C
cells in proportion? If the former, what is the required level, and can it be reached
supplementation as well as IV infusion?

Research has also documented that cancer cells consume significant amounts of vi
robbing the body and increasing the risk of pre-scurvy in cancer patients.

**Readers, please keep in mind that this interview is a discussion between two
ongoing research on vitamin C (ascorbic acid) and should NOT be construed a
advice to anyone. Information in this interview is intended for educational ar
only. It is not intended as medical or nutritional advice for the treatment or p
In the United States, the Food and Drug Administration regulations state tha
nutrient treats a disease, immediately, by definition, changes such nutrient i
subject to all drug regulations. We will be discussing ongoing scientific resear
medical advice. For medical advice, please consult your personal health care
Nonetheless, you may find our discussion of this ongoing research interestin**

An important aspect of vitamin C nutriture is that it is highly water-soluble and is q
the blood by the kidneys. In biochemistry, the time required for a quantity of a com
to half its initial value is known as the “biological half-life” of a compound. Unlike th
compounds — which is purely exponential — biological half-lives are more comple
that it takes for the concentration of a substance in blood plasma to reach one-half
value (the “plasma half-life”). The relationship between the biological and plasma h
can be complex, due to factors including accumulation in tissues, active metabolite
interactions.

Since vitamin C is highly water-soluble it is readily excreted in urine and should be

throughout the day to maintain desired blood levels at all times. Dr. Robert Cathca amount of vitamin C absorbed is not constant but depends on need (1). Dr. Steve H colleagues have determined that the plasma half-life for high doses of vitamin C is well-nourished, normal healthy individuals (2). However, while it is being excreted, absorption from the gut or by redistribution from other body compartments. Wher deficiency, the kidney will attempt to re-absorb more of the vitamin C and put it ba is a "dynamic flow" rather than a steady fixed value. As my youngest son Michael p is a critical concept — we seem to grasp that we shouldn't try to inhale a day's supp sitting, or drink a day's supply of water/fluid in one sitting; why do we think we sho supply of vitamin C in one sitting? When we work harder, we breathe deeper and fa stressed we should take more vitamin C.

In 2005, based on their biochemical and clinical findings, Drs. Hickey, Roberts and C Dynamic Flow model for absorption and action of vitamin C in the body (3). The dyr refutes the current low-dose recommendations for vitamin C intake and supports r for the adjunct use for disease conditions. We will discuss the meanings of all of thi

In a recent column, I discussed Dr. Hickey's point that there is a widely quoted dogma from a 1996 NIH study which claimed that the blood can become "saturated" with vitamin C at a single dose of 200 milligrams (4). Dr. Hickey had pointed out that this 1996 NIH study's own data even showed this is not so (5). The figure that I included in the March 2018 column is shown again as Figure 1 here. It is based on page 82 of reference 6.

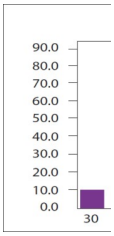

Figure 1: Th confirms th reached wi vitamin C because, as vitamin C l higher. The is expresse Data from

In a newer graph prepared by Dr. Hickey using the same NIH data, the point is made very clear. A 200 mg dose is not the maximum amount that can be absorbed. (Please see Figure 2.)

Dr. Hickey will discuss this point in this column.

Dr. Hickey, after studying mathematics and science at the Open University and pha Manchester Metropolitan University, earned his Ph.D. in medical biophysics from th Manchester. Dr. Hickey has coauthored several books including "Vitamin C: The Rea Andrew Saul, 2008), "Ascorbate: The Science of Vitamin C" (with Dr. Hilary Roberts, Nutrition and Survival" (with Dr. Hilary Roberts, 2005), "Ridiculous Dietary Allowanc

Roberts, 2005), "The Vitamin Cure for Migraines" (with Dr. Andrew Saul, 2010), " The (with Dr. Hilary Roberts, 2007) and "The Vitamin Cure for Heart Disease" (with Dr. H

Passwater: *Welcome back! Dr. Hickey, previously, we have discussed "The Science Cancer" and "The Inappropriateness of So-Called 'Evidenced Based Medicine' — Esp Nutrients: A Tarnished Concept" in this column (8,9).*

In December 2007, we discussed "The Science of Vitamin C and Cancer" (8). That wa column it seems as if we were discussing the same main points that we will review scientific community learned that the data often quoted on vitamin C absorption a vitamin C that the blood can hold is wrong? Is that because the incorrect data was National Institutes of Health (NIH) or what? Could it be that they don't want to char

Hickey: Yes. The so-called authorities have a thing about vitamin C. It became evid Pauling tried to make the case for gram- level intakes several decades ago now. De Pauling was subject to public abuse and castigation despite the data he presented. about the vitamin continues to this day.

The NIH continues to promote the low-dose dogma despite a great deal of public e their errors. They have simply waited for people to forget and changed a few descr phrase "tightly controlled" was substituted for "saturated," for example. One impro were forced to switch from a maximum blood level of only 60-70 µM/L to 200-250 µ still hiding is that their own data show these higher levels require a dynamic flow ir grams a day rather than 200 mg.

Passwater: *Surely other scientists working in nutrition would have corrected the error?*

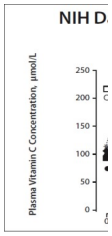

Figure 2: T plasma lev obvious er

Hickey: It is indeed a strange situation. For over a decade, the NIH papers were quoted widely, described as uniquely rigorous, and used for specifying the RDA. There is what we might call a core NIH supporters group. Even now, years after the errors were made clear, peer reviewed papers report on the NIH work as if there were no problems. This continuation is despite the public embarrassment for the NIH when the mistakes became public knowledge.

Passwater: *What are the implications for the typical person of a recommended int recommendations?*

Hickey: The NIH have data for young healthy middle-class adults. So, if you are in t non-smoker, not sick, or stressed, then 200 mg a day will prevent you from getting their data do not cover someone who is under stress, ill, or aging. Importantly, they long-term effects of a higher intake of vitamin C. Many of the major chronic disease heart disease, arthritis, and cancer, could be a result of inadequate intake. We just

Dr. Robert Cathcart explained a phenomenon of massively increased absorption w stressed. The maximum tolerated intake can go from, say, 2 grams a day when a pe to 100 grams when they are sick. This huge increase is consistent with a similar rise He observed that the symptoms of many illnesses are improved at these high level mainstream researchers simply ignore Dr. Cathcart's work.

Passwater: *How do Dr. Cathcart's observations and those of other nutritional doct mainstream claims that clinical trials have shown megadose vitamin C to be ineffec common cold?*

Hickey: The mainstream clinical trials on vitamin C and the common cold or other generally used doses around one gram a day and often less. Physicians such as Ro Hoffer did not claim that a gram (or 1,000 mg) would cure a cold. They observed th of 10 grams (10,000 mg) would prevent most colds but that treating a cold could re (50,000-100,000 mg). In other words, the trials confuse by calling a small nutritiona and avoiding the issue. People are being hoodwinked.

One notable thing is that the NIH are promoting an idea for the use of IVC in cance that only IVC could be helpful in cancer as supplements could not work. In doing so initial errors by adding more mistakes.

For example, they inaccurately claimed that the successful clinical trials of vitamin C Cameron, Linus Pauling and others were done with IV. The failure of the Mayo Clini successful studies was supposedly because they used oral vitamin C.
The initial trials using oral vitamin C in cancer gave astounding results. Patients live Hoffer gained similar results to Cameron and Pauling as did a group of doctors in Ja these successful trials used oral vitamin C, or oral vitamin C occasionally suppleme

Cameron was quite specific and stated that IVC provided no additional benefit unle
unable to take the vitamin by mouth because of vomiting.

The NIH emphasize the massive concentrations that can be briefly achieved in the blood using IV. High levels are obviously possible as the vitamin is being poured directly into a vein. In taking this macho IV approach they have forgotten one of the first rules of pharmacology. The effect of a substance depends on the dose, duration and frequency of administration. In other words, how often you take a drug and for how long can be as important as the size of the dose. I know saying it like this is obvious but apparently it needs restating.

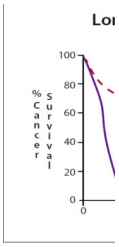

Figure 3: Lo
line) kills m
percentage
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six-hour ex
cells were c
concentrati
one-hour e
are destroy
vitamin C t
cancer cells
Hickey)

Passwater: *Each of the parameters is important. It's like a three-axis graph, with the effective area in the middle and the ineffective areas along the edges.*

OK, this is the crux of this discussion, so let's be as clear as possible for our readers, even if we must be redundant. Is it your contention then that the scientific literature supports that oral vitamin C can be safely consumed at as effective as IVC? As a follow-up, is it your contention that the science suggests th be even more effective that the current IVC protocols?

Hickey: Yes. Essentially IVC will increase blood levels to a very high value for a shor However, oral intakes can sustain high blood levels. In other words, oral doses can total amount of vitamin C to a tumor than can be achieved practically using IV. I car supporting the contention that IVC is a more effective cancer treatment than oral v minimum effective concentration, the longer the exposure, the more cancer cells a figure 3.)

Passwater: *Just to be clear as possible for our readers, is it your contention that th supports the premise that it is simply a matter of killing more cancer cells with vita replicate (as opposed to the effectiveness being that a threshold blood level is beir*

Hickey: The important thing is to maintain the pressure on the cancer so that it car the treatment.

Passwater: *Can multiple doses of high amounts of vitamin C raise the plasma leve sufficiently to kill cancer cells?*

Hickey: With standard ascorbic acid taken orally the maximum plasma level seems 250 µM/L. Biochemists usually express the concentration of a solute (in this case vi terms of molarity such as micromoles (µM) per liter. The advantage is that it's easy because the solute may be measured in grams, converted into moles, and mixed w molarity (M) is defined as the number of moles of solute per liter of solution. A hea this level for a short period with a single dose of about five grams. Liposomal vitam efficient. Liposomal vitamin C surrounds the vitamin C molecules in phospholipids into the blood by bypassing the normal absorption route. Plasma levels of 400 µM/ achieved using liposomal vitamin C. The limiting factor is the phospholipid which h tolerance level.

Standard vitamin C (ascorbic acid) and liposomal vitamin C are absorbed by differe are approximately independent. Taking both together leads to the blood levels bei the 250 from ascorbic acid to the 400 or so from the liposomes giving 600-700 µM/ enough to kill cancer cells. (Please see Figure 4.)

Passwater: *This appears to contradict NIH claims that oral vitamin C will not help c is necessary.*

Hickey: For fun we can use the NIH data to show once again that they are wrong. T indicate the killing of Burkitt's lymphoma cells by increasing concentrations of vitar figure 5.) It shows how a very short exposure to dynamic flow levels of vitamin C ca chart shows that 0.3 mM/L (300 µM/L in the units we are considering) kills these ca adding some other supplements increases the selective cancer killing of vitamin C, lipoic acid enhances the effect by a factor of 5-10 times.

Passwater: *You have been careful to say a "very short exposure." Is something else being hidden?*

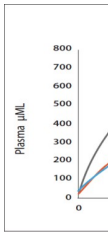

Figure 4: A expected r (repeated

Hickey: Yes. Typically, the experiments used to test selective killing of cancer cells only expose the cancer to vitamin C for a single hour. The NIH are explicit and indicate that they are considering IV which is administered over a similar short interval.

As you might expect, more cancer cells are killed the longer they are in *(Courtesy* contact with the vitamin. The effect is quite dramatic. (Please see figure 3.) Extending the exposure for only a few more hours shows that oral vitamin C ma than IV. This is what Cameron and the others found and why the recent IV studies h same benefits.

I cover this in a new book "Vitamin C and Cancer" (published by CreateSpace) that v this year.

Passwater: *Can cancer cell killing levels be sustained?*

Hickey: Yes. With repeated doses the levels can be sustained indefinitely. An IV infu but oral dynamic flow can continue for years. Repeating doses a few hours apart m levels.

Passwater: *One of your books with Dr. Hilary Roberts, "Ascorbate: The Science of V most informative book on vitamin C that I have read (6). There are several excellen but if I had to recommend just one book, it would have to be yours. Thanks for wri about?*

Hickey: Following Dr. Linus Pauling's death, Dr. Hilary Roberts and I were concerne about vitamin C had increased and had not been challenged properly. At that time, accepted that NIH had shown that the body did not absorb high intakes. It was clea contradiction between this and claims for high-dose vitamin C. If only low doses ar claims must be false.

The NIH published their research shortly after Pauling's death and met with little cr Although few nutritionists believed the NIH results, there was apparently no reason If the NIH were correct, however, Pauling and the orthomolecular physicians had b dose vitamin C would be useless.

Around the 10th anniversary of Linus Pauling's death, we decided to review the cur benefits of vitamin C. Our aim was to bring more rationality into a subject characte lack of objectivity. We wanted to explain the discrepancy between the orthomolecu and the experimental work, which apparently indicated it was not absorbed at high

Passwater: *Well, that's certainly important. The Dynamic Flow model for vitamin C developed by yourself and Drs. Roberts and Cathcart brings together evidence from both viewpoints and resolves the apparent contradictions (3).*

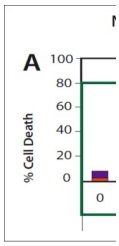

Figure 5: Th
concentrati
About 60%
death can b
concentrati

Hickey: Linus Pauling did a lot to popularize the claims for high doses of vitamin C in preventing and treating infections, heart disease and cancer. However, current medical thinking was inconsistent with clinical observations on high-dose vitamin C. Dr. Archie Kalokerinos, in his 1974 book "Every Second Child," describes using high-dose vitamin C to bring sick children back from the brink of death, within minutes. Dr. Ian Bright vitamin C could reverse AIDS. Drs. Pauling, Cameron and Hoffer presented data sh prolongs the lives of cancer patients. Multiple independent physicians replicated th seemed to show that high-dose vitamin C could have astounding results.

If these powerful claims for vitamin C were correct, the NIH claims that the body w dose must be wrong, or vice versa, since the two ideas were incompatible. In scien paradoxes indicate areas where we are ignorant of the underlying mechanisms an can be made. To us, the contradiction was an indication that there was fun to be h understand the workings of vitamin C in the human body.

Passwater: *As I mentioned earlier, more than 11 years ago, you had found flaws in vitamin C and other nutrients. You asserted then that the RDA justification for low was both invalid and indefensible. I promised that we would get back to this later. now.*

Hickey: It had become apparent that the NIH's work on vitamin C pharmacokinetic Indeed, their own data indicated that a healthy person could consume at least 18,0 get a corresponding increase in blood plasma levels (5). We tried explaining this to but they did not seem to understand.
The NIH publications misinterpret their data. Their results showed clearly that the "saturated," at low doses as they suggested. It seemed to me that they were so kee Pauling to be wrong that they were unable to see what their data implied.

Vitamin C is unusual in that, at low intakes, it has a biological half-life of 8–40 days. prevent it from being excreted. When vitamin C is in short supply, this is an essenti

animals such as humans that do not synthesize the vitamin internally. At high dose
biological half-life is only about 30 minutes. Given this fast excretion time, the NIH
measure the blood levels. By the time they took their measurements, the vitamin C
excreted, so the plasma level did not increase greatly with the dose. Instead of real
twice daily dose interval was too long, they thought the body had become saturate

We gave the NIH a year to consider the need for a correction or to support their sa
They refused to collaborate on a paper to amend the claim. When they did not resp
error known to the public.

Passwater: *Even the National Academy of Sciences 2000 RDA publication stated th
C above a gram (1,000 mg) are absorbed. The 2000 RDA states in humans "approxi
vitamin C is absorbed at moderate intakes of 30–180 mg/day. However, at doses a
absorption falls to less than 50%" (12).*
*It goes on to explain that vitamin C Ascorbic acid is absorbed in the body by both a
passively by simple diffusion. So even if the vitamin C transporters become saturat
still push vitamin C across the intestinal walls. Diffusion is the net movement of mo
a region of high concentration to a region of low concentration because of random
molecules.*

*According to the 2000 RDA for Vitamin C document, sodium-dependent active tran
ascorbate co-transporters (SVCTs) and hexose transporters (GLUTs)—are the two t
required for active absorption of vitamin C. SVCT1 and SVCT2 import the reduced f
across plasma membranes. GLUT1 is a good intake valve for the dehydroascorbic a
vitamin C. It is better at transporting DHA than Glucose.*

*I believe that a big part of the problem is that the NIH group may have ignored the
due to diffusion and confused "blood saturation" with "blood steady state." Please*

Hickey: You are right, the NIH's initial problem was that they measured plasma lev
giving the dose. They were measuring the steady state baseline level after the dose
The minimum level rather than the maximum.

The National Academy is quoting a drop-off in absorption with high doses in health
drop-off does not occur when a person is ill or stressed. In sick people the plasma
fall to near undetectable levels and massive intakes are needed to restore the body

question is what is going on when a person is stressed or sick and their intake incre
magnitude or so.

Passwater: *I have seen no other study to add to or clarify these data since your 20*
only paper I have found to even discuss your data is the review by Dr. Jorge Ducon
Have there been others?

Hickey: That's a difficult one. I can't speak for others but often their private comme
the publications. Only one scientist, from the Linus Pauling Institute of all places, ha
NIH work to me. In private many scientists find the NIH errors impossible to suppo
be professional suicide to challenge them. The attempt to destroy Linus Pauling's r
supported high-dose vitamin C acts as a warning to others.

Passwater: *OK, let's look at some of the specifics that the Dynamic Flow model tell*
of any amount of vitamin C have important biological effect?

Hickey: The pioneers using vitamin C for treating the sick explained that the doses
and frequent. To give examples, Drs. Fred Klenner, Robert Cathcart and Irwin Stone
needed doses repeated through the day. We now have a good understanding of wh

The half-life of high dose vitamin C in the blood is very short perhaps half an hour.
dose is absorbed half of it will be excreted. After one hour the blood level would be
quarter. This gave rise to the "expensive urine" myth but is actually how dynamic fl

A single large dose of vitamin C provides antioxidant electrons which it can supply t
means the body does not need to use energy to provide the antioxidants to help it
vitamin C carries two antioxidant electrons, but they are used up quickly and need
next dose. If you think about it, once a vitamin C molecule has given up its electron
and it can be excreted in oxidized form or recycled (recharged) by synergistic antio

Passwater: *What are the blood levels normally found in the general population by*

Hickey: It depends on the population and their state of health. Most people are me
fraction of the baseline level and are deficient. Some vegetarians and, of course, pe
take high-dose supplements, have adequate levels provided they are in reasonably

Passwater: *Could measurement of blood levels of vitamin C be useful in establish*
What would the data suggest as a "healthy" blood level for vitamin C? Is there any t
ascorbate-producing animals?

Hickey: The whole idea of an RDA for vitamin C does not make sense. Firstly, we ar
population who are largely deficient (below the baseline). Then there is biological v
individual requirements. But the proverbial elephant in the room is bowel toleranc

Suppose the NIH were correct and, say, 200 mg a day is sufficient for a healthy you
baseline plasma level of 60-70 µM/L. He will occasionally feel tired, stressed or get
plasma levels will drop dramatically, potentially to something close to zero. Now th
might need an intake of, say, 20,000-40,000 mg (20-40 grams) a day to maintain his
the RDA would place a sick person in a state of induced scurvy and to correct the p
increasing the intake by a factor of 100 or more. When stressed even a healthy you
be consuming a year's worth of RDA intakes in a single weekend.

Passwater: *What is the largest dose you have studied?*

Hickey: Seventy-two grams of ascorbic acid and liposomal vitamin C over a period
healthy individual. However, I have known cancer patients who take similar amoun

Passwater: *Did any of the studies show kidney stones? I ask this because there's a*
suggests that vitamin C can cause kidney stones. The literature shows that vitamin
stones; it does not cause them (14).

Hickey: I have not come across kidney stones with oral intakes and the physicians
communicate with me have not reported the problem. There are some indications
kidney stones may be an issue with IVC, but the problem is overstated.

Passwater: *Can we expect to see the rest of the scientific community starting to u*
flow model for vitamin C?

Hickey: The current pressure is for scientists working in the area to support the NI
oral doses are absorbed and only IV can help cancer patients. One way of checking
much vitamin C the researchers take themselves. Often, they publicly recommend
say 500 mg or less, but take many times the amount themselves, several grams a d

Passwater: *OK, this begs the question of how much do you take?*

Hickey: My minimum and typical daily intake is about 9 grams of ascorbic acid spre
but this can increase 5-10-fold if I feel a cold might be on the way.

Passwater: *Dr. Hickey, thanks for sharing your research with us, and for your book
Science of Vitamin C." We will look forward to your new book on Vitamin C and Can*

*Next month we will discuss whether or not we can further optimize the uptake of v
with the "Multi-C Protocol" of Dr. Thomas E. Levy.* **WF**

Dr. Richard Passwater is the author of more than 45 books and 500 articles on nutrition. Dr. Passwater has been WholeFoods Magazine's science editor and author of this column since 1984. More information is available on his website, www.drpasswater.com.

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