

Linus Pauling vindicated

BETHESDA, MARYLAND. In 1971 Dr. Linus Pauling, a two-time Nobel Prize winner, and Dr. Ewan Cameron, a Scottish physician, evaluated vitamin C in the treatment of terminal cancer. They found that daily intravenous infusions of mega doses (10 grams) of vitamin C for 10 days followed by oral administration indefinitely extended the lifespan of more than 1000 patients involved in the trials by 6 months or a year, while at the same time resulting in significantly less pain and a greater sense of well-being.

After much cajoling and presentation of convincing research data, the Mayo Clinic finally agreed to evaluate mega doses of vitamin C in the treatment of cancer. However, over Dr. Pauling's strenuous protests the Mayo researchers decided to administer the 10 grams of vitamin C by mouth rather than intravenously. Not too surprisingly, their trial concluded that mega doses of vitamin C were worthless in cancer treatment. Nevertheless, many progressive alternative and complementary physicians continued to use intravenous injections of vitamin C in cancer treatment with good results. Additional research also confirmed that vitamin C is highly toxic to cancer cells *in vitro* in blood plasma

concentrations of 1000 micromol/L or greater. There is no indication that it is toxic to normal cells.

Now, 25 years after Dr. Pauling's initial discovery, researchers at the National Institutes of Health have taken a second look at the possibility of using intravenous vitamin C in cancer treatment. The first phase of their work did not involve a clinical trial to determine if vitamin C combats cancer, but rather a detailed comparison of the blood plasma concentrations achievable with oral and intravenous administration of vitamin C. The study involved 17 healthy young men and women who were hospitalized for 3-6 months in order to keep their environment and dietary intake under strict control. Over the trial period, the researchers administered various doses of vitamin C either orally or intravenously and measured the resulting plasma concentration. Among the highlights of their findings:

- Plasma concentrations achieved through intravenous injection were at least 8 times higher than those achieved through oral administration.

- The maximum achievable plasma concentration via the oral route was 220 micromol/L and was obtained by supplementing with 3 grams of vitamin C every 4 hours. In contrast, administration of 3 grams intravenously produced a plasma concentration of 1760 micromol/L.
- Intravenous infusion of 10, 50, and 100 grams produced plasma concentrations of 5580, 13,350 and 15,380 micromol/L respectively. Thus it is possible to attain plasma levels of vitamin C via intravenous administration that are 70 times higher than what is obtainable through oral supplementation. Doses of 60 grams, given intravenously, are used for cancer treatment by complementary and alternative medicine practitioners.
- A diet rich in fruit and vegetables may provide as much as 200 mg/day of vitamin C and this would result in a plasma concentration of about 90 micromol/L. Plasma concentration can be further increased by oral supplementation. Peak plasma concentration increased to 187 micromol/L after supplementing with 1.25 grams (1250 mg) and to 220 micromol/L after ingesting 3 grams every 4 hours. The researchers suggest that 220 micromol/L

may be about the highest plasma concentration achievable through oral supplementation.

- Vitamin C, whether administered orally or intravenously, is rapidly excreted in the urine, essentially returning to baseline levels in 4-6 hours.

The researchers conclude that the plasma levels necessary to kill cancer cells (1000 micromol/L or greater) can only be achieved through intravenous administration. They further state that intravenous vitamin C would be expected to have little toxicity compared with conventional chemotherapy agents. They conclude that, "the role for intravenous vitamin C in cancer treatment should be reevaluated".

Padayatty, SJ, et al. Vitamin C pharmacokinetics: implications for oral and intravenous use. Annals of Internal Medicine, Vol. 140, April 6, 2004, pp. 533-37

Editor's comment: It is nice to see the discovery of Drs. Pauling and Cameron vindicated. Too bad it had to take the medical establishment 25 years to do so. Of immediate practical application is the researchers' finding that plasma levels return to baseline 4-6 hours after administration. This confirms current advice to take vitamin C supplements throughout the day rather than in one daily dose only.