

In Extremis: First Aid for Advanced Cancer

(or for anyone with cancer, at any stage)

If the medical profession has just told you that you have a short time to live, or have an "incurable" cancer such as pancreatic, liver, brain or lung cancer, where conventional systemic treatment is at best only palliative, there is a remarkable therapy you can try which is relatively simple and cheap, can be done at home, without side-effects, and which a number of MDs who use it claim has saved the lives of between 60% to 70% of terminal cancer patients, and which at the very least has been shown to halt or control the spread of cancer. This therapy is high dose intravenous vitamin C. Intravenous vitamin C is not the same as oral vitamin C. By giving vitamin C intravenously doctors can achieve a blood saturation that is not at all comparable with that achieved by the oral route. The order of magnitude is something like 200%, as opposed to 2% saturation by the oral route. This very high concentration of vitamin C is critical in terms of achieving a chemotherapeutic, cytotoxic - tumour cell destruction - effect. If it is feasible to have a Hickman line put in the patient, extraordinary doses of vitamin C - anything between 50g to 100g, depending on the malignancy of the cancer, - can be self-administered at home on a daily to weekly basis over a period of months, stepping down or up in frequency according to the individual response. Otherwise this treatment can be administered on an out-patient basis, anywhere in the world. Its effects appear to be enhanced by weekly injections of large doses of vitamin B12, (hydroxycobalamin 1000 micrograms), which forms cobalt ascorbate, another benevolent non-toxic, but tumour cytotoxic, compound, or in combination with vitamin K (specifically vitamin K3, though K1 is also efficacious), and Lipoic Acid, (300mg oral, twice daily.) Lipoic Acid recycles the Vitamin C to keep the cytotoxic dose more constantly in the body for longer periods.

Counter indications to this approach are few. However they include anyone with kidney failure, or on dialysis, or with uncommon forms of iron overload. Responsible physicians should also screen for red blood cell glucose-6 phosphate dehydrogenase deficiency, a rare condition whose presence can lead to haemolytic crisis involving red blood cell breakdown. The very large doses should also be built up to gradually over some days to establish good tolerance, starting at 15 grams for 1 or 2 sessions, then to 50 grams and, if necessary, to 100 grams. The exact dose is determined by the individual's plasma saturation by Vitamin C immediately after an infusion. **WARNING:** To avoid the well-documented Rebound Effect, which can lead to scurvy, this treatment should not be stopped abruptly. Patients should be gradually weaned off it over a period of weeks, or even months, and oral vitamin C therapy should continue indefinitely and on the days in between the IVC infusions.

The American Dr Hugh Riordan M.D. is probably the world expert on this approach. His institute, The Center for the Improvement of Human Functioning, has just completed a 10 year research project on high dose intravenous C and cancer, and his patented method recently underwent Phase I clinical trials at the University of Nebraska medical school hospital. These trials have established the non-toxicity of this treatment for cancer, and Dr Riordan is now proceeding with a Phase II clinical trial, under the auspices of the National Institutes of Health, using therapeutic doses of vitamin C on Renal Adenoma patients. Dr Riordan has also published several successful case histories, including the results of treatment on a late-stage lung cancer patient - now cancer free several years on -, in The Journal of Orthomolecular Medicine. I would recommend anyone interested in this to get in touch with Dr Riordan, and to consult him generally for nutritional strategies against cancer, in particular as Dr Riordan has at his disposal some of the most refined lab-tests in the world for determining individual bio-chemical profiles and needs in cancer, (or indeed any other condition). These tests should be a standard in determining optimal individual nutritional therapy. Unfortunately, as yet, they are not widely available. Dr Riordan is also recruiting "end-stage" cancer patients for a trial of a new immunotherapy for cancer, in which the immune system is taught to recognise and destroy the cancer cells in its midst that it usually overlooks. The trials are free. But you must be able to travel to the U.S.

However, there are a number of other intravenous vitamin C practitioners throughout the world. The International Society for Orthomolecular Medicine, (Ms Claire D'Intino) can give you the name and address of your nearest orthomolecular physician worldwide. (Or see the Countries List in the Resource Section.) The Doctors and Organisations pages list a few English speaking practitioners, all M.D.s, who also offer excellent alternative and complementary, immunotherapeutic approaches to cancer. For maximum efficacy, they should follow Dr Riordan's treatment protocol, available here, and on request from the Center for the Improvement of Human Functioning:

DR HUGH RIORDAN

**Center For The Improvement Of Human Functioning
N. Hillside Avenue, 3100**

Wichita, KS 67219
Kansas
U.S.A

Tel: 001 316 682 3100
Fax: 001 316 682 5054

Ascorbic Acid Orally - Not for IV
Dear Vitamin C Foundation

I have found that vitamin C in the ascorbic acid form is the best form to take orally. I have been able to achieve what I call the ascorbate effect with only ascorbic acid by mouth. Mineral ascorbates by mouth, while being a fine source of vitamin C, do not seem to carry the same punch, probably more electrons.

However, Klenner and I have used sodium ascorbate intravenously and when used rarely intramuscularly. This is confused by the fact that even Klenner referred to the intravenous solutions as ascorbic acid. However, I had talked with him before his death and also talked with his wife and nurse, Annie Klenner, and they said it was the sodium ascorbate powder that he simply mixed in water that he used. See <http://www.orthomed.com/civprep.htm>

All this is further confused by the fact that the commonly available form used by many orthomolecular physicians is from Merit Pharmaceuticals and it is labeled ascorbic acid. It is, however, made as prescribed in the U.S. Pharmacopoeia made from ascorbic acid and then buffered to a pH of 5 or 6 (I have to check for that exact pH specified) with sodium hydroxide or sodium bicarbonate. This, in effect, is actually mainly sodium ascorbate. It cannot be pure ascorbic acid because that would be a pH of 3.5 and that would be far too acid. The problem here is that everyone keeps talking about ascorbic acid intravenously when they really should be using sodium ascorbate or at least highly buffered ascorbic acid.

All this is bound to be causing mistakes. Last week I was consulting with three doctors at the Mayo Clinic that are allowing an old patient of mine I had seen years ago, die of pneumonia rather than give her sodium ascorbate. She was in the habit of taking 30 grams of ascorbic acid by mouth per day. I had cured her of transverse myelitis years ago to the astonishment of the transverse myelitis experts and the University of California Medical Center in San Francisco with several weeks of sodium ascorbate intravenously. They, of course, did nothing to follow up on this cure with further investigations. Anyway, the Mayo Clinic doctors were giving the usual nonsense arguments about not using C like that it would cause metabolic acidosis. I pointed out how ridiculous this was to worry about metabolic acidosis when you were giving an alkali solution. But they kept talking about ascorbic acid.

There is in the literature a story about a black man who was given intravenous ascorbic acid for a small burn who died of subsequent kidney failure. Here again we have the ascorbic acid story. In some foreign countries, they are beginning to pick up on this intravenous vitamin C for cancer. I want to make sure they use either sodium ascorbate or highly buffered ascorbic acid. There are bound to be mistakes if we keep talking about ascorbic acid intravenously without qualification.

So please modify all the references to ascorbic acid intravenously to preferably sodium ascorbate or at least highly buffered ascorbic acid. Also it is important that it not have preservatives.

Thanks.

Dr. Robert Cathcart, III, MD www.orthomed.com
Vitamin C Foundation

Intravenous Vitamin Therapy

Vitamin C Therapy (Introduction):

The benefits of long-term vitamin C consumption in excess of the U.S. government recommended daily allowance (RDA) are widely acknowledged and include reduced risks of cancer, cardiovascular disease, and cataracts. Higher than RDA vitamin C intakes have been associated with increases in HDL cholesterol, decreases in LDL cholesterol oxidation, decreased blood pressure, and decreased cardiovascular mortality. Vitamin C enhances non-heme iron absorption in individuals with low iron status. Helpfulness has been reported for severe attacks of ulcerative colitis, advanced human cancer, and reticulum cell sarcoma. Doses in these reports ranged from 50 to 150 gm intravenous per day, with no adverse effects reported. The manufacturers' literature states that doses as high as 6 gm per day has been administered without toxicity. High dose IV vitamin C has been used to treat optic neuritis, and was found to produce equivalent results to oral or intravenous corticosterone, or oral vitamin B12. No adverse events were encountered among 25 patients treated. The possibility of its working through its action on free radicals was raised.

Higher dose vitamin C (170 mg/kg/24 hours) was shown to have no adverse effects upon guinea pigs. These animals had 70% body surface area deep thermal burns. Animals receiving the vitamin C had lower water content of the burned skin, suggesting that postburn capillary permeability was minimized by the use of vitamin C. With even higher doses, the authors were able to reduce the 24 hour resuscitation fluid volume from 4 ml/kg/% burn to 1 ml/kg/% burn, while still maintaining adequate cardiac output. In contrast, with a lower dosage and measured only 5 hours after the injury, vitamin C infusions had no effect on graded scald produced burns, at least in terms of changes in microvascular permeability or in edema formation among dogs with hind-paw lesions. Pre-burn infusions did significantly attenuate burn-induced increases in paw weight gain, and no adverse reactions were encountered.

Oxidized LDL cholesterol (oxLDL) induced leukocyte adhesion to both microvascular and macrovascular (aortic wall) endothelium, can be prevented by pre-treatment of hamsters with oral or intravenous vitamin C. The mechanism of action was thought to be the scavenging of reactive oxygen species. Vitamin E and probucol did not show these effects.

Vitamin C Therapy (Studies):

Eight placebo-controlled, double blind studies and 6 non-placebo clinical trials have shown no adverse effects of vitamin C doses up to 10,000 mg consumed daily for up to three years. The possibility of any adverse effects of higher (multiple gram doses) has received considerable scrutiny. Despite concerns and several contradictory case reports, extensive searches have failed to produce any adverse effects. The exceptions occur among patients with renal insufficiency, patients on chronic hemodialysis, possibly patients with hemochromatosis and iron overload, and a subset of oxalate stone formers. One case report exists of acute oxalate nephropathy occurring in a patient with nephrotic syndrome and primary amyloidosis who was given 45 gm IV vitamin C as a bolus injection. Most protocols use slow infusions (25-50 gm/hr) and do not give high doses to patients with renal insufficiency. Nevertheless, definite causality was not established in this case report. Concerns about high dose vitamin C affecting uricosuria, vitamin B-12 destruction, mutagenicity, are calcium oxalate stones have not been substantiated despite careful and thorough searches.

A 42 year old male with widely disseminated, biopsy-proven reticulum cell sarcoma was treated with high dose (100mg infusion Vitamin C. He experienced two complete, spontaneous regressions of his illness coinciding exactly in time with, intravenous vitamin C administration. He remains alive 17 years later. Of course, placebo has been reported to accomplish as much (the drug krebazolin), but that patient died after his second spontaneous regression of cancer when he learned the the drug in which he so believed had been declared by the FDA to be worthless.

Vitamin C Therapy (Products):

Vitamin C (ascorbic acid) -is available in three size ampules -- 1 ml with 500 mg of vitamin C and 10 mg monothioglycerol, 10 ml with 1 g of sodium ascorbate, 0.5% monothioglycerol, and 25 ml with 25 gm sodium ascorbate. The pH of the solution is general buffered with sodium hydroxide or calcium carbonate. Sodium hydrosulfite 0.5% is often used as an antioxidant. The pH is buffered from 5.5 to 7.0, and the 500mg/ml solution has an osmolality exceeding 2000 mOsm/kg.

Vitamin C Therapy (Stability Issues):

Ascorbic acid gradually darkens on exposure to light. A slight color developed during storage does not impair the therapeutic activity. However, Abbott recommends protecting the intact ampuls from light by keeping them in the cartons until ready for use. HPLC analysis showed that ascorbic acid was stable at room temperature (23 degrees Centigrade) when protected from light, exhibiting less than a 10% loss. Exposure to light results in losses of approximately 50 to 65%. Although refrigeration is recommended, Lilly has stated that its ascorbic acid injection has a maximum room temperature stability of 96 hours. Intact ampuls of

commercial ascorbic acid injection (Vitarine) have been reported to be stable for four years at room temperatures not exceeding 25 degrees C. Ascorbic acid is rapidly oxidized in air and alkaline media.

Trissel has reviewed available studies on physical compatibility of vitamin C with other products for injection. Vitamin C is compatible with 6% Dextran in 5% dextrose or 0.9% sodium chloride, dextrose-Ringer's solution combinations included those that are lactated, dextrose-saline combinations, 2.5% dextrose in water, 5% dextrose in half normal saline, 5 or 10% dextrose in water, 10% fat emulsion solution (for 48 hours), 10% fructose in normal saline or water, 5 or 10% invert sugar in normal saline or water, Ionosol products, lactated or non-lactated Ringer's injection solutions, Half-normal or normal saline, 1/6th molar sodium lactate, amikacin sulfate in all solutions, calcium chloride, calcium gluceptate, calcium gluconate, cephalothin sodium, chloramphenicol solution, chlorpromazine HCl, colistimethate sodium, cyanocobalamin (no loss of activity for either at 24 hours when protected from light), diphenhydramine HCl, heparin sodium, kanamycin sulfate, methicillin sodium, methyldopate HCl, penicillin G potassium, polymyxin B sulfate, prednisolone sodium phosphate, procaine HCl, prochlorperazine edisylate, promethazine HCl, and verapamil HCl. Conflicting results were found for aminophylline (higher doses were incompatible) and erythromycin lactobionate. Physical incompatibility was found for nafcillin sodium, sodium bicarbonate solution. Loss of all bleomycin activity occurred after 1 week together in solution. Precipitation occurred after several hours in solution with warfarin sodium. Precipitation occurred after 24 hours for etomidate, 7 days for propofol, and 24 hours for thiopental sodium.

More importantly, TPN solution number 189 was studied with vitamin C. No incompatibility was found up to 24 hours (not studied afterwards). TPN # 189 consists of 500 ml of 10% amino acids with electrolytes (Synthamin 17 with electrolytes), 500 ml of 50% Dextrose, 2.2 mM calcium, 2.5 mM magnesium, 42.5 mM potassium, 45 mM sodium, 15 mM phosphorous, 55.65 mM chloride, 81.25 mM acetate, and 1 ml trace mineral solution.

Other studies of vitamin C in parenteral nutrition solutions have shown no loss of activity so long as the mixture is protected from light. A 35% loss of activity was seen at 39 hours when the mixture was exposed to light continually. Thirty to forty percent of vitamin C activity was lost after 24 hours when ascorbic acid was added to parenteral nutrition solutions consisting of amino acids, dextrose, electrolytes, multivitamins, and trace minerals in 3 liter PVC bags stored at 3 to 7 degrees C. The degradation slowed as the oxygen supply was reduced to the diffusion through the bag. About a 55 to 65% loss of activity was reported after 7 days of storage. The oxidation of the ascorbic acid was catalyzed by metal ions, especially copper. In the absence of copper, less than 10% loss of activity occurred at 24 hours. No immediate incompatibility or precipitation was observed over the 7 days.

Extensive decomposition of ascorbic acid and folic acid was reported in a parenteral nutrition solution composed of amino acids 3.3%, dextrose 12.5%, electrolytes, trace elements, and multi-vitamin infusion -12 (USV) in PVC bags. Half-lives were 1.1, 2.9, and 8.9 hours for ascorbic acid and 2.7, 5.4, and 24 hours for folic acid stored at 24 degrees C. in daylight, 24 degrees C. in darkness, and 4 degrees C. in darkness, respectively. Catalyzing metal ions increased the rate of decomposition greatly. Interactions with other vitamins present increased the rate of decomposition.

In another parenteral nutrition solution composed of amino acids (Kabi-Vitrum), dextrose 30%, and fat emulsion 20% (Kabi-Vitrum) in a 2:1:1 ratio with electrolytes, trace elements, and both fat- and water-soluble vitamins, no significant loss of activity of retinyl palmitate, alpha tocopherol, thiamine mononitrate, sodium riboflavin-5'-phosphate, pyridoxine HCl, nicotinamide, folic acid, biotin, sodium pantothenate, and cyanocobalamin were found at 96 hours when the solution was stored in darkness at 2 to 8 degrees C. Sodium ascorbate and its biologically active degradation product, dehydroascorbate, totaled 59 and 42% of the starting concentration at 24 and 96 hours, respectively. No precipitation or incompatibilities were found. No significant loss of activity was found in a simulated infusion over 24 hours at room temperature without light protection. This procedure did increase the decomposition rate of vitamin C, however, with ascorbate showing 51% concentration and dehydroascorbate showing 65% concentration. Light protection did not significantly change this degradation rate at room temperature.

HPLC analysis of the stability of vitamin C in parenteral nutrition solutions with and without fat emulsions showed retention of 90% vitamin C content for 12 hours when the solutions were exposed to fluorescent light and for 24 hours when they were protected from light. Storage in a cool, dark place resulted in retention of activity for 7 days.

Ascorbic acid loss was studied with MVI-12 (Armour) admixed in parenteral nutrition solutions containing different amino acid products, with or without Intralipid 10%, and stored in either glass bottles or PVC bags,

either refrigerated or at room temperature. Ascorbic acid was lost under all conditions at room temperature and not at refrigerated temperature. Losses were greater in PVC bags than glass bottles. No immediate incompatibilities or delayed precipitations were found.

One can conclude from all these studies that some loss of vitamin C activity is inevitable and that it is prevented by light protection, preparing mixtures for infusion as close as possible to the time of infusion, and by giving higher concentrations of vitamin C than needed, to counteract degradation. Since no physical incompatibilities were found, giving higher concentrations seems logical, especially when trace minerals are found in the solution. The higher the mineral content of the solution and the longer from time of preparation to administration, probably the higher the vitamin C content should be. Further studies are needed in clinical settings to determine the extent of degradation expected and the amounts of vitamin C which should be given (at different mineral concentrations) to achieve desired dosing.

Intravenous Infusions: Studies of Multiple Nutrients:

In support of a molecular explanation of the perceived clinical benefit reported by patients who receive intravenous vitamin infusions, especially vitamin C, beneficial changes in erythrocyte ATP/ADP ratios after infusion have been reported. The effect was to normalize the ratio. Low ratios increased, and high ratios decreased. Control subjects were unaffected and the results were statistically significant. No adverse effects were seen in this study on patients receiving high-dose intravenous vitamins.

Intravenous B Vitamin Infusion:

Up to 40% of cancer patients receiving parenteral nutrition were deficient in vitamins B1, B2, B6, and niacin, despite receiving the recommended daily doses of 3mg, 3.6 mg, 4 mg, and 40 mg, respectively. Even at twice the recommended daily doses, these deficiencies did not disappear. They concluded, "since intravenous doses of B1, B2, B6, and niacin are safe and well tolerated, it appears that increased daily amounts of these vitamins should be given to cancer patients on parenteral nutrition.

Thiamine. Three patients who developed Wernicke's encephalopathy despite being given intravenous thiamine have been reported. These authors suggested that the amount of intravenous thiamine commonly given is much too low.

Therefore, we propose that the PT Committee allow us to increase the amount of Vitamin C given to the 2 gm to 25 gm range, depending upon the patient.

References:

- Bendich A, Langseth L. The Health Effects of Vitamin C Supplementation: A Review. *J Am Coll Nutr* 1995; 14(2): 124-36.
- Rivers JM. Safety of High-level Vitamin C Ingestion. *Int J Vitam Nutr Res Suppl* 1989; 30:95-102.
- Truelove SC, Jewell DP. Intensive Intravenous Regimen for Severe Attacks of Ulcerative Colitis. *Lancet* 1974 June 1; 1(7866): 1067-70.
- Cameron E, Campbell A. The Orthomolecular Treatment of Cancer. II. Clinical trial of High-dose Ascorbic Acid Supplements in Advanced Human Cancer. *Chem Biol Interact* 1974; 9(4): 285-315.
- Cameron E. Protocol for the Use of Vitamin C in the Treatment of Cancer. *Med Hypotheses* 1991; 36(3): 190-4.
- Campbell A, Jack T, Cameron E. Reticulum Cell Sarcoma: Two Complete 'Spontaneous' Regressions in Response to High-dose Ascorbic Acid Therapy. A Report on Subsequent Progress. *Oncology* 1991; 48(6): 495-7.
- Physicians' Desk Reference, 53rd Edition. Medical Economics Company, Oradell, New Jersey, 1999.
- Ichibe Y, Ishikawa S. Optic Neuritis and Vitamin C. *Nippon Ganka Gakkai Zasshi - Acta Societatis Ophthalmologicae Japonicae* 1996; 100(5): 381-7.
- Matsuda T, Tanaka H, Shimazaki S, Matsuda H, Abcarian H, Reyes H, Hanumadass M. High-dose Vitamin C Therapy for Extensive Deep Thermal Burns. *Burns* 1992 18(2): 127-31.
- Aliabadi-Wahle S, Gilman DA, Dabrowski GP, Choe EU, Flint LM, Ferrara JJ. Postburn Vitamin C Infusions Do Not Alter Early Postburn Edema Formation. *Journal of Burn Care and Rehabilitation* 1999; 20(1 Pt 1): 7-14.
- Lehr HA, Frei B, Olofsson AM, Carew TE, Arfors KE. Protection from Oxidized LDL-induced Leukocyte Adhesion to Microvascular and Macrovascular Endothelium in vivo by Vitamin C but not by Vitamin E. *Circulation* 1995; 91(5): 1525-32.
- Lawton JM, Conway LT, Crosson JT, Smith CL, Abraham PA. Acute Oxalate Nephropathy After Massive Ascorbic Acid Administration. *Arch Intern Med* 1985; 145(5): 950-1.

Trissel LA. Handbook of Injectable Drugs. Milwaukee: American Society of Health-System Pharmacists, 1996, p.99.

Package Insert: Cenolate. Abbott Laboratories, North Chicago, Illinois, December, 1991.

The United States Pharmacopeia, 23rd Rev. United States Pharmacopeia Convention, Rockville, MD, 1995.

Trissel LA, Martinez JF, Xu Q. Data on File. Pharmaceutical Analysis Laboratory, University of Texas, M.D. Anderson Cancer Center, Houston, Texas, January 24, 1994.

McEvoy GK (ed). American Hospital Service Drug Information 95. American Society of Health System Pharmacists, Bethesda, Maryland, 1995.

Martins HJ. Stabilität Wasserlöslicher Vitamine in Verschiedenen Infusions-benteln.

Krankenhauspharmazie, 1989; 10(Sept): 359-361.

Vogenberg FR, Souney PF. Stability Guidelines for Routinely Refrigerated Drug Products. Am J. Hosp Pharm 1983; 40(Jan): 101-102.

Wolfort RR, Cox RM. Room Temperature Stability of Drug Products Labelled for Refrigerated Storage. Am J. Hosp Pharm 1975; 32(June): 585-587.

Coles CLJ, Lees KA. Additives to Intravenous Fluids. Pharm J. 1971; 206(March 27th): 153-154.

Gilbar PJ, Groves CF. Visual Compatibility of Total Parenteral Nutrition Solution (Synthamin 17 Premix) with Selected Drugs During Simulated Y-site Injection. Aust J Hosp Pharm 1994; 24(2): 167-170.

Shine B, Farwell JA. Stability and Compatibility in Parenteral Nutrition Solutions. Brit J Parenteral Therapeutics 1984; 5(4, March): 44-46, 50.

Allwood MC. Factors Affecting the Stability of Vitamin C in Total Parenteral Nutrition Solutions. J Clin Hosp Pharm 1984; 9(June): 75-85.

Nordfjeld K, Pedersen JL, Rasmussen M. Storage of Mixtures for Total Parenteral Nutrition III. Stability of Vitamins in TPN Mixtures. J Clin Hosp Pharm 1984; 9(Dec): 293-301.

Dahl GB, Jeppsson RI, Tengborn HJ. Vitamin Stability in a TPN Mixture Stored in an EVA Plastic Bag. J Clin Hosp Pharm 1986; 11(Aug): 271-279.

Yamaoka K, Nakajima Y, Okinaga S. Variation by Combination of Hyperalimentation with Fat Emulsion. Jap J Hosp Pharm 1987; 13:211-215.

Lonsdale D, Shamberger RJ, Stahl JP, Evans R. Evaluation of the Biochemical Effects of Administration of Intravenous Nutrients using Erythrocyte ATP/ADP Ratios. Alternative Medicine Review 1999; 4(1):37-44.

Inculet RI, Norton JA, Nicholds GE, Maher MM, White DE, Brennan MF. Water-soluble Vitamins in Cancer Patients on Parenteral Nutrition: A Prospective Study. Journal of Parenteral and Enteral Nutrition 1987; 11(3): 243-9.

Tapiador-Sanjuan MJ, Lopez-Gaston JI, Gracia-Naya M, Ayusco-Blanco T. Wernicke Encephalopathy in Patients Given Parenteral Nutrition. Neurologia 1995; 10(2): 104-6.

I.V. VITAMIN C

Recent studies demonstrate that vitamin C, infused intravenously, can achieve a plasma concentration high enough to exert cytotoxic effects on many types of cancer cells. Interestingly, vitamin C has both anti-oxidant and oxidant activities. At low to moderate dosage (achieved by taking Vitamin C orally), vitamin C is a potent antioxidant with important functions in immune response, wound healing and recycling of other antioxidants such as vitamin E. However at large dosage (achieved by taking Vitamin C intravenously), vitamin C can induce oxidative damages to cancer cell DNA, mainly through the increased production of hydrogen peroxides. This increase in oxidative stress preferentially induces cancer cells to undergo apoptosis (i.e. cell death) since cancer cells are relatively deficient in catalase, an enzyme that neutralizes hydrogen peroxide. Studies completed in Japan have successfully demonstrated that vitamin C infusion can enhance the therapeutic effects of chemotherapies.

I.V. vitamin C is usually given 3 times per week for at least 4 weeks, according to the following schedule:

Typical schedule	1 st time	2 nd time	3 rd time
Week 1	15 gm	15gm	30 gm
Week 2	40 gm	40 gm	50 gm
Week 3	50 gm	50 gm	50 gm
Week 4	60 gm	60 gm	60 gm
Week 5 on	Varies depending on clinical presentations and lab workup		

Note: This schedule is typical for a patient not currently on chemotherapy or radiation. Schedule and dosage may vary depending on clinical symptoms, lab and/or conventional treatment schedules.

SIDE EFFECTS/COMPLICATIONS:

A phase I study done at the University of Nebraska medical centre has shown no side effects or toxicities associated with intravenous vitamin C procedure. However, some relative contra-indications and potential side effects to be considered are:

- **Rapid tumour necrosis, hemorrhage and subsequent death:** very rare, but has been described by Campbell and Jack (Scot Med J 1979;24-p151). Small initial dosage and gradual increase is recommended according to the above schedule.
- **Localized pain at the infusion site,** which can be minimized with slow drip.
- **Allergic reaction,** including slow onset anaphylactic shock.
- **G-6-phosphate deficiency:** risk of hemolysis
- **Kidney stones:** relative contra-indication. The administration of magnesium and vitamin B6 inhibits the formation of kidney stones.
- **Any condition which could be adversely affected by increased fluid** (such as congestive heart failure) would be relatively contraindicated, due to the relatively large amount of fluid being used.