Vitamin C as Protection Against Radiation Exposure

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Abstract *The nuclear accident in Fukushima, Japan, in March 2011 led to drastic mechanistic measures (e.g., evacuation, decontamination showers of clothing, and use of protective clothing by rescue workers) to protect the population against imminent and future radiation exposure. Besides mechanistic measures, no orthomolecular protection measures other than iodine supplementation were taken, although scientists from Japan's Ministry of Defense had demonstrated that oral vitamin C in mice protects against radiation injury. This article highlights the opinions of Dr. Atsuo Yanagisawa that were presented at the 40th Orthomolecular Medicine Today Conference in Toronto (April 29, 2011) to support the use of oral and/or intravenous vitamin C (ascorbic acid), as well as other antioxidants, as internal protectants against radiation exposure.*

Introduction

On March 11, 2011, there was an earthquake and a tsunami with devastating consequences in Japan. It led to a serious nuclear accident at the Fukushima nuclear power plant (NPP) with the release of a substantial amount of radiation. Of primary concern was the protection against radioactive contamination of the population, of the rescue workers, and of the persons trying to control the nuclear disaster in locales and in areas surrounding the NPP.

The mechanistic measures taken by the authorities included evacuation of the population, decontamination showers of clothing, and the use of protective clothing for workers at the NPP. All of these measures are aimed to minimize contamination. Except for potassium iodide tablets that protect the thyroid gland against radioactive isotopes of iodine (i.e., iodine-131), there has been little implementation of orthomolecular protection methods by the Japanese authorities. This article highlights the opinions of Dr. Atsuo Yanagisawa that were presented at the 40th Orthomolecular Medicine Today Conference in Toronto, April 29, 2011, to support the use of oral and/or intravenous vitamin C (ascorbic acid), as well as other antioxidants, as internal protectants against radiation exposure.

The Published Evidence

Studies with vitamin C, financed partially by the Japanese Ministry of Defense under the Special Research Program, demonstrate that vitamin C can limit the adverse effects of radiation exposure in mice.[1]

In the main part of the study (**Figure 1,** p.142), mice were pretreated with 150 milligrams (mg) of vitamin C per kilogram (kg) of body weight daily for three days, and were then exposed to 14 Gy of whole body radiation followed by bone marrow transplant (BMT) at 24 hours post-radiation. (Gy represents the SI unit of absorbed radiation dose of ionizing radiation and is defined as the absorption of one joule of ionizing radia-

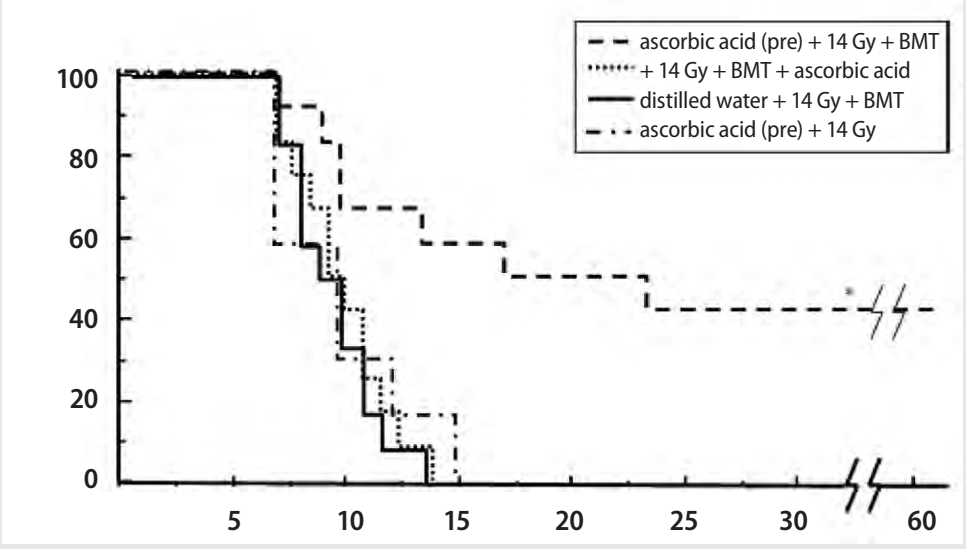
tion by one kg of matter). There was a 42% survival in the mice pretreated with vitamin C prior to radiation compared to no survival if only provided with vitamin C post-radiation. Of note, when mice were pretreated with vitamin C, but not given BMT, none survived. The best results were obtained when vitamin C was given before radiation exposure and was then combined with BMT.

The results of this animal study suggest that patients and rescue workers should consider supplementing with vitamin C since accidental exposures to a lethal dose of radiation might be mitigated when combined with bone marrow or stem cell transplants. Vitamin C can significantly decrease deoxyribonucleic acid (DNA) damage in the cells of the intestinal crypt, preventing damage to the intestinal mucosa. Radiation in the small intestine leads to the expression of genes involved in cell death (apoptosis), which is reduced by supplemental vitamin C.

The Japanese government became involved in this research due to a nuclear accident in 1999. Persons exposed to high doses of radiation developed severe bone marrow aplasia and required stem cell transplantation. These persons developed severe intestinal damage with diarrhea and bleeding, and subsequently died from multiple organ failure despite intensive supportive therapy. This severe gastrointestinal condition resulting from high doses of radiation is known as fatal gastrointestinal syndrome (GIS). It is also an unfortunate complication of abdominal radiation therapy in cancer patients.

There are currently no effective therapies against GIS due to extensive radiation exposure. Vitamin C might help to prevent or limit severe gastrointestinal damage, thereby preventing fatal GIS. Unfortunately, the rescue team members of the National Self-Defense Force did not get intravenous vitamin C or even vitamin C supplements when they were in the Fukushima Nuclear Plant.[2]

Figure 1. The effect of treatment with ascorbic acid on mouse survival after radiation. The mice were irradiated at 14 Gy and received BMT 24 h after radiation. They received ascorbic acid p.o. for 3 days either before or after radiation, or received distilled water only before radiation. The mice pretreated with ascorbic acid were also irradiated at 14 Gy without BMT. N = 12 in each group, *P < 0.01 vs other groups (used with permission).



Additional Vitamin C Experiments

Narra et al demonstrated that vitamin C mitigates radiation-induced damage from tissue-incorporated radionuclide (i.e., iodine-131).[3] In this study, an experimental model of spermatogenesis in mice was used since it closely resembles that of humans.[3] The experiment showed that intratesticular vitamin C protected mice sperm cells that were previously injected with radioactive iodine. As a result of vitamin C, the 37% sperm head survival dose (D37) increased by a factor of 2.2 compared with the D37 in animals receiving only the radionuclide. In a separate experiment, mice were placed on a vitamin C-enriched (1% by weight) diet five days prior to the administration of the radionuclide. The vitamin C-enriched diet was continued for seven days post-radionuclide. The vitamin C-enriched diet was found to have a similar therapeutic effect to that of injected vitamin C, which led the researchers to conclude that vitamin C may play an important role as a radio-protector against accidental or medical radiation exposures, especially when radionuclides are chronically incorporated in the body.

In another study, nucleated cells from freshly isolated whole blood taken from normal human subjects before and one hour after they had eaten a meal in combination with approximately 35 mg of vitamin C/kg of body weight, were subjected to ionizing radiation (i.e., radioactive cobalt).[4] The addition of vitamin C led to significant reductions in DNA damage, with its therapeutic effects peaking four hours post-ingestion.

The vitamin C studies presented here suggest that it should be used to mitigate radiation damage following acute exposures, chronic exposures, and as prophylaxis against potential radiation exposures.

Ensuring an Optimal Antioxidant Reserve

Radiation can damage DNA in two ways: (1) by directly ionizing DNA molecules; and (2) indirectly by ionizing water in body cells, where free radicals are formed which in turn damage DNA. There are scientific reports documenting the benefits of using a complement of several radio-protective antioxidant orthomolecules, which presumably mitigate DNA damage.

In one study, a combination of antioxidants (i.e., alpha-lipoic acid, vitamins C and E, selenium, N-acetylcysteine, and coenzyme Q10) improved the survival of mice following total-body irradiation.[5] The mice not given antioxidants were dead by day 16, but 4 of 14 mice that were given antioxidants immediately after total-body irradiation were alive on day 16. When antioxidants were delayed by 24 hours post-exposure, there was a marked increase in survival, which resulted in 14 of 18 mice surviving at 30 days compared to none surviving when given a diet supplemented with antioxidants immediately after total-body irradiation. When administered 24 hours post-radiation, the antioxidant combination improved bone marrow cell survival and moderated lethality, yielding a radiation protection factor of approximately 1.18.

In another study, 600 mg/day of alpha-lipoic acid was taken orally by nine individuals that had been involved in the clean-up of the Chernobyl nuclear accident.[6] These individuals were given the alpha-lipoic acid 11-12 years following their exposure, and only took the antioxidant daily for two months. The results demonstrated non-specific normalization of various immune parameters, such as neutrophil phagocytic activity, complement titer, and reaction of autorosette formation.

An optimal antioxidant reserve, therefore, plays a key role in the protection against radiation-induced injury. The general population in locales and in areas surrounding NPP should protect themselves with daily antioxidant supplementation (**Tables 1-3**, p.144). Potassium iodide should also be included to saturate the thyroid. This will ensure that the thyroid absorbs less radioactive isotopes of iodine in cases of a radioactive disaster. Potassium iodide tablets during or immediately after a disaster is especially useful if an individual is iodine deficient.

Table 1. Dietary supplements to protect against radiation injury among women of childbearing age[2]

Multivitamin/mineral supplement	High dose	1/day
Vitamin C or	1,000 - 2,000 mg	3-4/day
Liposomal vitamin C	1,000 mg	2/day
Alpha-lipoic acid	100-200 mg	2/day
Selenium	50-100 mcg	2/day
Vitamin E	100-200 mg	2/day

Table 2. Dietary supplements to protect against radiation injury among general population (excludes women of childbearing age)[2]

Multivitamin/mineral supplement	High dose	1/day
Vitamin C or	2,000 -3,000 mg	3-4/day
Liposomal vitamin C	1,000 mg	2/day
Alpha-lipoic acid	300 mg	2/day
Selenium	200 mcg	2/day
Vitamin E	200 mg	2/day

Table 3. Dietary supplements to protect against radiation injury among workers in contaminated areas[2]

Intravenous Vitamin C (as part of Myers' Cocktail)[7]	25 g	Administered pre- and post-exposure
Multivitamin/mineral supplement	**High dose**	**1/day**
Liposomal Vitamin C	1,000 mg	2/day
Alpha-lipoic acid	300 mg	2/day
Selenium	200 mcg	2/day
Vitamin E	200 mg	2/day

Official Statement

At the request of Dr. Yanagisawa, the Japanese College of Intravenous Therapy issued an official statement on March 29, 2011, directed towards the Japanese government: "It is our strongest recommendation that those living in the affected areas regularly take antioxidant supplements such as vitamin C to counteract the negative consequences of long-term low dose radiation exposure as well as to protect the health of coming generations. It is further recommended that those working in environments that require exposure to high-concentrations

of radiation should immediately undergo high dose IV vitamin C therapy along with a vigorous antioxidant supplementation program."

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Competing Interests

Dr. Schuitemaker is consultant to The Ortho Company, a company distributing food supplements, mainly in the Netherlands.

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