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PERSPECTIVE

Being Unprepared for Nuclear Terrorism Would Lead to Panic and Fear in America

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Abstract

Chernobyl demonstrated that iodine-131 (131I) released in a nuclear accident can cause malignant thyroid nodules to develop in children within a 300 mile radius of the incident. Timely potassium iodide (KI) administration can prevent the development of thyroid cancer and the American Thyroid Association (ATA) and a number of United States governmental agencies recommend KI prophylaxis. Current pre-distribution of KI by the United States government and other governments with nuclear reactors is probably ineffective. Approximately two billion people are at risk for iodine deficiency disorder (IDD), the world's leading cause of preventable brain damage. Iodide deficient individuals are at greater risk of developing thyroid cancer after 131I exposure. There are virtually no studies of KI prophylaxis in infants, children and adolescents, our target population. We encourage global health agencies (private and governmental) to consider these critical recommendations.

Keywords

Chernobyl, Iodine-131 (131I), Potassium iodide (KI), American thyroid association (ATA), Nuclear reactors, Iodine deficiency disorder (IDD)

With over 400 nuclear reactors and 15,000 nuclear warheads around the world it is likely that nuclear events or historic releases will occur. We must understand that the panic associated with them will likely be due to lack of preparation, short term I131 exposure and long term strontium-90, cesium-134, and cecium-137 exposure. Those immediately in crisis will be managed acutely by hematology but still the bulk of those exposed will in turn need potassium iodide and instruction on cesium and strontium.

While we appreciate the recent articles touching on the crucial question of preparedness for attacks by nuclear terrorists on America, some seem to focus primarily on lethality issues. 13 The short term consequences, as horrible as they are, may not compared to the societal collapse that may ensue as a result of the long term morbidity of vast radiation exposure. As psychiatrists and neuroscientists, we are compelled to provide information on nonlethal effects of radiation poisoning that will affect millions more. Thyroid cancer in children and adolescents has to be considered as the most severe health consequence of a nuclear reactor emergency with release of radio iodine into the atmosphere. 15 American people and the world have real concerns over the threats from North Korea. In fact, being unprepared for a nuclear attack on American soil would provoke widespread panic and fear.

A comprehensive review of the literature published shows that while the potentially lethal effects are important, the well documented non-lethal effects of ionizing radiation would be, by far, the most devastating medical consequence of a nuclear emergency. These consequences are now well known after four cases of mass radiation exposures:

1) The 1945 Japanese atomic bombings,

2) Nuclear weapon testing in the Pacific and the Southwest United States,

3) The Chernobyl nuclear accident and

4) Fukushima nuclear accident in 2011.

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These cases unambiguously demonstrate that thyroid damage, including thyroid cancer, would be the most pervasive threat to millions of people. For the medical community to responsively deal with the question of preparedness for nuclear terrorism, the risks to the thyroid cannot be ignored. Most recently, the American Thyroid Association (ATA) issued a statement pronouncing that Potassium Iodide (KI) should be distributed within 50 miles of an operating nuclear power plant and that KI should be stockpiled in local public facilities [1].

As has been reported, "*Thyroid cancer was the first solid tumor reported to be increased in frequency among* [Japanese] *atomic bomb survivors*" and "*thyroid cancer among children living near Chernobyl in 1986 is the only convincing late effect from the nuclear accident*" [1]. These findings are consistent with research conducted by others who found that the release of radioactive iodine (RAI) from a nuclear weapon or nuclear reactor could threaten populations located hundreds of miles from the release point. For example, a 26-year study tracked the effects of RAI on South Pacific Islanders exposed to fallout from a 1954 atomic test (who were located more than 150 miles downwind). It noted that "*15 of the 22 Rongelap people under age ten years at the time of exposure developed thyroid lesions*". Within the continental United States, the National Cancer Institute has calculated that as many as 212,000 excess cases of thyroid cancer may have occurred as a result of nuclear weapons testing in Nevada during the 1950s and 60s.

Moreover, commercial US nuclear power plants represent a similar threat should an accident occur. As the US Nuclear Regulatory Commission (NRC) has reported "*immediate effects would probably be confined to areas relatively close to the reactor (a few tens of miles)...however cancer deaths and thyroid nodules could occur over much large distances (100's of miles)* [2]. Sadly, this prediction was upheld at Chernobyl, where there were 30 to 35 immediate fatalities (at the plant site), and thousands (probably tens of thousands) of late-occurring thyroid cancers and other thyroid disorders among people located up to 300 miles away. This finding led the World Health Organization to conclude that "*The accident demonstrated that significant doses from radioactive iodine can occur hundreds of kilometers from the site, beyond emergency planning zones"* [3]. Since more than 100 million Americans under age 40 live within 50 miles of a commercial nuclear reactor, it is clear that the thyroid health of millions of people could be at risk.

US officials do not dispute this. At least two NRC studies have quantified reactor accident risks, and both estimate that exposures to RAI could be hundreds of times "safe" levels among those located 50 or more miles from a release. In recognition, the NRC's accident response planning guidelines specifically caution reactor operators that "*much of any particulate material in a radioactive plume will be deposited on the ground within about 50 miles from the facility*" [4]. Yet, these findings are ignored in the creation and implications of policies designed to protect the American public. We suggest that preventing nuclear terrorism is unlikely to be universally successful, the medical community and policymakers should emphasize steps to mitigate the effects of a radiological emergency on Americans.

One safe, efficient, and inexpensive way to do this is to assure the widespread availability of potassium iodide (KI) for children and young adults. In an earlier report by Braverman, et al. [5] timely potassium iodide (KI) administration can prevent the development of thyroid cancer and the American Thyroid Association (ATA) and some United States governmental agencies recommend KI prophylaxis [1]. Importantly, KI's effectiveness at blocking RAI from being absorbed by the thyroid is well known. Some KI was distributed at Chernobyl, with the NRC reporting that among recipients, "*The use of KI was credited with permissible iodine content (less than 30 rad) found in 97% of the 206 evacuees tested"* [6]. The US Food and Drug Administration has concluded that KI prophylaxis can provide "*safe and effective protection against thyroid cancer caused by irradiation"* [7]. The American Thyroid Association calls KI "essential" and has urged that it be stockpiled or pre-distributed with 50 miles of all US nuclear facilities [1]. Yet the amount of KI in the US today is only a tiny fraction of what would be required, should any significant amount of RAI, be released from a power-plant or weapon. Should the need arise, most people would not have access to KI, and this could lead to thousands of cases of thyroid cancer that can easily be prevented.

Furthermore, the recognition of the need for KI is not new. In 1980, the Presidential Commission appointed to study the accident at Three Mile Island correctly noted that "*The greatest concern during the accident was that significant amounts of radioactive material (especially radioactive iodine) trapped within the plant might be released*". They called this potentially "*catastrophic*" and they recommended that "*an adequate supply of the radiation protective (thyroid blocking) agent, potassium iodide for human use should be available regionally for distribution to the general population*" [8]. Unfortunately, neither the nuclear industry nor the NRC, has chosen to follow this recommendation.

While no one disputes that evacuation, sheltering, and food control are all essential elements in dealing with the risks associated with a nuclear emergency, the availability of KI for thyroid protection should not be dismissed or ignored people in power. Certainly we can all agree that "prevention is better than cure".

We should expect and therefore prepare for an onslaught of nuclear terrorism and as the medical community and policymakers should emphasize steps to mitigate the effects of a radiological emergency on Americans. While there may be other prophylactic possibilities it is parsimonious to consider the safe, efficient, and inexpensive way to assure the widespread availability of potassium iodide (KI) for pregnant women, children and young adults.

On the simplest level addressing diet-related iodide insufficiency in the US and worldwide should be the first and least expensive step in reducing the risk to the thyroid. The mechanism of action of radioactive iodine is physiological. The radioactive form of iodine is taken up by iodide transporter of the thyroid the same way as natural iodine is similarly processed [9]. Thyroidal uptake of radioactive iodine is higher in people with iodine deficiency than in people with iodine sufficiency. There is a more pronounced biological effect of radioactive iodine in the thyroid in iodine deficiency [10]. For this reason, iodine-deficient individuals have a higher risk of developing radiation-induced thyroid cancer with exposed to radioactive iodide. Studies in the Bryansk region of Russia after Chernobyl accident showed that the excess relative risk of thyroid cancer related to I-131 exposure was twice as high in areas of severe iodine deficiency [11-13]. Foodstuffs such as kelp and seaweed have significant iodine concentrations and are valuable for maintaining sufficiency. Further, it has been reported that the lowest effective dose in the can vary from as little as 4 to 20 mg of KI (for ~ 70 kg person). Therefore infants and children may require a very small dose of iodide to be effective. It is assumed that the fast food and prepared food industries currently use non-iodized salt for economic reasons and because rarely people have an allergy. One teaspoon of iodized salt contains approximately 4000 mcg iodine [5,14,15].

In an analogous understanding regarding our proposal relating to diet, we must be reminded of the necessity to avoid a public health emergency similar to sailors developing scurvy without citrus fruit or the development of beriberi (vitamin B1 deficiency) among the Japanese Navy as result of a diet consisting mostly of polished rice.

Previously Braverman, et al. [5] proposed:

1) Pre-distribution of KI to at-risk populations;

2) Prompt administration, within 2 hours of the incident;

3) Utilization of a lowest effective KI dose;

4) Distribution extension to at least 300 miles from the epicenter of a potential nuclear incident;

5) Education of the public about dietary iodide sources;

6) Continued *post-hoc* analysis of the long-term impact of nuclear accidents and

7) Support for global iodine sufficiency programs [5].

Approximately two billion people are at risk for iodine deficiency disorder (IDD), the world's leading cause of preventable brain damage. Iodide deficient individuals are at higher risk of developing thyroid cancer after I-131 exposure [5]. The impact of iodine deficiency on fetal radiation damages is mainly that on radiation damages to the thyroid [10]. Also, Linus Pauling demonstrated that cesium 1 Cs-134, 137 will remain in the soil of contaminated areas for 30-300 years. A more pervasive consequence may be an increased number of confirmed thyroid nodules in both men and women. Physicians have long underestimated the consequences of the thyroid radiation - this point made clear by the fact that radiation to the face and neck by X-ray for the treatment of acne used up until the 1960s caused a widespread increased in the incidence of thyroid cancer [16]. We agree with Gale & Armitage [17] encourage global health agencies (private and governmental) to consider these critical recommendations.

In summary, when we as a country are prepared for disasters in any form, involving a public health crisis [18], it is better than to be caught by surprise, eliciting the psychiatric responses to fear, anxiety and panic, and disastrous uncontrollable uproar across our beloved Americans.

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