

## Letter to the Editor

# A reflection on Fukushima nuclear disaster: View of Taiwan doctor

On 11 March 2011, the Fukushima nuclear disaster shocked the world. A 9.0 magnitude earthquake induced a tsunami, which then shut down the power supply of cooling system of the nuclear plant. The nuclear reactor exploded due to overheat and hydrogen accumulation. Radioactive materials were released and plutonium was detected positive in the soil of the power plant. It is the most severe nuclear accident after the Chernobyl event. According to the nuclear safety agency of Japanese government, Fukushima Daiichi nuclear disaster was a level-7 event, the same as Chernobyl disaster. Taiwan, although 2000 kilometers away from Japan, is still under the threat of radiation exposure. Being doctors, it is our responsibility to understand the management of radiation exposure and to educate people.

The radiation effect on human varies with the exposure dosage. When the exposure dosage is less than 500 mSv (millisievert), there are no symptoms, but white blood cell count decreases. Symptoms of fatigue, vomiting, poor appetite, transient hair loss, and decreased red blood cell are developed when human is exposed to 1000–2000 mSv dosage. Between 2000–4000 mSv dosage, exposure induces bone marrow damage, and granulocytopenia or aplastic anemia may occur. Exposure doses higher than 4000 mSv cause human death directly.<sup>1</sup>

Among the main products of nuclear fission, the radioactive iodine isotopes including  $I^{131}$  and  $I^{132}$  are the targets of stable iodine protection. The protection are against two kinds of radiation effect: deterministic effect and stochastic effect.<sup>2</sup> Deterministic effects are caused by high level of radiation exposure, and people in the vicinity of nuclear accident are at the greatest risk. These iodine isotopes will be concentrated in the thyroid gland if contaminated foods are ingested or radioactive materials in the air are inhaled, causing hypothyroidism and acute thyroiditis. Stochastic effect, also named the chronic health effect, can affect people as far as 500 kilometers away. It is not closely dose-dependent, but possibility of thyroid cancer and autoimmune thyroiditis increases with increasing radiation exposure.

People at high risk of radioactive iodine exposure should take stable iodine before exposure or as early as possible. The mechanism is the Wolff-Chaikoff effect, to inhibit the thyroid gland for uptake of radioactive iodine. When large amount of iodine is given, iodopeptides are formed, which would

temporarily inhibit thyroid peroxidase mRNA and protein synthesis and, therefore, thyroglobulin iodinations.<sup>3</sup> Inhibition of intrathyroidal dehalogenation by iodide was also observed on animals.<sup>4</sup> According to the World Health Organization guideline of iodine prophylaxis against nuclear accident, children and adolescents are the most radioactive iodine sensitive group, but their side effects to stable iodine are minimal.<sup>5</sup> When avertable dose of 10 mGy (Gray) to the thyroid gland is estimated, stable iodine prophylaxis for children and adolescents is recommended. Adults, however, are less radioactive iodine sensitive, and their side effects to stable iodine are larger than that of the children. Therefore, avertable dose to the thyroid, only more than 100 mGy, is recommended for stable iodine prophylaxis. For adults older than 40 years, their risk of developing radiation thyroid cancer is minimal, and their side effects to iodine could be severe. Stable iodine prophylaxis to adult, older than 40 years, is generally not recommended, except estimated dosage exposure above 5 Gy.

The side effects of stable iodine are usually not serious. Skin rash, salivary gland enlargement, oral burning sensation, gingival soreness, gastrointestinal discomfort, and diarrhea are the minor side effects. Allergic responses to iodine includes fever, arthralgia, facial swelling.<sup>6</sup> People with active thyroid disease such as Graves' disease should not take iodine prophylaxis, and people with known iodine hypersensitivity, dermatitis herpetiformis, and hypocomplementemia vasculitis should also avoid stable iodine intake. The recommended daily doses are 100 mg for adults and adolescents, 50 mg for children aging 3–12 years, 25 mg for infants aging 1 month to 3 years, and neonates (birth to 1 month) 12.5 mg.<sup>5</sup>

As residents in Taiwan, protection against deterministic effect is not necessary because of the long distance from Japan. However, protection against stochastic effect is important, and we should reduce the risk as low as reasonably achievable. In Taiwan, the possible source of radiation are radioactive cloud, food and water contaminations. Before the radioactive cloud arrives, sheltering is the first priority. It is only when the estimated exposure dosage exceeds the World Health Organization recommended interventional level, we should take stable iodine. Food control and regulation are better than stable iodine intake because the side effects of stable iodine increase with dosage and there is escape effect

of stable iodine. Because being Taiwan doctors, we should educate people, when and how to take stable iodine, and those people with contraindication to iodine who should not take it. Voluntary purchase of stable iodine should be allowed, and the government should tell the public where they can get the stable iodine and the timings to take it.

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