

Use of potassium iodide for thyroid protection during nuclear or radiological emergencies

Technical brief

Revised 31 March 2011 (originally published on 29 March 2011)

Introduction

During a nuclear accident, radioactive iodine may be released in a plume, or 'cloud', and subsequently contaminate soil, surfaces, food, and water, as well as settle on an individual's skin and clothing resulting in external exposure. Radioactive iodine deposited during external exposure can be removed by washing with warm water and soap.

Another type of exposure with greater risk to human health occurs when radioactive iodine is either inhaled or ingested or when substances, such as contaminated food, milk or water, are consumed. Internal exposure, or irradiation, occurs when radioactive iodine enters the body and accumulates in the thyroid gland.

The thyroid gland is at particular risk from irradiation from radioactive iodine because the thyroid uses iodine to produce hormones that regulate the body's metabolism. The thyroid gland does not differentiate between non-radioactive and radioactive iodine. Uptake of radioactive iodine may increase the risk of thyroid cancer, particularly in children. The younger the age at exposure, the higher the risk is for developing thyroid cancer.

In this situation, potassium iodide is used to protect, or block, the thyroid from irradiation. Commonly known as thyroid blocking, taking potassium iodide (KI) before or at the beginning of exposure to radioactive iodine blocks the uptake of radioactive iodine by the thyroid gland, thus reducing exposure of the thyroid to internal radiation.

KI does not:

- protect against any other radioactive substances, e.g. radioactive caesium. It is not a generic radiation antidote.
- protect against external radiation, e.g. from radioactivity deposited on the ground, on surfaces, or on foods.
- prevent radioactive iodine from entering the body, but does prevent its accumulation in the thyroid.

Stable iodine in a normal diet

Stable iodine, or non-radioactive iodine, is an essential nutrient that humans need in very small quantities for the thyroid gland to function properly. This gland gathers iodine to produce thyroid hormones, which are essential for metabolism in all age groups. Thyroid hormones are also crucial for brain maturation and development in the foetus and young child from the 15th week of gestation to 3 years of age.

When iodine intake falls below certain levels, the thyroid is no longer able to produce hormones in sufficient amounts, which is a threat to health. In some areas, where foods and diet are deficient in iodine, intake is supplemented through the use of iodized table salt.

- [Additional information about iodine deficiency](#)

However, when used in day-to-day eating and cooking, iodized table salt does not contain sufficient concentrations of iodine to block the uptake of radioactive iodine by the thyroid. During nuclear emergencies, iodized salt should not be used as a substitute for KI since it will not provide protection against radioactive iodine, and eating excessive amounts of iodized salt will itself pose a significant health hazard.

How KI works

When taken at the appropriate dosage and within the correct time interval around exposure to radioactive iodine, KI saturates the thyroid gland with stable (non-radioactive) iodine. As a result, radioactive iodine will not be taken up and stored by the thyroid gland. Any iodine which exceeds the thyroid's requirement for production of thyroid hormones (either non-radioactive or radioactive) will be excreted through the urine within two days.

When to take KI

KI tablets should be taken by individuals only when explicitly instructed to do so by public health authorities. Nuclear emergency preparedness usually includes plans to ensure that KI tablets are readily accessible (e.g. pre-distribution to strategic sites²).

If the implementation of thyroid blocking with KI is warranted, public health authorities should define the geographic area in which the population should take KI tablets and provide information about when, how, and by whom KI tablets should be taken. These instructions may be given through the radio, TV, internet, loudspeakers, and other available channels, and should be carefully followed.

The effectiveness of KI for thyroid blocking depends on its timely administration. Taking KI shortly before or immediately at the time of exposure to radioactive iodine offers the most effective protection. If KI tablets are taken too early or too late, the thyroid is less likely to be effectively or fully protected. If taken 4 hours after exposure, protection will be reduced by half; taking KI more than 24 hours after exposure will offer no protection.

How many KI tablets should be taken?

Instructions from public health authorities about how KI must be taken should be followed carefully; the correct dose of KI will differ according to age. In the absence of any explicit instruction to the contrary, only one dose of KI should be taken. A single dose of KI is usually sufficient for adequate protection for 24 hours.

In the event of prolonged or repeated exposure, public health authorities may advise taking KI tablets more than once. Under such circumstances, neonates (< 1 month) and pregnant or breastfeeding women should not be given repeated doses of KI; other protective actions should be considered for these particular groups on a case-by-case basis and under medical advice.

Recommended single dosage of stable iodine according to age group

Age group	Mass of KI (mg)	Example of fraction of tablets (130 mg KI tablets)
>12 years and adults	130	1
3 – 12 years	65	1/2
1 month – 3 years	32	1/4
Neonate (< 1 month)	16	1/8

Use of KI tablets in children

The risk of thyroid cancer in children following exposure to radioactive iodine is higher than in adults; younger age groups are at highest risk. As a result, the protection of children must be considered a priority when public health authorities distribute and administer KI to individuals. It should be given to all children at the recommended dosage. The only exceptions are children who have an absolute contraindication (see the section below on contraindications).

Newborn babies (< 1 month) should only ever take one single dose of KI. These babies should have their thyroid hormone levels monitored after the administration of KI; a consultation with a paediatrician within the first week after the administration of KI is advisable.

KI tablets in pregnant women

During pregnancy, the mother's thyroid gland is metabolically more active than in non-pregnant women, and the amount of radioactive iodine that will be taken up by the thyroid increases in comparison with other adults. The foetal thyroid gland may be exposed to radioactive iodine through the placenta, but will also be protected by the KI taken by the mother.

Like the rest of the population, pregnant women should take KI tablets when instructed by public health authorities, following the recommended dosage for adults. By doing so, they will protect their own thyroid as well as the thyroid of their unborn child.

Once the nuclear emergency is over, pregnant women should inform their doctor so this information can be added to their medical records and thyroid function of the newborn baby can be evaluated. Pregnant women should usually take only one single dose of KI.

KI tablets in breastfeeding women

Like the rest of the population, breastfeeding women should take KI tablets when instructed by public health authorities, following the recommended dosage for adults.

The amount of KI that a breastfeeding woman will provide to an infant through breast milk is not enough to protect the thyroid of an infant exposed to radioactive iodine. Therefore, in addition to the KI tablet taken by a woman who is breastfeeding, the baby should also be given KI at the recommended, age-specific dosage. Under these conditions, breastfeeding can continue.

Unless otherwise instructed, breastfeeding women and newborn babies should take one single dose of KI³.

KI tablets in adults

Adults should take KI tablets when instructed by public health authorities, following the recommended dosage. The risk of side effects from KI increases with age, while the risk of radiation-induced thyroid cancer in individuals over 40-years old is low. For this reason, thyroid blocking with KI is not generally indicated in adults over 40 years of age, unless the projected radiation dose to the thyroid rises to levels that threaten the thyroid gland and interfere with its function. While such levels will not usually be reached at sites far away from the radioactive release, instructions by public health authorities should be followed.

Side effects

When used as instructed by public health authorities, the overall benefits of thyroid blocking with KI during a nuclear emergency will outweigh the risks of side effects in all age groups. As thyroid function in newborn babies is critical for brain development, babies should have their thyroid hormone levels monitored after the administration of KI, as described above in the section “Use of KI tablets in children”.

When the appropriate dosage is followed, side effects from KI are rare in children and young adults. However, they may include mild allergic reactions, skin rash, and gastrointestinal upset.

Adverse effects of KI on thyroid function are more frequent in individuals with other, pre-existing thyroid disorders. These disorders are more common in older adults and in the elderly than in children or young adults. Side effects are more likely in individuals who receive a dosage higher than recommended, or who receive repeated doses of KI. The frequency of these thyroid disorders varies between countries, so national authorities may adopt different approaches when determining the appropriate age groups and dosing for administration of KI.

Clinical conditions in which KI tablets are contraindicated

There are very few clinical conditions in which the administration of KI is absolutely contraindicated. People with these conditions must not take KI and need to be protected by other measures on a case-by-case basis and under medical advice. These conditions include:

- hypersensitivity to iodine. This is a very rare disorder that should not be confused with the more common hypersensitivity to contrast agents used with iodine in certain radiological examinations;
- dermatitis herpetiformis (a chronic skin condition);
- hypocomplementaemic vasculitis (an uncommon inflammation of the vascular walls, which can occur in certain immunological disorders); and
- myotonia congenita (an extremely rare congenital defect involving muscle stiffness).

¹ Potassium iodide is an inorganic salt where potassium (K) and iodine (I) are combined in a one-to-one ratio to form potassium iodide. Therefore, its chemical formula is KI. Another compound that national health authorities may decide to use is potassium iodate (KIO₃) and, in that case, the corresponding dosage will be specifically instructed.

² E.g households, schools, hospitals, pharmacies, fire stations, police stations, and evacuation and civil defense centres.

³ KI is usually presented in scored tablets, which facilitates fractionation for paediatric dosage.