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Iodine blockade of the thyroid in the event of a nuclear accident

Recommendation by the German Commission on Radiological Protection

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Empfehlung der Strahlenschutzkommission

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In the event of any doubts about the meaning, the German original as published shall prevail.

Contents

1 Recommendation

The Commission on Radiological Protection (SSK) recommends to adopt the 1989 recommendations of the World Health Organization (WHO) [1] on iodine blockade of the thyroid. These contain the following changes as compared to the recommendations currently in force in the Federal Republic of Germany [2]:

– Reduction of the iodine dose, which is administered as one single intake per day according to the following dosage pattern:

Age group	Dose per day (mg Iodide)
< 1 month	12.5
1 - 36 months	25.0
3 - 12 years	50.0
13 - 45 years	100.0
> 45 years	0

Pregnant and breast-feeding women receive the same dose as adolescents and adults. For new-born children the intake should be restricted to one day, for pregnant and breast-feeding women to two days.

In the Federal Republic of Germany, a region deficient in iodine, an iodine blockade is not recommended for persons over the age of forty-five, because of the increased risk of iodine blockade side effects due to metabolic disturbances in the thyroid (functional autonomy) which become more frequent with advancing age and because of the steeply decreased risk of radiation-induced thyroid carcinoma at an advanced age.

– Assessment of the following secondary thyroid doses as intervention levels:

Age group	Organ dose
0 - 12 years, pregnant women	50 mSv
13 - 45 years	250 mSv

Iodine tablets should be stocked in amounts sufficient to supply at least all children up to the age of twelve and pregnant women.

2 Justification

2.1 Current knowledge on iodine release

The reassessment of the consequences of the Chernobyl reactor accident gives rise to reconsider the recommendations on preventing the absorption of radioactive iodine into the thyroid by the intake of iodine tablets.

The Chernobyl experience has demonstrated that following a reactor accident, airborne radioactive iodine may, in certain circumstances, be transported in the atmosphere over several hundred kilometres. While the population can effectively protect themselves against the intake of radioiodine with food by refraining from eating fresh vegetables and drinking milk, the prevention of an intake of radioiodine with respiratory air is considerably more difficult. Although remaining indoors after a reactor accident does offer some degree of protection, nevertheless, it may become necessary to initiate additional protective measures (such as taking iodine tablets).

2.2 The effect of iodine blockade

"Iodine blockade" involving doses in the range of 100 mg of iodide and more reduces the absorption of radioactive iodine into the thyroid by a factor of 90 and more – provided that the tablets are taken in good time [3]. If possible, iodine tablets should have been taken before radioactive iodine is absorbed. A satisfactory blockade can still be achieved, if radioactive iodine was absorbed less than two hours ago. Even a few hours after the uptake of radioactive iodine its residence time in the body is reduced by iodine tablets. However, the first application should not be later than one day after the uptake of radioactive iodine, since otherwise the excretion of the latter will be delayed [4].

Radioiodine may cause both stochastic and deterministic effects in the thyroid. Whereas no dose thresholds can be established for stochastic effects (occurrence of thyroid cancer), experience shows that deterministic effects (thyroiditis, hypothyrosis) occur rarely below an organ dose of 10 Gy. However, it must be expected that in the immediate vicinity of nuclear reactors serious accidents can result in incorporations of considerable radioiodine activities, which may cause thyroid doses of several Gy.

2.3 Previous recommendations for the Federal Republic of Germany

The Federal Republic of Germany was one of those states giving recommendations on the iodine blockade of the thyroid in the event of nuclear emergencies very early – in 1975 (published 1977 in [5]). According to the "intervention levels for sheltering, administration of stable iodine and evacuation" [2], the lower intervention level for taking iodine tablets is 200 mSv, the upper 1000 mSv. These lower and upper intervention levels are by a factor of 4 higher than those recommended by WHO [1]. This is justified on the grounds that most parts of the Federal Republic of Germany are iodine-deficient areas and that the administration of iodine tablets involves an increased risk of undesired side effects.

The „iodine information sheets“ (Jodmerkblätter) [2] provide the following dosage plan (the figures apply to tablets of 100 mg potassium iodide corresponding to approximately 80 mg iodide):

– Adults, including pregnant women: initial dose of two tablets of 100 mg potassium iodide each, thereafter one tablet approximately every eight hours up to a total of ten tablets within three to four days.

– Children (up to a weight of 40 kg): initial dose of one tablet, thereafter ½ tablet every eight hours up to a total of five tablets.

– Toddlers and infants (up to a weight of 20 kg): ½ tablet per day up to a total of two tablets.

2.4 1989 WHO recommendations

As mentioned above, the WHO intervention levels [1] are lower by a factor of 4 (lower intervention level at 50 mSv, upper intervention level at 250 mSv) than the corresponding intervention levels in the Federal Republic of Germany. The dosage recommendations also differ (the WHO relates its dosage figures to tablets of 100 mg iodide corresponding to 130 mg potassium iodide):

– Adults, pregnant or breast-feeding women and young people over the age of twelve: one tablet daily.

– Children aged between three and twelve: ½ tablet daily.

– Small children aged between one month and three years: ¼ tablet daily.

– Infants up to the age of one month: $^{1}/_{8}$ tablet daily.

The WHO recommends that the total dose for pregnant or breast-feeding women and new-born children should be restricted: new-born children should receive no more than 1 x 2.5 mg of iodide, pregnant or breast-feeding women a maximum of 2 x 100 mg. This means that in the event of an accident involving continuous release or absorption, these risk groups must be evacuated from the affected regions within one to two days at the most.

2.5 Adjustment of the German iodine blockade recommendations to the international iodine blockade recommendations

There are several reasons to harmonize the German and international recommendations. One reason is that it is very difficult for the population to understand why, after a reactor accident in a neighbouring country, the local population receives iodide tablets whereas, due to higher intervention levels in Germany, the German population which might be living at a distance of only a few kilometres does not. However, the most important argument in favour of changing the German intervention levels derives from experiences following the Chernobyl reactor accident: it was found that the frequency of thyroid cancer in children increased significantly, even in areas of Belarus and Ukraine lying in a distance of several hundred kilometres. Follow-up examinations in the A-bomb survivors of Hiroshima and Nagasaki revealed that the additional relative risk of thyroid cancer following radiation exposure is age-dependent

and, at 6.4 per Gy for 0 to four-year-olds, 3.7 per Gy for five- to nine-year-olds and 2.1 per Gy for ten- to nineteen-year-olds, distinctly increased for children and adolescents, whereas there is only a minimal increase for older persons, at 0.7 per Gy in the case of twenty- to twenty-nine-year-olds, 0.9 per Gy in the case of thirty- to thirty-nine-year-olds and 0.0 per Gy in the case of the over forty-fives [6]. But it had not been anticipated that considerable incorporations of radioiodine and a resulting increase in the frequency of cancer in children can occur in areas far removed from the location of an accident [4].

These experiences justify the recommendations of the German Commission on Radiological Protection to adjust the German intervention levels to the international recommendations and to plan appropriate organizational measures in areas remote from nuclear reactors.

2.6 Determination of an upper limit of age for the iodine blockade of the thyroid

The Federal Republic of Germany is an iodine-deficient region, where, according to recent studies, a previously postulated south-north gradient involving a distinctly inadequate supply of iodine in the south and an adequate supply of iodine in the north is at most of minor significance. According to studies conducted on adolescent schoolchildren in the age of puberty, the frequency of a goitre from iodine-deficiency among this age group is between 40% and 60% [7]. While the administration of high iodine doses in the order of 1000 times the daily iodine-intake with food for younger people is relatively uncritical, it may lead to considerable complications in the case of older people with long-standing iodine-deficiency goitres for many years. In long-standing iodine-deficiency goitres, a disturbance of the iodine metabolism of the thyroid, termed "functional autonomy", frequently occurs. Postulating that the frequency of iodine-deficiency goitres among citizens of the Federal Republic of Germany between the ages of forty and fifty is approximately 20% to 30%, and taking into account recent studies on the frequency of functional autonomy, it can be assumed that about 10% of the citizens of the Federal Republic of Germany between forty and fifty have such a disturbance of the iodine metabolism of the thyroid [8]. In such persons an iodine blockade may cause a serious and barely controllable development of hyperthyroidism. Since this risk is higher than the low, virtually non-existent risk of radiation-induced thyroid carcinoma, persons who are older than approximately forty-five years should be excluded from iodine blockade of the thyroid [3].

However, this recommendation accepts that in the event of an accidental release, unprotected persons over forty-five years staying in the vicinity of nuclear reactors may suffer deterministic radiation damage. This involves relatively harmless disorders, such as temporary thyroiditis and hypothyrosis easy to correct by medication. Given the additional fact that the number of people living in the vicinity of a nuclear reactor assumed to be affected, is far lower than the older population living in a remote area, it is recommended that iodine blockade should generally not be administered on over forty-fives.

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