IAEA-CN-67/84

Thyroid cancer in Belarus after the Chernobyl accident: incidence, prognosis of progress, risk assessment.

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Abstract. Starting from 1990, an increasing number of persons, suffering from thyroid cancer was diagnosed in Belarus. These persons were exposed to radiation in 1986 due to the Chernobyl accident and were children and adolescents at the time of the accident. This paper gives an overview of the total number of thyroid cancer cases observed in Belarus after the Chernobyl accident among the persons exposed to radiation under 18 years of age. Duration of the latent period and background incidence rate are under discussion. Based on the most reliable data about thyroid doses and incidence rate among the persons exposed to radiation under 6 years of age, the estimation of risk coefficient for radiation induced thyroid cancer was carried out. For childhood exposure from I-131, the excess absolute risk per 10000 PYGy was 4.5.

It is well known that exposure of the thyroid gland to low doses of radiation may induce thyroid cancer in humans. The experience on external radiation and thyroid cancer comes mainly from studies of children irradiated for a variety of medical conditions and the Japanese atomic bomb cohort. The data about thyroid cancer following radioactive iodine exposure, in particular exposure from I-131, are limited. In this connection, investigation of the thyroid cancer incidence after the Chernobyl accident will provide the unique possibility to analyze new information on this issue.

The accident at the Chernobyl NPP released about 1.8×10^{18} Bq of I-131 [1]. As the result of the accident, the overwhelming part of the territory of the Republic of Belarus was contaminated with I-131. In five out of 6 regions of the Republic, density of contamination of I-131 ranged from 0.4 to 37 MBq/sq.m. [2].

Exposure from I-131, mainly formed by ingestion of radionuclides with contaminated milk, developed conditions for thyroid stochastic consequences among the exposed population.

The aim of this paper is to present the main aspects within risk analysis study that was carried out during the post-accidental period in Belarus. These aspects are:

- cohort under investigation,
- background level of thyroid cancer incidence rate,
- duration of the latent period,
- prognosis of the thyroid cancer cases based on known risk coefficients,
- preliminary estimation of the risk coefficient for specific conditions.

Correct determination of the cohort under investigation is an important aspect for making correct decision about the level of the incidence. For epidemiological purposes, it is no sufficiently informative to analyse incidence rates by the age at diagnosis, but is very important to analyse it by the age at the time of the accident. Such cohort should be followed up during a long period of time for clear estimation of risk coefficient. During the first stage of our study, a cohort of persons who were exposed to radiation at the age under 14 years was

selected [3,4]. In the course of time, reliable data about persons who were children and adolescents in 1986 became available. As a result, cohort of Belarusian people, exposed at the age under 18 is under investigation now. Within this cohort, there are 790 thyroid cancer cases diagnosed in 1986 - 1996. 755 cases were registered in 1990-1996 and 35 cases in 1986-1989 (Table 1).

Table 1. The incidence of the thyroid cancer after the Chernobyl accident among persons exposed to radiation under 18 years of age.

Years	Thyroid cancer cases			Thyroid cancer incidence rate per 100,000		
	Girls	Boys	Total	Girls	Boys	Total
1986	2	1	3	0.14	0.07	0.1
1987	10	3	13	0.71	0.21	0.45
1988	4	4	8	0.28	0.27	0.28
1989	6	5	11	0.43	0.34	0.38
1990	16	17	33	1.13	1.17	1.15
1991	55	23	78	3.90	1.58	2.7
1992	50	41	91	3.54	2.82	3.17
1993	94	33	127	6.66	2.27	4.42
1994	103	46	149	7.30	3.16	5.2
1995	95	49	144	6.73	3.37	5.0
1996	90	43	133	6.38	2.95	4.63
1986-1996	525	265	790	3.38	1.65	2.5
1990-1996	503	252	755	5.1	2.5	3.9

The level of the thyroid cancer incidence in Belarus before the Chernobyl accident (1971-1985) was low for children (0.04 per 100,000 children population annually) and relatively higher for adults (0.3-2.5 per 100,000 population for men and 1.2-3.9 per 100,000 population for women) [5].

For persons aged 0-18 in 1986, the thyroid cancer incidence rate during 1986-1989 did not differ significantly from the background level. To confirm this fact and to determine the duration of the latent period, three different levels of incidence rate were compared:

a).incidence rate for persons aged 0-18 before the accident;

b).incidence rate for persons aged 0-18 after the accident;

c).incidence rate among persons who were born since 1987.

It is obvious, that it is possible to compare the level of incidence rate among persons who were born since 1987 with other levels only with some assumptions, because the age of this cohort in 1996 was only 0-9. However, incidence rate among this group reflects the "pure" background level (Fig.1).

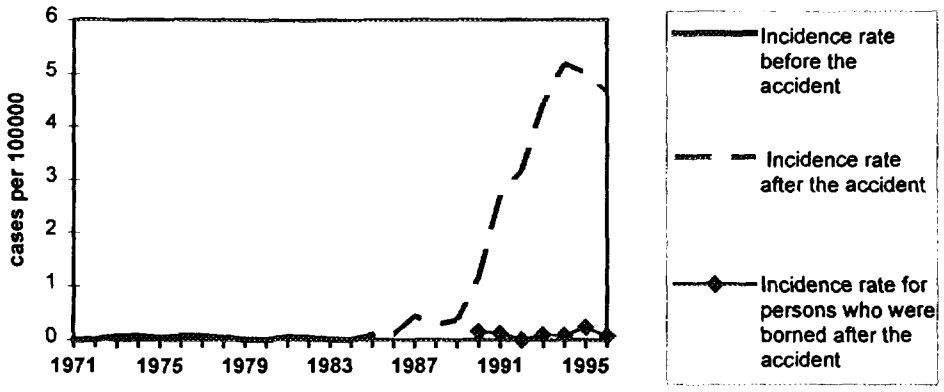

Fig.1. Thyroid cancer incidence rate during different periods.

Based on this comparison we confirmed the significant increase of thyroid cancer incidence rate since 1990 and came to the conclusion about the background level of incidence among persons under investigation during 1986-1989. So, the duration of the latent period in our study is 4 years, as described for Ukrainian cohort [6] and in our previous reports [3,7].

For cohort aged 0-14 in 1986, prognosis for thyroid cancer cases during the life period was carried out in our previous studies. For this purpose we used NCRP model of specific risk estimates for thyroid carcinogenesis and different values of absolute risk coefficient [8,9]. The comparison of numbers for predicted and observed thyroid cancer cases showed that the uncertainties of using this model were very high. There were different sources of uncertainties: the value of risk coefficient, demography and dosimetry, duration of latent period, value of dose effectiveness reduction factor. Some of this questions were defined more precisely and based on this, preliminary estimation of the specific value of risk coefficient was carried out. For this estimation, a cohort of persons aged 0-6 years in 1986 with the data about thyroid doses based on direct measurements [10] was selected. This selection was also based on the necessity of selecting of persons who were exposed to radiation in the young childhood due to the highest risk of radiation-induced thyroid cancer for them.

Risk coefficient was calculated based on the additive model using linear dose-response relationship. The calculated value of absolute risk coefficient for I-131 exposure of children is 4.5 per 10000 PYGy (Table 2).

Table 2. Preliminary estimation of absolute risk coefficient for children exposed to radiation under 6 years of age.

Dose interval, Gy	Number of settlements	Population	Average dose, Gy	Person-Year-Gy	Number of cases
<0.1	14	294664	0,061	125933	84
0.1 - 0.49	21	169602	0,349	414879	214
0.5 - 0.99	9	19722	0,715	98715	29
≥ 1	6	16359	1,58	181213	52
Total	50	500347	0,23	820740	379
Background					9
Excess cases					370
Absolute risk coefficient					4,508

The use of this value and a 4-year duration of the latent period for prognosis of thyroid cancer cases for all the cohort of persons aged 0 - 6 years in 1986 (with the data for direct measurements and without them) shows a good agreement between the prognosed and registered cases (Fig.2).

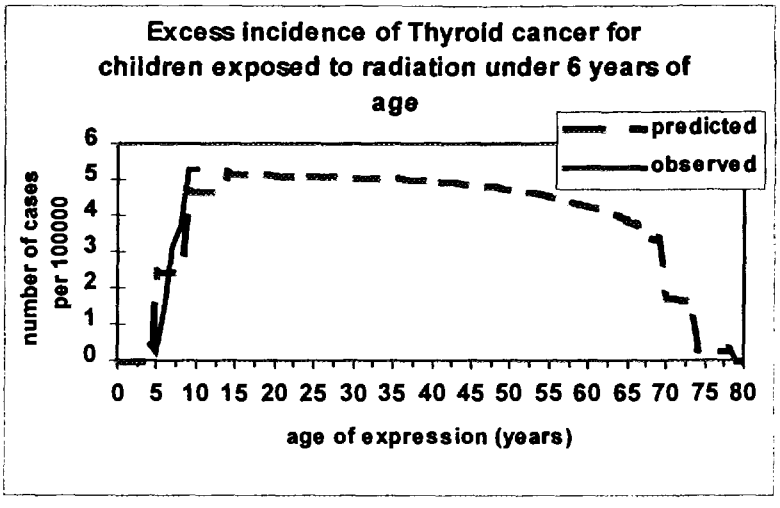

Fig.2. Comparison of the predicted and observed thyroid cancer incidence rate during life for exposed till 6 years children of Belarus based on specific risk coefficient.

Based on this prognosis we discovered that among the exposed persons of this age group, about 3,400 thyroid cancer cases may develop during the life period. About 2,200 may develop among the exposed inhabitants of the most contaminated Gomel Region.

Future activity. Investigation in the field of risk analysis will be continued in the future based on the obtained data. The main aspects under consideration will be:

- continuous collection of data about thyroid cancer cases for cohort under investigation;
- analysis of the role of short-lived isotopes in the thyroid exposure;
- estimation of risk coefficient for people of different age at the time of exposure taking into account their sex, years at risk, age-dependent background incidence rate.

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