THYROID

Shigenobu Nagataki, M.D

Chairman, Radiation Effects Research Foundation
Hiroshima and Nagasaki

The Thyroid and Radiation Emergency

The explosions of nuclear weapons or accidents at nuclear power station affect the thyroid, and radiation-induced thyroid diseases are due to exposure to external radiation at the time of explosion or from the radioactive fallout and to exposure to internal radiation from radioactive iodine that accumulates within the thyroid glands.

Reports on Radiation-induced Thyroid Diseases

Atomic Bomb

Thyroid cancer, thyroid adenoma and hypothyroidism increased by external radiation at the explosion of atomic bomb in a dose dependent manner.

A significant increase in the prevalence of thyroid nodule was found in the radioactive fallout areas. Radiation dose, however, is not known

Radiation at the Neck

Children received radiation at the neck for treatment of enlarged thymus, tinea capitis, hemangiams showed a significantly higher prevalence of thyroid cancer than controls. Mean dose was from 0.06 to 1 4 Gy

Marshall Islands

Nuclear weapon test at Bikini island distributes radioactive fallout to surrounding islands and fisherman's boats Prevalence of thyroid atrophy, thyroid cancer and thyroid nodules was significantly higher in children living surrounding islands than controls

Total thyroid intake of radioactivity from iodine and tellurium isotopes are shown in Table 1.

Table 1: Total intake of radioactivity from iodine and tellurium isotopes according to location

Radionuclide	t1/2	Total intake of radioactivity from iodine and tellurium isotopes (*f*Ê Ci)		
		Rongelap	Ailingnae	Utirik
Iodine-135	6.7	1900-3500	670-1200	79-140
Iodine-134	0.8	670-1200	430-780	-
Iodine-133	20.8	1200-2100	310-570	160-320
Iodine-132	2 3	310-560	67-120	60-110
Iodine-131	193 0	53-96	11-20	13-23
Tellunum-132	78 0	300-550	72-130	57-110
Tellurium-131m	29 0	44-81	13-24	-17

It is important to note that the radioactivity from short-lived isotopes was much more than that of iodine-131

Chernobyl

In addition to direct external exposure to workers, fireman, etc. at the nuclear plant, a huge dose of radioactive materials was released at the time of accident Table 2 shows some of the radionuclides released

Table 2 Radionuclides released

Radionuclide	Activity of releases (pBq)
Te-129m	240
Te-132	1000
I-131	1200-1700
I-132	
I-132	2500
Cs-134	44-48
Cs-136	36
Cs-137	74-85

According to the map of Cs-137 contamination, (other isotopes disappeared at the time of examination in 1989-1990) 4 million subjects were living in the contaminated areas The international conference of the IAEA, EC and WHO, held in April 1996 and entitled "One Decade after Chernobyl" concluded that the only clear evidence to date of the public health impact of radiation exposure as a result of the Chernobyl accident, is a highly significant increase in the incidence of thyroid cancer among those persons in the affected areas who were children in 1986 Fig 1 shows number of children with thyroid cancer.

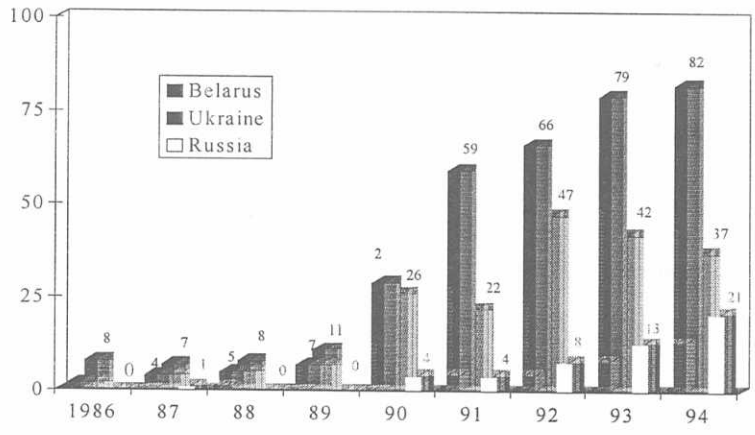

Figure 1: Number of children with thyroid cancer

However, the conclusion is based on the circumstantial evidence of geographical and temporal distributions of cases It is unclear what type of radiation exposure involves and what kind of radionucleotides causes the increase of thyroid cancer

In the Sasakawa Chernobyl Project, we have screened 150,000 children in 5 diagnostic centers around Chernobyl: Gomel and Mogilev in Republic of Beralus, Korosten and Kiev in Ukraine, and Klincy in Russian Federation. The increased prevalence of thyroid cancer was confirmed for the first time by epidemiological method Median of whole body Cs-137 contents and median level of urinary iodine are also shown (Table 3)

Table 3 : Results of Screening in Five Diagnostic Centers around Chernobyl

Center	Subjects		Thyroid Cancers		Median of Whole Body Cs-137 Contents by Region (Bq/Kg)	Median Level of Urinary Iodine (ƒÊg/dL)
		Number	Number	Prevalence (per 100,000)		
Gomel	Total	19,273	39	202		
					30-140	16 9
	Boys	9 320	14	150		
	Girls	9,953	25	251		
Mogilev	Total	23,585	3	13		
					10-80	17 7
	Boys	11,514	2	17		
	Girls	12,071	1	8		
Korosten	Total	28,958	9	31		
					20-100	3 9
	Boys	13,668	3	22		
	Girls	15,290	6	39		
Kiev	Total	27,498	6	22		
					30-40	8 5
	Boys	13,167	2	15		
	Girls	14,331	4	28		
Klincy	Total	19,918	8	40		
					50-100	7 0
	Boys	9,860	3	30		
	Girls	10,058	5	50		

The possible cause of thyroid cancer is summarized in Table 4

Table 4: Possible Cause of Thyroid Cancer

Cs-137	
no correlation in our project	with whole body Cs-137
	with Cs-137 in the soil
many previous papers mentioned that thyroid cancer increased in highly radio-contaminated areas determined only by the Cs-137 content in the soil.	
I-131	
some reports of correlation	with I-131 in the soil
	with I-131 in thyroid glands
no reports of carcinogenesis in human.	
External Radiation	
no reports on correlation (not studied yet)	
many reports on carcinogenesis	atomic bomb, medical treatment
Short-lived Radioactive Iodine. Te-132 (78hrs), I-132 (2.3hrs)	
no reports on correlation (not studied yet)	
some reports on carcinogenesis	
Other Environmental Factors	
Iodine: possible but urinary iodine did not correlate with the prevalence of thyroid cancer	
Chemicals: no reports on correlation (not studied yet)	

Cs-137

In our project, there was no correlation between the prevalence of thyroid cancer and whole body Cs-137 nor Cs-137 in the soil.

I-131

A map of I-131 contamination was presented several years ago in which I-131 in the soil was measured shortly after the accident by Russian Army. Some reports shows the correlation between thyroid cancer and reconstructed thyroid dose of I-131. However, there are no reports which show that I-131 administered for diagnosis or treatment significantly increases the incidence of thyroid cancer in human

External radiation

Although there are many papers on carcinogenesis (atomic bomb, medical treatment), the effect of external radiation has not been studied in the fallout areas of Chernobyl

Short-lived radioactive iodine

Some reports showed that external radiation or short-lived radioactive iodine is more carcinogenic than I-131. As shown in Table 5, many short-lived radioactive iodine were released at the time of accident and Te-132 (half life: 78 hr) can produce I-132 continuously In fact, 4 travelers who came back to Japan from Mogilev on May 1, 1986, showed the internal exposure of I-132 similar to that of I - 131 (Table 5).

Table 5: Internal Exposure of Japanese Travelers

Radionuclide	Burden (kBq)	Dose in Thyroid (mSv)
Te-129m		
Te-132	0.59	
I-131	0.14-0.31	0.3-0.7
I-132		03-1.0
I-133		
Cs-134		
Cs-136		
Cs-137		

However, there are no reports yet on the short-lived radioactive iodine in Chernobyl

Other environmental factors

Iodine deficiency may modify the effect of radioactive iodine However, our study showed that Gomel whichs howed the highest prevalence of thyroid cancer is not the iodine deficient area (Table 3)

Cause of Thyroid Cancer in Radioactive Fallout Area:

It is clear that thyroid glands accumulate radioactive iodide and the internal contamination is the cause of thyroid diseases Since the half life of I-131 is relatively long when compared to the other radioactive iodine released by accident, I-131 has been thought to be the major radioactive iodine.

However, as shown in sections of Marshall islands and Chernobyl, various radioactive iodine with short-half life were released more than I-131, and Tellurium-132 with half life of 78 hours can be distributed far from the nuclear plant and produce I-132 with half life of 2.3 hours External radiation from the radioactive fallout is also not negligible in some accident.

The evidence that the increase of thyroid cancer in fallout areas is due to I-131 or radioactive iodine is still circumstantial.

Thyroid and Medical Preparedness:

The cause of thyroid disease in the radioactive fallout areas is still circumstantial and, therefore, it is important to prevent not only 1) oral intake of radioactive iodine (mainly I-131), but also 2) radiation from inhalation, especially short-lived radioactive iodine and 3) external radiation.

Prevention of Radiation by Radioactive Fallout:

Iodine prophylaxis is mainly used for the prevention of radiation, and Table 6 shows the recommendation for dose of stable iodine.

Table 6: Recommendation for dose of stable iodine

	WHO		IAEA		ICRP		JAPAN	
dose of stable iodine	adult	100mg	adult	100mg	adult	100mg	adult	100mg
	3-12 y	50mg	children	100mg	3-12 y	50mg	children	
			less than					
	1-3 y	25mg					1y<	100mg
	newborns	12 5mg			3y>	25mg	1y>	50mg

However, probably more important in preventing radiation from the fallout, is to evacuate people from the area before the release of radioisotope from the nuclear plant, since it will be possible at the present situation that the first information about the accident is delivered from the headquarters several hours or even one day before the actual release of radioactive materials from the reactor.

It is also very important to stay inside the room and shield the window by water (wet paper or cloth) during the period of the fallout of short-lived isotopes.

Prevention of Thyroid Diseases after Irradiation:

There are no effective treatments to prevent thyroid diseases after irradiation In Chernobyl accident, more than 1,000 children were confirmed to have thyroid cancer, and number of children with thyroid cancer may increase dramatically in the near future It is very important to invent the method of prevention

At present, iodine prophylaxis to prevent iodine-deficiency (up to several hundred microgram per day), or the administration of thyroid hormone to suppress the serum TSH levels have been discussed, but these were not proved to be efficient in preventing thyroid cancer in exposed children.