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(IPHECA)

THYROID PILOT PROJECT

Incidence of clinical and morphological features of thyroid cancer among children and adolescents in Ukraine after the Chernobyl accident

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Incidence of clinical and morphological features of thyroid cancer on children and adolescents in Ukraine after the Chernobyl accident

Report presented at the WHO Expert Meeting on Thyroid Cancer, Kiev, Ukraine, 18-21 October 1993

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1. Introduction

The problem of thyroid pathology has assumed particular importance since the Chernobyl accident, with the rise in incidence of thyroid disorders, especially malignant tumours, in recent years. As expected, children and adolescents have been worst affected.

We believe that in order to tackle this major problem it is essential to obtain complete information on incidence of disease in children, to verify the pathomorphological diagnoses, and to enter the resulting data in a clinical-morphological data base.

2. Statistical data on thyroid cancer in Ukraine

Over the last few years the Ukrainian Institute of Endocrinology and Metabolism has built up a register of all cases of thyroid cancer among children and adolescents. This features individual records of clinical and morphological indicators that can be used to establish the age of the disease, the doses sustained by the thyroid, the clinical course of the disease, the extent of surgical intervention, metastases, and description of tissue specimens. The extraction from that register of specific morphological information from cytological and histological examinations and from electronmicroscopy, allows a detailed description of each case, which can be further analysed as data are accumulated.

Between 1981 and 1992, 269 cases of thyroid cancer among children up to the age of 14 and adolescents from 15-18 were recorded in the Ukraine (see fig. 1); more accurate figures will be provided for subsequent years. The patients' age at the time of the operation was noted. Whereas in the five years preceding the accident there were 59 patients (12 per year on average), in the five years following the accident this number rose to 108 (22 per year on average). In 1991-1992 there were 102 cases: 51 per year on average. Furthermore, in 1992, 10 patients aged 19-20 underwent surgery and were put on the register. They had been children at the time of the accident. By 1 October 1993, in our Institute alone, 30 children, two adolescents and one patient of 21 years of age have undergone surgery. To date, therefore, there are 312 cases of thyroid cancer on the register, 253 of which were reported after the Chernobyl accident; 157 of them were children and 85 were adolescents.

It is clear from the above that incidence among children increased faster than among adolescents (see fig. 2). Whereas in 1981-1985 there were 25 cases of cancer among children in Ukraine, between 1986 and 1992 there were 127 cases. The sharpest increases occurred in 1990 (25 cases), in 1991 (21 cases), and in 1992 (45 cases); in our Institute, 18, 10 and 33 children underwent surgery in those three successive years.

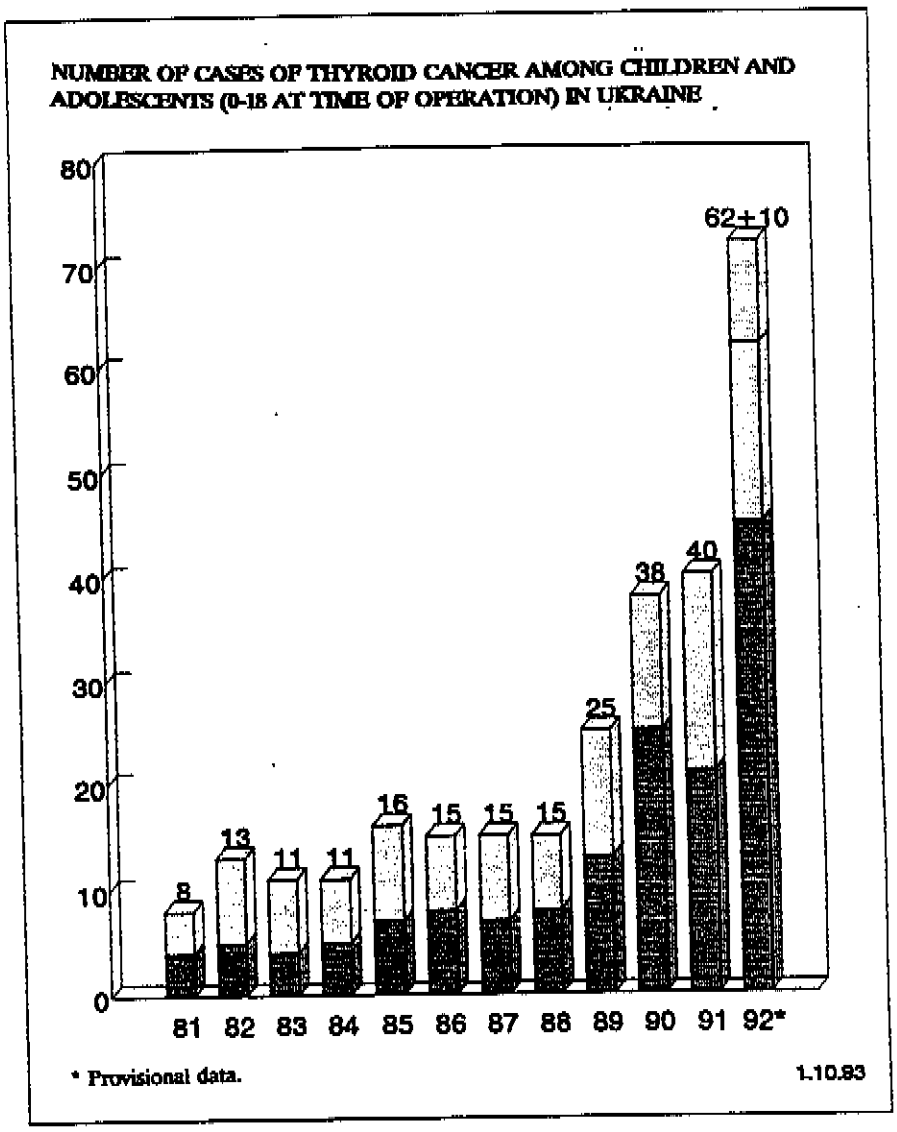
NUMBER OF CASES OF THYROID CANCER AMONG CHILDREN AND ADOLESCENTS (0-18 AT TIME OF OPERATION) IN UKRAINE
80
70
60
50
40
30
20
10
0
8
13
11
11
16
15
15
15
25
38
40
62±10
81 82 83 84 85 86 87 88 89 90 91 92*
* Provisional data.
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FIG.1

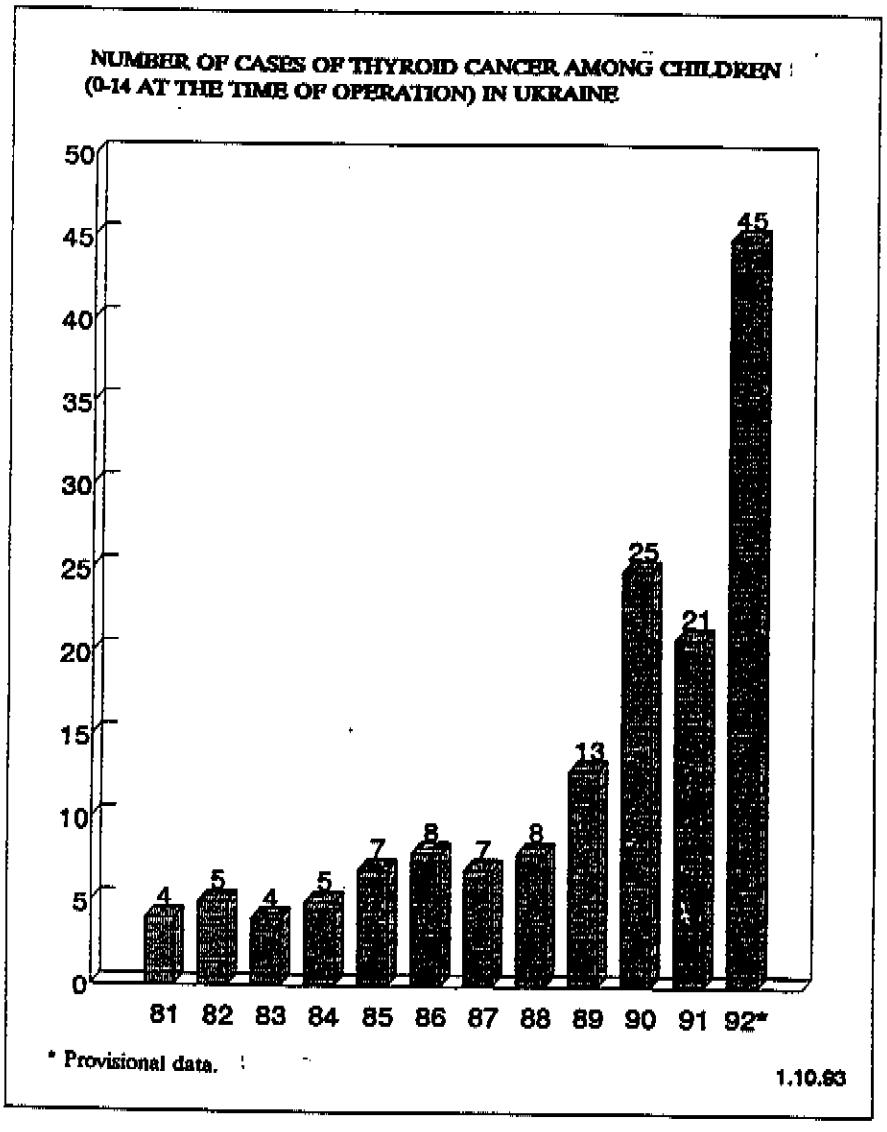

NUMBER OF CASES OF THYROID CANCER AMONG CHILDREN
(0-14 AT THE TIME OF OPERATION) IN UKRAINE
50
45
40
35
30
25
20
15
10
5
0
4
5
4
5
7
8
7
8
13
25
21
45
81 82 83 84 85 86 87 88 89 90 91 92*
* Provisional data.
1.10.93

FIG. 2

The incidence of malignant thyroid tumours among adolescents was 34 in 1981-1985 and 83 carcinomas in 1986-1992 (see figure 3). The increased incidence in malignant tumours of the thyroid among adolescents can also be seen over the last three years: 13 in 1990, 19 in 1991, and in 1992 17 + 10 among older people; this is less marked than among the child contingent. Furthermore, all these patients were children under the age of 14 at the time of the Chernobyl accident.

In 1982-1985 the incidence of thyroid cancer among children in Ukraine (figure 4) was between 0.04 and 0.06 cases per 100 000. In 1990 this had increased to 0.23, in 1991 to 0.19, and in 1992 to 0.41, which was 6.5 to 10 times higher than the pre-Chernobyl level. In individual regions of Ukraine which were worst affected (figure 5), the incidence was considerably higher: in 1992 it stood at 2.5 for Kiev oblast, 1.1 for Cernigov, 1.7 for Rovenskij and 0.6 for Zitomir oblast. There was also a considerable increase in incidence in the city of Kiev (1.5) and Cerkasskij oblast (1.3).

Numbers of cases for the last three years (see figure 6) are as follows: 19 cases of cancer in Kiev oblast, 8 in Cernigov oblast, 6 in Rovenskij and 5 in Zitomir. In the city of Kiev there were 11 cases and 7 in Cerkasskij oblast. It should be noted that in 1981-1985, with the exception of Cerkasskij oblast, there were no cases of thyroid cancer among children in those regions.

As figure 7 shows, those oblasts account for over 60% of the incidence of thyroid cancer among children in the Ukraine over the last three years.

In the raions covered by IPHECA (see figure 8) from 1987 until the present time (end of 1993) three cases of cancer among children have been reported in Kiev oblast (2 in Polesskij and one in Ivankovskij raion) and two among adolescents (from Polesskij raion). In Zitomir oblast there were two cases, both children from Ovrucskij raion. In the Repkinskij raion of Cernijov oblast, there were no cases in the population under observation.

Figure 9 shows the age distribution of patients who underwent surgery in 1990-1992. Especially in 1992, the number of patients under the age of 10 was particularly high; at the time of the accident they were not more than four years old, and they were in the age group most receptive to radioactive iodine. Furthermore, a girl from Cernigov underwent surgery in 1992 who was born after the Chernobyl accident (on 5 July 1986) and was therefore exposed to ionizing radiation in the womb (in the last third of foetal development). The same is true of a boy who underwent surgery at our clinic in 1993.

The ratio of boys to girls with thyroid cancer (figure 10) did not change significantly: 1: 1.8 before the accident and 1:1.5 in the last three years.

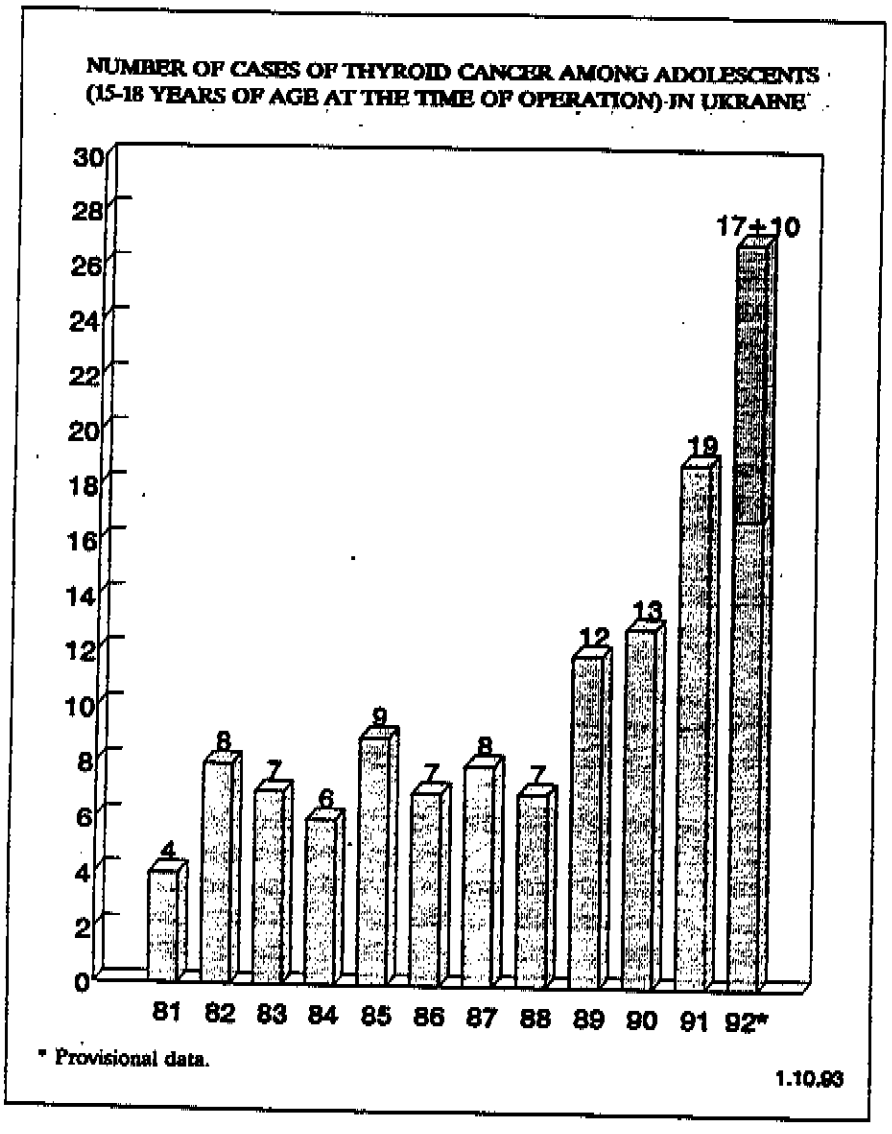

NUMBER OF CASES OF THYROID CANCER AMONG ADOLESCENTS
(15-18 YEARS OF AGE AT THE TIME OF OPERATION) IN UKRAINE
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
4
8
7
6
9
7
8
7
12
13
19
17±10
81 82 83 84 85 86 87 88 89 90 91 92*
* Provisional data.
1.10.93

FIG. 3

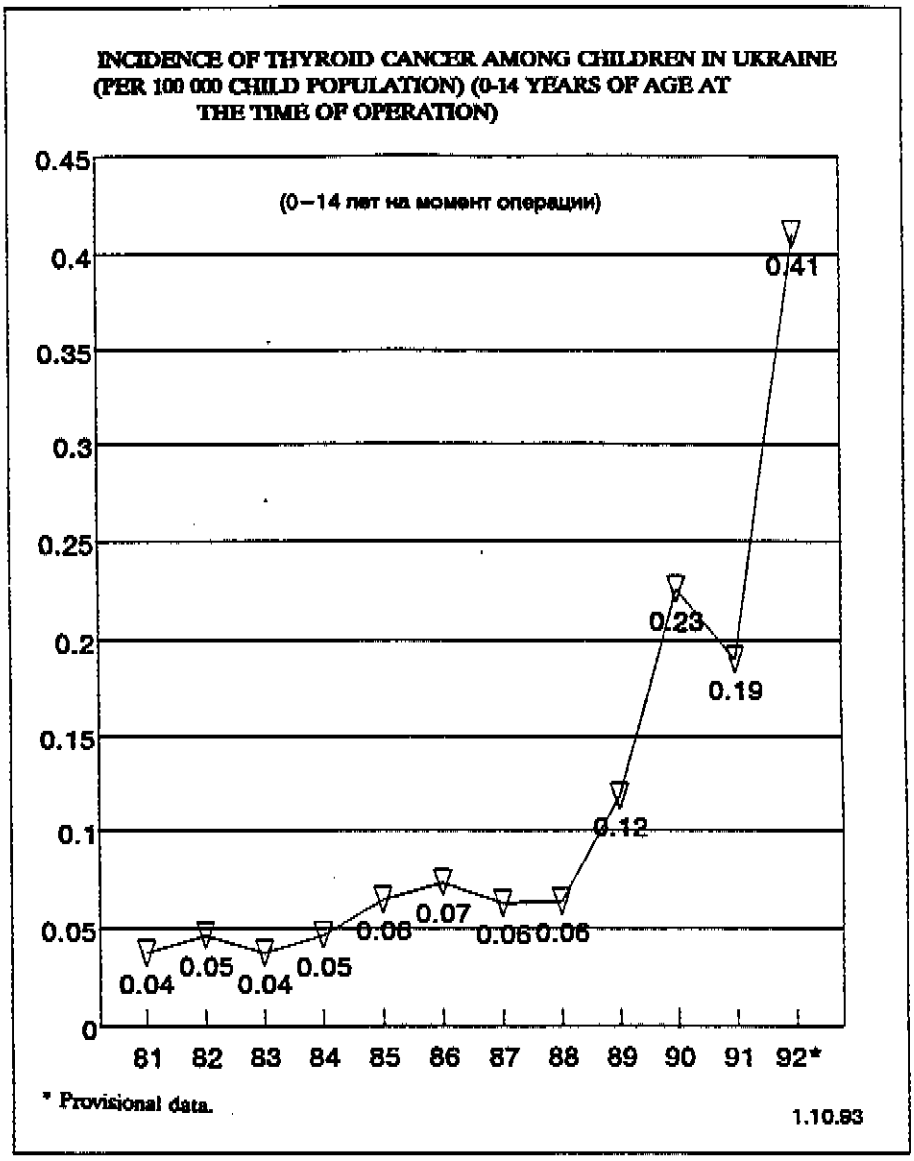

INCIDENCE OF THYROID CANCER AMONG CHILDREN IN UKRAINE
(PER 100 000 CHILD POPULATION) (0-14 YEARS OF AGE AT
THE TIME OF OPERATION)
(0–14 лет на момент операции)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.04
0.05
0.04
0.05
0.06
0.07
0.06
0.06
0.12
0.23
0.19
0.41
81 82 83 84 85 86 87 88 89 90 91 92*
* Provisional data.
1.10.93

FIG. 4

FIGURE 5. INCIDENCE OF THYROID CANCER AMONG CHILDREN IN UKRAINE (PER 100 000 CHILD POPULATION) (0-14 YEARS OF AGE AT THE TIME OF OPERATION)

By 1 October 1993	Year											
	81	82	83	84	85	86	87	88	89	90	91	92*
Republic of Crimea	-	-	-	-	0.45	-	-	0.22	-	0.21	-	-
Vinnickaja oblast	0.48	-	-	-	-	-	-	-	0.26	-	-	0.53
Volynskaja	-	-	-	-	-	0.40	-	-	-	-	-	0.39
Dnepropetrovskaja	-	-	-	0.25	0.13	0.25	0.11	-	-	0.49	0.24	0.12
Doneckaja	-	-	0.09	-	0.09	-	0.18	-	-	-	0.09	0.47
Zithomirskaja	-	-	-	-	-	-	-	-	-	0.60	0.31	0.63
Zakarpatskaja	-	-	-	-	-	-	-	-	-	-	-	-
Zaporozskaja	0.24	-	-	-	-	0.22	0.22	0.22	0.22	0.22	-	-
Ivano-Frankovskaja	-	-	-	-	-	-	-	0.30	-	0.29	-	-
Kievskaja	-	-	-	-	-	0.48	-	-	0.48	0.72	1.45	2.45
Kirovogradskaja	-	-	-	-	-	-	-	-	-	0.79	-	0.79
Luganskaja	-	0.17	-	-	-	-	0.16	-	-	-	0.33	-
Lvovskaja	-	-	-	-	0.33	-	-	-	0.17	-	-	-
Nikolaevskaja	-	-	0.35	-	-	-	-	0.33	-	0.33	-	0.33
Odessaskaja	-	-	-	-	-	-	-	-	0.17	-	0.18	-
Poltavskaja	-	-	0.30	-	-	-	-	-	0.29	-	0.29	-
Rovenskaja	-	-	-	-	-	-	-	-	-	-	0.34	1.71
Sumskaja	-	0.69	-	-	-	-	-	0.36	-	0.35	0.35	-
Ternopolskaja	-	0.38	-	-	-	-	-	-	-	-	-	-
Harkovskaja	-	-	-	0.48	0.16	0.16	0.16	-	-	0.16	-	-
Hersonskaja	-	0.36	-	-	-	-	0.34	-	0.34	0.69	-	-
Hmelnickaja	-	-	0.32	-	-	-	-	-	-	-	-	0.32
Cerkasskaja	0.32	-	-	-	-	-	-	0.33	0.33	0.32	0.65	1.31
Cernovickaja	-	-	-	-	-	-	-	-	0.89	-	-	-
Cernigovskaja	-	-	-	-	-	-	-	-	0.38	1.11	0.75	1.14
City of Kiev	-	-	-	-	-	0.19	-	-	0.17	0.36	0.18	1.47
City of Sevastopol*	-	-	-	-	-	-	-	1.12	-	-	-	-
City/oblast of Kiev	-	-	-	-	-	0.31	-	-	0.30	0.51	0.72	1.89
Ukraine	0.04	0.05	0.04	0.05	0.06	0.07	0.06	0.06	0.12	0.23	0.19	0.41

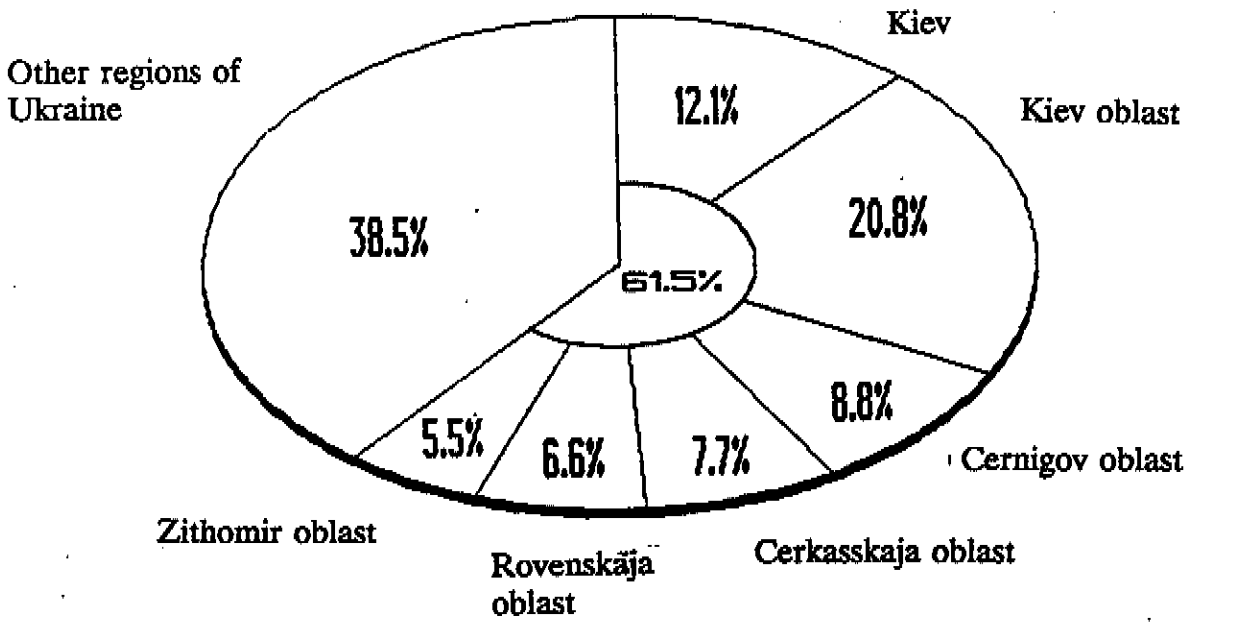
* Provisional data.

FIGURE 6. NUMBER OF CASES OF THYROID CANCER AMONG CHILDREN (0-14 AT THE TIME OF OPERATION) IN UKRAINE

By 1 October 1993	Year												
	81	82	83	84	85	86	87	88	89	90	91	92*	81-92*
Republic of Crimea	-	-	-	-	2	-	-	1	-	1	-	-	4
Vinnickaja oblast	2	-	-	-	-	-	-	-	1	-	-	2	5
Volynskaja	-	-	-	-	-	1	-	-	-	-	-	1	2
Dnepropetrovskaja	-	-	-	2	1	2	1	-	-	4	2	1	13
Doneckaja	-	-	1	-	1	-	2	-	-	-	1	5	10
Zithomirskaja	-	-	-	-	-	-	-	-	-	2	1	2	5
Zakarpatskaja	-	-	-	-	-	-	-	-	-	-	-	-	-
Zaporozskaja	1	-	-	-	-	1	1	1	1	1	-	-	6
Ivano-Frankovskaja	-	-	-	-	-	-	-	1	-	1	-	-	2
Kievskaja	-	-	-	-	-	2	-	-	2	3	6	10	23
Kirovogradskaja	-	-	-	-	-	-	-	-	-	2	-	2	4
Luganskaja	-	1	-	-	-	-	1	-	-	-	2	-	4
Lvovskaja	-	-	-	-	2	-	-	-	1	-	-	-	3
Nikolaevskaja	-	-	1	-	-	-	-	1	-	1	-	1	4
Odessaskaja	-	-	-	-	-	-	-	-	1	-	1	-	2
Poltavskaja	-	-	1	-	-	-	-	-	1	-	1	-	3
Rovenskaja	-	-	-	-	-	-	-	-	-	-	1	5	6
Sumskaja	-	2	-	-	-	-	-	1	-	1	1	-	5
Ternopolskaja	-	1	-	-	-	-	-	-	-	-	-	-	1
Harkovskaja	-	-	-	3	1	1	1	-	-	1	-	-	7
Hersonskaja	-	1	-	-	-	-	1	-	1	2	-	-	5
Hmelnickaja	-	-	1	-	-	-	-	-	-	-	-	1	2
Cerkasskaja	1	-	-	-	-	-	-	1	1	1	2	4	10
Cernovickaja	-	-	-	-	-	-	-	-	2	-	-	-	2
Cernigovskaja	-	-	-	-	-	-	-	-	1	3	2	3	9
City of Kiev	-	-	-	-	-	1	-	-	1	2	1	8	13
City of Sevastopol	-	-	-	-	-	-	-	1	-	-	-	-	1
Inhabitant of Ukraine								1					1
City/oblast of Kiev	-	-	-	-	-	3	-	-	3	5	7	18	36
Ukraine	4	5	4	5	7	8	7	8	13	25	21	45	152

* Provisional data.

DISTRIBUTION OF CASES OF THYROID CANCER AMONG CHILDREN
BY REGIONS OF UKRAINE, 1990-1992*



* Provisional data

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FIG. 7

FIGURE 8. NUMBER OF CASES OF THYROID CANCER AMONG PATIENTS
(0-18 YEARS OF AGE AT THE TIME OF OPERATION)

By 1 October 1993	Year								
	1986	1987	1988	1989	1990	1991	1992	1993	1986-1993*
Zitomir oblast									
Luginskij raion	-	-	-	-	-	-	-	-	-
Narodicskij raion	-	-	-	-	-	-	-	-	-
Ovrucskij raion	-	-	-	-	-	-	-	2	2
Kiev oblast									
Ivankovskij raion	-	-	-	-	-	-	1	-	1
Polesskij raion	-	1	-	-	3	-	-	-	4
Cernigov oblast									
Repkinskij raion	-	-	-	-	-	-	-	-	-

* Provisional data.

FIGURE 9. AGE DISTRIBUTION OF CHILDREN WITH THYROID CANCER*

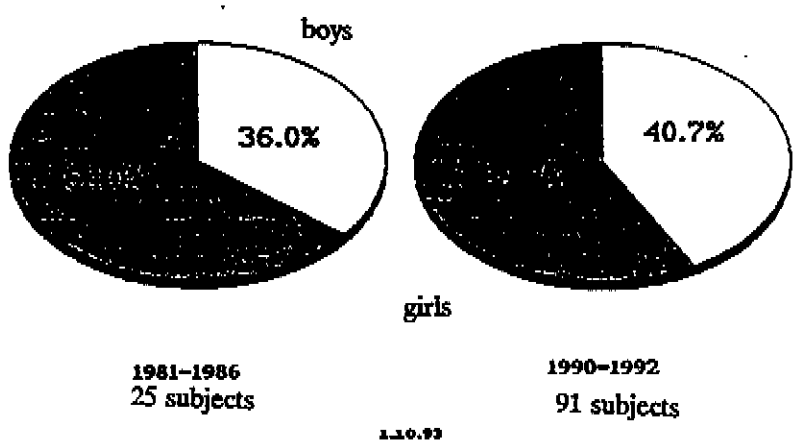
Age at time of operation	Year		
	1990	1991	1992
0-6	5	1	2
6-10	9	7	24
11-14	11	13	19

AGE DISTRIBUTION OF PATIENTS WITH THYROID CANCER*

Age at time of operation	Year		
	1990	1991	1992
0-6	13	9	31
6-10	12	14	25
11-14	13	17	15

* Provisional data

FIGURE 10. SEX DISTRIBUTION OF THYROID CANCER IN CHILDREN



3. The detection of thyroid cancer

In view of the vital importance of early diagnosis of cancer we tested the process of detection of that disease on 61 patients who were treated in the children's department of our institute in 1990-1992. It turned out that preventive mass screening of children by physicians identified approximately half the cases of cancer, in 40% of cases the patients' parents noticed the thyroid problem, and in 10% of cases the tumour was discovered by chance, by paediatricians consulted for another complaint.

Parents, and even physicians, did not always realize the gravity of the thyroid disorders. This can be seen from the fact that only 43 children were sent for further examination and surgery within a month of the first consultation with the physician. The other children underwent surgery only six months to four years after the appearance of the first disorders. Here it must be said that in four cases there was no clear deterioration of the thyroid, in terms of nodules or local densigy, but only swollen lymph nodes, which probably made the physicians and parents tend to overlook the possibility that a tumour was developing.

However, in the vast majority of cases the main sign leading to confirmation of thyroid cancer was a dense nodule in a thyroid that was otherwise functionally normal. Hypothyroidism was found in only three cases.

Usually, palpation revealed a dense nodule on a very slightly enlarged thyroid (77.7%). In eight cases only a dense nodule was found on palpation, in four cases there was no nodule in the thyroid and five children had multi-nodular goitre. Restricted mortality of the thyroid (during palpation) was noted in eight cases.

Practically all the children had enlarged regional cervical lymph nodes and in four cases, as mentioned above, this was the first and only sign of disease.

Rare symptoms were hoarseness of voice, in one child, and weakness and fatigue in two children.

In more than 60% of the observed cases there were metastases of tumours in the cervical lymph nodes, and in 8.6% of cases (five children) there were metastases in the lungs. X-ray examination showed spherical and nodular metastases, and cancerous lymphadenitis. Thirty-four children were given x-ray examinations. Five of them had small nodules disseminated through the middle and lower parts of the lungs. The nodules were no larger than 2 to 5 mm in diameter.

4. Diagnostics of thyroid cancer

It was important in the pre-operation period to study the hypophysial and thyroid system of children suffering from thyroid cancer. It was found that the average blood thyrotropin level (2.05 ± 0.20 μU/ml) was not significantly different from control (1.91 ± 0.20 μU/ml, $P > 0.5$). None of the children examined showed significant changes in blood thyrotropin level, nor were any substantial differences found between the total thyroxine

level in the cases examined (126.15 ± 16.13 nanomoles per litre) and children from the control group* (115.34 ± 5.43 nanomoles per litre, P > 0.5).[1]

Ultrasound screening of the malignant process in the children's thyroid showed an absolute prevalence (six) of nodules without clearly-defined boundaries with low echogenicity, and an acoustically unhomogeneous interior. Some nodules were regular in shap, others were irregular.[2]

5. The treatment of thyroid cancer

Confirmed diagnosis of thyroid cancer means that surgery is necessary. The indications for surgery have now been considerably extended. There are two basic approaches to surgical intervention for thyroid cancer. Many surgeons specializing in endocrinology prefer to save the organ where they can, removing the tumours from healthy tissue and retaining any normal thyroid parenchyma. Most oncologists take the more radical view that thyroidectomy is advisable when there is a primary tumour of any size. The latter group also often dissect the facia of the adipose tissue of the neck, including lymph nodes, even when there is no clinical sign of regional metastasis. The advocates of these different approaches support their arguments with a large body of evidence and statistics.

In our clinic there is a clear trend towards more radical and extensive surgery. Whereas in 1986 thyroidectomy was performed on 44.4% of cases in 1990-1991 the proportion had risen to 75%, and to 80% in 1992. This is because there are increasing numbers of patients with diffuse neoplasm affecting both parts of the gland and involving adjacent tissue. There are also more cases of multi-focal neoplasm, where the clinically defined primary focus is found, on histological examination, to be accompanied by multiple foci of malignant growth in the parenchyma of the gland.

The matter of regional lymphatics is very important. We believe they should be removed only if there are clinical signs of regional metastases prior to or during surgery. We are of the opinion that undamaged lymph nodes should not be removed, since they block, to some extent, the spread of the cancer.

The most common post-operative complication was hypoparathyrosis. Nine patients had tracheostomy. The only patient to die in the post-operative period was a young girl from Kiev oblast: the cancer had spread from the thyroid to the trachea and the mediastinum, and there were extensive metastases in the lung.

In addition to surgery, the course of compulsory treatment for thyroid cancer includes radiation therapy (when indicated) and hormone therapy (compulsory). Until recently we made considerable use of radiotherapy. This policy is being reviewed at present, and preference is given to methods involving radioactive iodine preparations (brachytherapy)in specially developed programmes. Since diagnostic scanning by means of radioactive iodine

[1] These data are from examinations conducted with equipment and reagents supplied by WHO for IPHECA.

after thyroidectomy reveals residual thyroid tissue in a large proportion of observations, radiation therapy is compulsory. Subsequently, permanent treatment with thyroid hormones ensures suppression and substitution.

6. The morphological characteristics of thyroid cancer

Analysis of the morphological data shows that, with few exceptions, thyroid cancer in children and adolescents takes the papillary form. Pre-operation cytological examination of the aspirate of such tumours showed a characteristic setting of follicular epithelium in smears, in small clusters with signs of occlusion of the nuclei. We have found that highly pigmented cytoplasm, clearly defined cell contours and eccentric nuclei are the most reliable defining features of papillary carcinoma. The principle distinguishing features of the nuclei of neoplastic cells are their unusual size, their translucence and the powdery appearance of their chromatin.

Nevertheless, no single one of these features is a conclusive sign of papillary neoplasm. It is only the combination of two or three of them that constitutes reliable cytological evidence.

Histopathological analysis of papillary carcinomas in a number of cases showed infiltration of the soft tissue around the gland, and multiple neoplastic foci, with papillary sections in relatively unaffected tissue.

Metastases in the lymph glands of the neck were found in 63% of cases. In 22% of cases the metastases were large - over 1 cm - and multiple, almost completely supplanting the tissue of the lymph nodes.

The papillary structures in the tumours studied contained follicular cells with characteristically clear nuclei. Such tumours had follicular, solid, alveolar-solid and clear cell sections. At the same time, nuclei in the follicular zones of the tumours were also translucent and poor in chromatin. Signs of sclerosis of the stroma were ubiquitous. Psammoma bodies were found in approximately half the cases.

Under the electron microscope the papillary and follicular zones of the carcinomas showed well-differentiated thyrocytes. These were distinguished by a high degree of functional activity, though active cells with well-defined cytoplasmic organelles predominatly granular endoplasmic reticulum, mitochondria and Golgi complex. The nuclei of the tumour cells were mostly well-defined nuclear membranes with low levels of heterochromatin and "inclusions" of cytoplasm in the nucleoplasm, which is typical of this form of cancer. Such "inclusions" are not genuine intranuclear inclusions, but rather deep and complex invagination of the nuclear membranes. This type of malformation of the cell nucleus is an important diagnostic sign of papillary cancer for cytological and morphological examination of preparations under an optical microscope.

All the tumours examined under optical microscopy showed solid zones consisting of poorly differentiated cells in the parenchyma of the tumour. Those cells were small and deformed, with processes and low levels of organelles. The cytoplasm often contained only isolated channels of granular endoplasmic reticulum, accumulations of ribosomes,

mitochondria and large vacuoles, typical of the early stages of embryogenesis of the endocrine glands. It must be noted that groupings of poorly differentiated cells are usually to be found also in the so-called undamaged part of the gland, a fact which points to multi-focal development of neoplasm. These solid zones often contain distinctly preformed Ashkenazi-Gurtle cells.

The carcinomas also contain parafollicular neuroendocrine s-cells, which can contain many specific secretory granules and are often found in clusters. There are also parafollicular cells with single secretory granules, characteristic of massive production of secretory material. Attempts to develop s-cells optically on paraffin sections by means of Grimelirus argentation did not produce results. Thus the presence and the function of s-cells in papillary carcinoma of the thyroid gland of children remains an open question; more detailed immunohistochemical study must be made in each individual case. We believe that s-cells, as neuroendocrine formations, may have some role in the paracrine stimulation of proliferative processes in oncogenesis.

The vessels of tumours in children have a distinct, bulging endothelium with considerably depressed micropinocytosis on abnormally thick basal membranes.

We believe it is also worth examining the ultra-structural criteria for the early stages of metastasis of tumour cells, which lose their intracellular links, become spherical and appear both in the capsule of the gland and, at times, in the lumen of the tumour vessels.

Tumour metastases in the lymph nodes have either typical papillary structure or, more frequently, occur as groups of cells with preformed nuclei, similar in structure to those described in the principal focus.

Together with Professor W. Yasui and Dr N. Takeichi of Hiroshima University we have begun immunohistochemical examination of the location of the cancer embryo antigen transforming factor α and the epidermal receptors of growth factor in malignant tumours and adenomas of the thyroid in children. Preliminary findings in tissue outside the tumour and adenomas show negative reaction to all those factors, while the reactions are positive in the malignant zones. The most marked reaction tended to be found in tumour cells infiltrating the capsule and stroma of the tumour.

Further research in this area is needed to elucidate the pathomorphoism of the carcinomas studied, and also, in complex cases, to make differential diagnoses of adenoma and carcinoma.

Overall, the morphological signs we have described would seem to indicate, given the age of the patients, that the tumours develop fairly quickly and are highly invasive. Further research and thorough analysis of the results is needed to establish the role of the radiation factor in the increase in malignant neoplasm of the thyroid of children and its contribution to the pathomorphoism of the tumours studied.

7. Prerequisites for epidemiological investigation

These problems cannot be solved without further information on the children who have undergone surgery in the oblasts, histological preparations or blocks of remote carcinomas, and complete information on doses accumulated in the thyroid. The dose information presented in this report relates to 82 children and adolescents with malignant thyroid tumours who underwent surgery in 1986-1993 and lived at the time of the accident in the city of Kiev, and in Kiev, Cernigov and Zitomir oblasts (figure 11). Most of the figures refer not to individual doses but to averages for the relevant age-group in the population centres concerned.

FIGURE 11. DISTRIBUTION OF PATIENTS (0-18 YEARS OF AGE AT THE TIME OF SURGERY) WITH THYROID CANCER, IN ACCORDANCE WITH EXPOSURE OF THE THYROID GLAND*

By 1 October 1993	Thyroid exposure, cGy							
	<1	1.5	5.10	10.30	30.50	50.100	100.150	>150
Number of patients	-	20	21	23	5	3	5	5

* Provisional data

These figures show that most of the children sustained less than one Gy to the thyroid. Any serious attempt to draw conclusions about the relationship between exposure to radiation and development of carcinoma in the thyroid of children will require more representative samples and more thorough investigation.

8. Conclusion

1. After the Chernobyl accident the incidence of thyroid cancer among children and adolescents in Ukraine increased from 0.04-0.06 per 100 000 child population in 1981-1985 to 0.23-0.41 in 1990-1992.

2. The incidence of thyroid cancer rose more sharply in regions that were particularly affected by the accident, to the following levels in 1992: 2.45 in Kiev oblast, 1.1 in Cernigov oblast, 0.6 in Zitomir oblast and 1.7 in Rovenskij oblast per 100 000 child population.

3. In most cases, the clinical manifestation of thyroid cancer in children was one or more fleshy nodules in either or both parts of the thyroid which was functioning properly, often in conjunction with enlargement of regional cervical lymph nodes. Ultrasound scanning showed nodules with ill-defined boundaries, low echogenicity and an uneven acoustic structure.

4. The trend in surgery for thyroid cancer is towards more radical operations, with extended indications for thyroidectomy, because of the aggressive nature of the tumours.

5. Morphological methods of studying thyroid cancer are widely used both for pre-operational diagnosis (cytological analysis of needle aspiration biopsy) and in post-operational examinations to confirm diagnosis and pursue investigation of the biological behaviour of the tumours.

6. Thyroid cancers in children tend to be of the papillary form, often with signs of multi-focal growth, and with follicular, solid and translucent cell zones in the tissue. Metastases to regional cervical lymph nodes were found histologically in over 60% of cases.

7. The thyroid exposure of children who underwent surgery for thyroid cancer after the Chernobyl accident was, in most cases (78%), between 1 and 30 cGy, while in 9.8% of cases it was between 30 and 100 cGy, and in 12.2% of cases it was in excess of 100 sGy.

8. A clinical morphology register of thyroid cancer among children and adolescents is being compiled in Ukraine, starting from 1981, with detailed information on each case. The information that will be gathered in the coming years will give an overall picture of the dynamics and nature of that disease and its links with the Chernobyl accident.