THYROID NODULARITY AMONG CHERNOBYL CLEAN-UP WORKERS FROM LITHUANIA

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1. Introduction

The accident at the Chernobyl NPP on 26 April 1986 was the worst in the history of nuclear power. This catastrophe resulted in massive contamination of the area necessitating evacuation of the population, an extensive clean-up and construction of sarcophagus. This clean-up and construction activity was accomplished by approximately 600,000 workers from former Soviet Union. Exposures were from rapidly-decaying radioactive iodines, as well as from $^{137}$Cs and other long-lived radioisotopes [1].

Because the thyroid gland is highly susceptible to the carcinogenic actions of radiation, especially when exposure occurs at a young age, a clinical examination survey was conducted to determine the prevalence of thyroid abnormalities among former clean-up workers [2]. Nodules are considered a sensitive for evidence of low-dose radiation effects [3]. Presence of benign tumors has been linked with development of thyroid cancer [4]. A remarkable increase in thyroid cancer has been reported among children living in contaminated areas around Chernobyl [5].

The objective of this study is to evaluate the dose effects of chronic radiation exposure (mainly from external gamma radiation, but residual $^{131}$I might also have been contributed to the thyroid dose among those sent to Chernobyl within one month after the accident), prolongation of time in zone and length of time after exposure role in developing thyroid tumors within a study population.

2. Materials and methods

2.1. Cohort construction

A study of the health effects from the Chernobyl reactor accident of 1986 on Lithuanians sent to contaminated area for clean-up activity was conducted by Lithuanian Chernobyl Medical Centre (LCMC). Since 1991, subjects have been invited to participate in annual health examinations. Lithuanian Chernobyl clean-up workers cohort was constructed using data from Lithuanian National Chernobyl Registry. National Registry was established in 1991 and was based on different sources:

1. Registration card established in 1987 by directive No 640-TN of the former Soviet Union Ministry of Health. These cards are in possession of the LCMC and, up to 1991, were used by local medical services for purposes of registration and follow-up.
2. Lists of the local military commissions of former Soviet Union Ministry of Defence. They became available to LCMC starting from September 1991.
3. Lists and records of Lithuanian Movement "Chernobyl". Since 1989, it has been in the Chernobyl clean-up workers' interests to give their data to the Movement in order to facilitate the Movements work directed towards getting health care benefits for the registered Chernobyl clean-up workers. It is important to note that to be registered as a Chernobyl
clean-up worker, there must be an official document, such as a military passport, service record. These people include those employed in the military, but the majority were specifically drafted for the clean-up under the pretence of repetition military training activity.

4. Lists and certificates of the staff of Ignalina Nuclear Power Plant (NPP) sent to Chernobyl. These documents are certified by authorities of Ignalina NPP.

5. Lists of the technical workers sent to Chernobyl by the Ministry of Construction. They are certified by authorities of the Ministry.

6. Lists of the Ministry of Internal Affairs. They include persons sent to Chernobyl area to maintain order in 30 kilometres area and also certified by authorities of the Ministry.

This information from each of the sources is to be compiled into one data file. The total estimate of 5446 is the best available at this time.

2.2. Physical examination

Thyroid examinations have been conducted by staff of LCMC for 3208 persons in the period between February 1991 and June 1995 as an item of annual health check-up and included palpation and sonographic examination. Each subject underwent a physical examination of the thyroid by at least two physicians: doctor of internal diseases and endocrinologist. The thyroid was palpated while motionless, as well as during swallowing.

All subjects underwent sonographic examinations using two ultrasound machines: both Hitachi Medical Corporation model EUB-310. A thyroid nodule was defined as an abnormality in echogenicity measuring more than 5 mm in diameter. Longitudinal images of all thyroid glands were obtained whether or not a nodule was identified. Nodules were classified as predominantly solid or cystic, single or multiple, isoechoic, hyperechoic, or hypoechoic. Their diameters were measured.

This study excludes the subjects whose health check-up has been provided by local medical staff in regional hospitals (data from these examinations are available to the LCMC).

2.3. Dosimetry

Doses based on individual thermo luminescent dosimetry (TLD) assessment and also by group assessment wherein one member of the group had a dosimeter were collected by former Soviet military authorities. This information was obtained from military records. Dose levels received by individuals and recorded in the military passports are shown in Table I. Recorded dose was missing for 30.9%.

<table>
<thead>
<tr>
<th>Dose, cGy</th>
<th>All clean-up workers, %</th>
<th>Workers with thyroid nodularities, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5</td>
<td>21.49</td>
<td>21.84</td>
</tr>
<tr>
<td>5 - 10</td>
<td>38.13</td>
<td>29.89</td>
</tr>
<tr>
<td>10 - 15</td>
<td>12.75</td>
<td>14.94</td>
</tr>
<tr>
<td>15 - 20</td>
<td>8.76</td>
<td>16.09</td>
</tr>
<tr>
<td>20 - 25</td>
<td>15.39</td>
<td>14.94</td>
</tr>
<tr>
<td>&gt; 25</td>
<td>3.49</td>
<td>2.30</td>
</tr>
</tbody>
</table>

3. Results

Ultrasound examination revealed thyroid nodules in 117 (3.7%) of 3208 examined subjects. Analyses in this study are based on ultrasound findings, as these are considered to be more reliable [6]. Table II shows the sonographic characteristics of nodules.
Table II. Ultrasonic characteristics of thyroid nodules

<table>
<thead>
<tr>
<th>Ultrasonic characteristic</th>
<th>No. of cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypoechoic</td>
<td>23</td>
<td>19.66</td>
</tr>
<tr>
<td>Isoechoic</td>
<td>6</td>
<td>5.13</td>
</tr>
<tr>
<td>Hyperechoic</td>
<td>65</td>
<td>55.56</td>
</tr>
<tr>
<td>Cystic</td>
<td>14</td>
<td>11.97</td>
</tr>
<tr>
<td>Mixed</td>
<td>9</td>
<td>7.69</td>
</tr>
<tr>
<td>Total</td>
<td>117</td>
<td></td>
</tr>
</tbody>
</table>

Most of the nodules (80.3%) were solid. 94 had a solitary nodule, 19 had two nodules and four had more than two nodules. 14 patients with nodules were operated, two cases of papillary carcinoma and one mixed papillary-follicular tumour was identified. Three patients had recurrences of nodules after have been operated 5-7 years before.

The presence of nodules was not associated with the dose from known external exposure. The mean dose was 11.07 cGy among men with nodules and 11.42 cGy in whole population. One of the patients with thyroid cancer had recorded dose of 20.47 cGy, the second - 9.6 cGy and in the third case dose was missing.

The probability of the development of the disease is estimated to be 11 - 14% and has slightly increasing dose dependent trend.

![Figure 1. Development of the thyroid nodularity by dose.](image)

Exposure to radiation does not initiate more frequent thyroid nodularity in comparison with nonexposed Lithuanian men's population where the frequency of thyroid nodularity is 1.6 - 16.3%.

Because of incompleteness and uncertain accuracy of recorded doses, the probability of nodularity also was estimated in terms of time spent in Chernobyl area. The prolongation of stay in contaminated area does not effect the frequency of thyroid nodularity (figure 2).

The active follow-up of Chernobyl clean-up workers revealed an appearance of the thyroid nodules at the end of 4 years period after exposure (figure 3).

More high risk (above 15%) to develope thyroid nodularities is expected after 10-12 years after exposure.
4. Discussion and conclusions

It appears that from five to nine years since participating in the clean-up activity after Chernobyl accident was not enough long time to occur radiation related both benign and malignant thyroid tumors. Routine medical check-up of 3208 clean-up workers revealed 117 (3.7%) having thyroid nodules. The similar results were in Estonia, where short term intensive screening of thyroid revealed 199 (10.0%) patients with thyroid nodules among 1976 clean-up workers [7]. All Estonian clean-up workers were screened in 1995 (nine years after exposure). The smallest acceptable size of nodules was here 0.3 cm. This might be an explanation of more high prevalence of nodules in Estonian cohort.

Exposure to radiation does not initiate more frequent thyroid nodularity in comparison with nonexposed Lithuanian men's population where the frequency of thyroid nodularity is 1.6 - 16.3%.

The presence of nodules was not associated with the dose from external exposure which was estimated as 11.07 cGy. Radiation doses may simply have been too low to produce demonstrable effects or accumulated over variable time periods.
The probability of nodularity also was not associated with prolongation of stay in Chernobyl area.
We were able to identify three thyroid cancers among 117 patients (2.6%) with thyroid nodules which is similar to the value of 5 thyroid cancers among 199 clean-up workers (2.5%) reported in Estonian study.
The absence of evident radiation effects now does not preclude the possibility that an excess of thyroid nodularity or thyroid cancer will appear in the future.

References