

# **Occupational Diseases in Uranium and Ore Miners in Connection with Radiation Exposure in the Czech Republic**

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## **Abstract**

Dozens cases of diseases are submitted to judgement as occupational diseases every year in the Czech Republic. Patients or attending physicians suggest that these cases are caused by occupational ionizing radiation. Only a part of these cases is qualified as occupational disease. The term “occupational disease” is rather a juridical term which underlies the right to financial compensation. The causal association with exposure to ionizing radiation cannot be indisputably verified by expert medical opinion.

Most diseases, which are proposed as occupational disease, are malignant tumors of the lungs. Total majority of judged cases are lung cancers from radioactive agents. In 2002, a total of 33 cases of lung cancer in former uranium or ore miners have been acknowledged as occupational diseases (1). The decision about occupational disease is derived from probabilistic approach based on estimation of probability of causation of irradiation on disease origin (methodical guideline No. 15 of Ministry of Health Bulletin, part 9, 1998).

The presented paper gives a general information about all judged causes of occupational diseases in former uranium and ore miners in the Czech Republic in 2002.

## **Introduction**

A total of 35 occupational diseases caused by occupational ionizing radiation have been acknowledged in uranium and ore miners in the Czech Republic in 2002 (1). Most of acknowledged diseases – a total of 33 cases – were lung cancers from radioactive agents (Item 6 Chapter III of the List of Occupational Diseases of Government Regulation No. 290/1995). The other two cases were diagnosed as acute and chronic myeloid leukemia (Item 1 Chapter II of the List of Occupational Diseases).

Paper gives a general information about all judged cases of occupational diseases in uranium and ore miners in the Czech Republic in 2002. There were a total of 72 cases submitted for judgement, 67 lung cancers, 1 acute myeloid leukemia, 1 chronic myeloid leukemia, 1 basaliom, 1 cancer of larynx and 1 cancer of nasal septum.

## **Methods**

It should be stressed that the term “**occupational disease**” is at first juridical term which underlies the right to financial compensation. Nevertheless the causal association with exposure to ionizing radiation cannot be always indisputably verified by expert medical opinion.

Acknowledgement of occupational disease is procedure which must correspond to requirements of **Regulation of Ministry of Health No. 342/1997**. The acknowledgement of

occupational diseases is executed in the medical centers of occupational diseases (§1, §3). Procedure of compensation is initiated by written report about suspicion of occupational disease. The report is submitted to competent regional medical center of occupational diseases. The procedure can be initiated by the clinician or by the patient (§2 section 1). The physician of the State Office for Nuclear Safety judges conditions of origin of disease which can be caused by work with ionizing radiation or radioactive agents (§2 section 3 b).

Occupational diseases are defined as “acute intoxications caused by negative effect of chemical agents on health, diseases caused by negative effect of chemical, physical, biological or another negative effects if they arose from conditions” presented in the **List of Occupational Diseases, Annex of Government Direction No. 290/1995**. Following three chapters of the list relate to effect of ionizing radiation:

- **Chapter II, item 1** – disease caused by ionizing radiation
- **Chapter III, item 6** – lung cancer from radioactive agents
- **Chapter IV, item 1** – skin diseases caused by physical, chemical or biological factors

Total majority of diseases in uranium and ore miners submitted for compensation as occupational disease caused by ionizing radiation are malignant tumors. The decision about occupational disease is derived from probabilistic approach based on knowledge of relation between dose and effect on target tissue where tumor arose. The **criterion of prevailing probability** is valid, i.e. causality is accepted if the probability of causation of irradiation on tumor origin is greater than probability of spontaneous tumor incidence.

The procedure recommended for judgment of cases of lung cancer from radioactive agents (Chapter III, item 6 of the List of Occupational Diseases) is based on this principle and it is published as **Methodical Guideline No. 15 of Ministry of Health Bulletin, Part 9, 1998**. This methodical guideline is designated for the assessment of lung cancer cases among workers or former workers in uranium mines or another workplaces with considerably high concentration of radon and its short-lived progeny. The disease must be proved or there must be reasoned suspicion of it. The term “reasoned suspicion” is understood as the situation when the diagnosis of lung cancer is considered by clinician as vindicated (with no histologic or bronchoscopic verification, too).

The decision about occupational disease is based on the estimation of **probability of causation** of irradiation on disease origin (PC).

$$PC = R_p / (1 + R_p),$$

where  $R_p$  is the excess relative risk of lung cancer in defined level of irradiation and in defined exposure periods (table No. 1).

$$R_p = \sum k_i W_i,$$

where  $k_i$  are risk coefficients depending on time-since-exposure and age-at-exposure and  $W_i$  are corresponding exposures.

The risk coefficients are derived from recent results of epidemiological studies in uranium miners (2). They are more precise and more favorable to the patient. The coefficients are valid for lung cancer in all histologic forms. The exposures can be found on individual dosimetric cards. The employer must keep the cards for all workers. **If PC value is higher than 0.5 the probability of causation is assessed as prevailing.** The case is qualified to financial

compensation. If PC value is **in border zone 0.4 – 0.5** the compensation is possible with respect to other circumstances. If the PC value is **lower than 0.4** the probability of causation is assessed as low and the case is not qualified to compensation.

The assessment of myeloid leukemia cases in two former uranium miners was also based on the estimation of probability of causation of irradiation on disease origin. It was necessary to estimate the dose to bone marrow from external irradiation and from inhalation exposure to radon and its progeny and from inhalation of powder particles containing long-term alpha emitters. The dose received from inhalation of uranium powder is the most important (80%). The dose estimation was based on the results of Czech and German studies (3, 4, 5). The doses in miners working in Czech uranium mines after 1969 can be estimated on 12 mSv/year in quarrymen and 4 mSv/year in other professions (table 2).

**Table No. 1:**  
**Lung cancer**  
**Relative risk coefficients per WLM**  
**(dependence on age at first exposure and time since exposure)**

Age at first exposure	Time since exposure			
	0 – 4	5- 14	15 - 24	25 +
- 29 years	0	0,205	0,084	0,038
30 – 39 years	0	0,029	0,027	0,02
39 - years	0	0,009	0,008	0,004

$$PPS = R_p / (R_0 + R_p)$$

$R_0$  .... 100%

$$R_p = \sum_i k_i \cdot WLM_i$$

$k$ .... relative risk coefficient

PPS < 0,4

Probability low

PPS 0,4 – 0,5

Probability borderline

PPS > 0,5

Probability high

The value of excess relative risk coefficient was 7,9 per 1 Sv. Excess relative risk was significant and PC values were higher than 0,5 in both cases. The probability of causation was assessed as prevailing and both cases of myeloid leukemia were qualified to compensation.

**Table No. 2:**

**Leukemia**

**Estimate of dose to bone marrow per year in uranium miners**

<b>Profession</b>	<b>1950-1959</b>	<b>1960-1969</b>	<b>1970-</b>
<b>Quarryman</b>	<b>34 mSv</b>	<b>23 mSv</b>	<b>12 mSv</b>
<b>Other</b>	<b>10 mSv</b>	<b>7 mSv</b>	<b>4 mSv</b>

**ERR/Sv = 7,9**

**Conclusion**

A total of 72 cases were submitted to judgement of conditions of disease origin to the National Radiation Protection Institute in 2002. 67 cases were lung cancers, 1 case was chronic myeloid leukemia, acute myeloid leukemia, basaliom, cancer of larynx and cancer of nasal septum.

The probability of causation was assessed as prevailing in 32 cases of lung cancer, borderline in 5 cases and low in other 30 cases of lung cancer.

The probability of causation was prevailing in both cases of myeloid leukemia.

**Literature**

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