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Retrospective assessment of occupational asbestos exposure among 220 patients with respiratory cancer hospitalized at Vilnius University Institute of Oncology

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Background. No cases of lung cancer or mesothelioma have ever been diagnosed or compensated as asbestos-related in Lithuania. This paper attempts to estimate the proportion of those occupationally exposed to asbestos among respiratory cancer patients.

Material and methods. Occupational exposure to asbestos was assessed retrospectively for 218 lung cancer and 2 mesothelioma patients admitted to Institute of Oncology, Vilnius University. The evaluation was based on personal interview data using an internationally established questionnaire. Cumulative exposure to asbestos at work was evaluated in fibre-years.

Results. A cumulative asbestos exposure of ≥25 fibre-years was found for 7 patients (3.2%), in further 135 (61.2%) a cumulative exposure from 0.01 to 24.99 fibre-years was assessed. The most common occupations among heavily (≥25 fibre-years) exposed patients were smith, welder or insulator in foundries, construction, shipyard as well as asbestos cement and glass industry.

Conclusions. Preliminary findings indicate that a fraction (3.2%) of the respiratory cancer cases could be attributed to occupational exposure to asbestos. Since 1560 or more cases of lung cancer are registered every year in Lithuania, about 50 cases per year could be predicted to be asbestos-related.

Key words: lung cancer, occupational exposure, asbestos, occupational disease

INTRODUCTION

Asbestos is a group of six naturally found minerals. Due to its physical properties asbestos has been widely used in the industry. Amosite, crocidolite, tremolite, anthophyllite, actinolite, belong to the group of amphiboles, their characteristics are long, thin and straight fibres. Chrysotile is a serpentine mineral exhibiting a tubular, crystalline structure on a submicron scale.

Asbestos is one of the most dangerous industrial pollutants, which may cause asbestosis, lung cancer, mesothelioma and nonmalignant neoplasms of pleura (1–3). Due to the long induction period (20–40 years), the related risk remains Right for decades after exposure (4). It is estimated that occupational exposure to asbestos could be responsible for about 4 to 7% or more of lung cancers and 80 to 90% of pleural mesothelioma in men in industrialized countries (5, 6, 10). Epidemiologic and toxicologic studies indicate that all types of asbestos including chrysotile and amphiboles can cause malignant neoplasms, however, chrysotile fibres do not accumulate in lung tissue to such an extent as do amphiboles, and they are removed more rapidly (7–9).

In many European Union countries the use of asbestos was prohibited more than 10–20 years ago, persons with a heavy asbestos exposure are diagnosed as having an occupational disease – they are entitled for compensation (8, 10, 11). The occupational groups that have been or are being exposed

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to asbestos are construction workers, insulators, pipe layers, assemblers, fitters, demolishers of old buildings, also workers in power stations, petroleum industry, shipbuilding, asbestos cement and asbestos textile production.

All asbestos used in Lithuania (mainly chrysotile) was imported from Russia. About 700000 tons of raw asbestos were used since 1961 in our country for asbestos cement corrugated sheets and pipes, for insulation of boiler stations and pipes, friction materials (12, 13). According to estimates, there were 7451 workers in 1997, exposed to asbestos in Lithuania, 3120 (42%) of them worked in the construction sector (14–16). There were two factories manufacturing asbestos cement pipes and plates in the country.

Asbestos was classified as carcinogenic to human (group I) by International Agency for Research on Cancer in 1977 (17). However, it is only recently that problem of asbestos has been recognized in our country. The first regulations on the production and use of asbestos were passed in 1998, measurements of asbestos fibres in the air were started in 1999. The import and use of asbestos was limited since the year 2000 and banned completely in 2004 (18, 19). The first legislation documents setting the limit values for the concentration of asbestos fibers in the air came into force in 2002 (20). The current limit level is 0.1 f/cm^3 (21).

In Lithuania, as in other Eastern European countries, the incidence of mesothelioma is lower than could be predicted from the extensive use of asbestos, possibly because of a smaller use of amphiboles, lower levels of tremolite impurities in the Russian chrysotile, shorter life expectancy of population and the lack of reliable incidence data (22).

Some asbestos-induced respiratory diseases are recognized as occupational in Lithuania. During the period 1995–2003, 3 cases were compensated for chronic obstructive pulmonary disease due to asbestos dust (a shipyard worker, a construction worker-insulator and a glass industry worker). Twelve cases of pneumoconiosis among workers employed in industries using asbestos-containing materials (asbestos cement plant, shipyard and construction) were diagnosed and compensated as an occupational disease. No cases have been diagnosed or compensated as asbestos-related occupational cancer so far.

The aim of the present study is to assess the proportion of those occupationally exposed to asbestos among lung cancer and mesothelioma patients.

MATERIALS AND METHODS

Three-hundred patients with the diagnosis of lung cancer or mesothelioma were enrolled for the study. This report includes 220 cases diagnosed as having this disease and hospitalized at Institute of Oncology of Vilnius University between November 01, 2003 and December 10, 2004. The information on the demographic characteristics, occupations and workplaces during lifetime as well as smoking habits was obtained via personally interviewing the patients, using a detailed questionnaire compiled by a group of scientists from Justus-Liebig University, Giessene (Germany). Information on the diagnosis was collected from medical documentation. All patients gave their written consent to be included into the study.

The distribution of patients by sex, age, diagnosis, smoking habits, cumulative asbestos exposure and by the type of activity was assessed. Cumulative exposure to asbestos at work was expressed in fibre-years as the product of intensity and duration of exposure summed over all work periods during the occupational history. Exposure assessments were based on job descriptions and the BK Faserjahre report (23). This report provides the estimates, compiled by a group of experts, of the concentrations of asbestos fibres for different types of occupations and workplaces. One fibre-year is defined as one-year full time work in asbestos exposure of $1 \cdot 10^6/m^3$ asbestos fibres in the air or two years of full-time work at $0.5 \cdot 10^6/m^3$, or any other combination. A dose exceeding 25 fibre-years has been estimated to cause a two-fold lung cancer risk. This value, set forth in Helsinki Criteria, is used for ascribing lung cancer to asbestos and for compensation of lung cancer in Germany, Denmark; an equivalent occupational history is applied in Scandinavian and some other countries (8, 24).

In the analysis, three exposure categories were used: not exposed (or <0.01 fibre-years), exposed: 0.01 – <25 fibre-years, and ≥ 25 fibre-years. Patients were divided according to smoking habits: never smokers, ex- (quitted ≥ 1 year before diagnosis) and active smokers.

RESULTS

A total number of 220 patients were interviewed, among them 207 (94.1%) men and 13 (5.9%) women. For most of the patients (208, 94.5%) the diagnosis was confirmed histologically or cytologically, and for 12 (5.4%) interviewed patients the diagnosis was confirmed by X-ray. The distribution of some basic characteristics among patients is displayed in Table 1. The mean age at diagnosis was 62.6 years (min 42, max 82) among men and 62.5 years (min 46, max 76) among women. Most patients were residents of the eastern part of Lithuania: 162 (73.6%) lived in Vilnius, Panevëþys or Utena districts. There were 21 patients (9.5%) from the Alytus, 18 (8.2%) from Ðiauliai and 6 (2.7%) from Klaipëda districts. The others lived in the Kaunas, Telðiai, Tauragë or Marijampolë districts. The distribution of the Lithuanian population by districts in the year 2004 was as follows: Vilnius 24.7%, Kaunas 20.0%, Klaipëda

11.1%, Ðiauliai 10.6%, Panevëþys 8.6%, Marijampolë and Alytus 5.4% each, Utena, Telðiai 5.2% each, Tauragë 3.8% (25).

Table 2 presents the distribution of patients according to cumulative asbestos exposure assessed from personal interviews. There were 142 (64.5%) patients exposed to asbestos (including 1 mesothelioma case). A low, <5 fibre-years, cumulative asbestos exposure was determin for most of the exposed (95,43.2%) patients. For 40 patients (18.2%) (including 1 mesothelioma) cumulative exposure was from 5 to 24.9 fibre-years. For 7 patients (3.2%), a cumulative asbestos exposure of ≥25 fibre-years was estimated. All patients heavily exposed to asbestos were men; 78 (35.4%) patients (68 men and 9 women) were not exposed occupationally to asbestos.

One patient with malignant pleural mesothelioma (out of 2) had an occupational asbestos exposure assessed as 8.8 fibre-years.

The mean age at diagnosis of patients with cumulative exposure to asbestos ≥25 fibre-years, 5 – <25 fibre years and those unexposed was 60.4 (SD 8.7), 63.0 (SD 7.9) and 64.0 (SD 9.3) years, respectively.

Most patients were smokers (72.7%) or ex-smokers (20.9%) (Table 3). The average number of pack-years among smokers was 37.6. All 7 patients heavily exposed to asbestos were current or ex-smokers (85.7% and 14.3%, respectively), there were no never smokers. Among patients unexposed to asbestos

Table 1. **Distribution of patients by age, diagnosis and smoking habits**

	Male	Female	Total
Age:			
<50	11	2	13
50–59	59	4	63
60–69	90	3	93
70–79	46	4	50
≥ 80	1	–	1
Total	207	13	220
Diagnosis:			
lung cancer	205	13	218
mesothelioma	2	–	2
Smoking:	207	13	220
never	3	11	14
Ex-smoker	45	1	46
current smoker	159	1	160

Table 2. **Distribution of the interviewed patients by cumulative occupational asbestos exposure**

Asbestos exposure category (fibre-years)	Average exposure (fibre-years)	Men	Women	Total
Unexposed or < 0.01	0	68 (33.3%)	9 (69.2%)	78 (35.4%)
Exposed, ≥ 0.01				
0.01–0.99	0.26	61 (29.5%)	1 (7.7%)	62 (28.2%)
1–4.99	2.44	31 (15.0%)	2 (15.4%)	33 (15%)
5–24.99	11.84	39 (18.8%)	1 (7.7%)	40 (18.2%)
≥25	41.24	7 (3.4%)	0	7 (3.2%)
Total		207	13	220 (100%)

Table 3. **Smoking habits among interviewed men by exposure**

Asbestos exposure category (fibre-years)	Never smokers	Ex-smokers	Current smokers	Total
Men				
Unexposed or <0.01	1 (1.4%)	16 (23.2%)	52 (75.4%)	69 (100%)
Exposed, ≥0.01				
0.01–0.99	1 (1.6%)	11 (18.0%)	49 (80.3%)	61 (100%)
1–4.99	0	8 (25.8%)	23 (74.2%)	31 (100%)
5–24.99	1 (2.6%)	8 (20.5%)	30 (76.9%)	39 (100%)
≥25	0	1 (14.3%)	6 (85.7%)	7 (100%)
Total	3 (1.4%)	44 (21.2%)	160 (77.3%)	207 (100%)
Women				
Unexposed or <0.01	8 (88.9%)	1 (11.1%)	0	9 (100%)
Exposed, ≥0.01				
0.02–0.99	1 (100%)	0	0	1 (100%)
1–4.99	2 (100%)	0	0	2 (100%)
5–24.99	0	0	1 (100%)	1 (100%)
Total	11 (84.6%)	1 (7.7%)	1 (7.7%)	13 (100%)

there were slightly less current smokers at the time of diagnosis: 52 men (75.4%), 16 (23.2%) stopped one year ago or earlier, one of them (1.4%) never smoked. Eleven (84.6%) women patients never smoked, there was one current smoker and one former smoker.

The distribution of exposed patients by industry and occupational activities is shown in Tables 4 and 5. Heavily exposed patients were working mostly as smiths or welders in foundries, construction, shipyard as well as asbestos cement plant or glass industry. The occupational histories of selected heavily exposed patients are presented in Table 6. The average time from the first exposure among them was 35 years (min. 27, max. 44), the average duration of exposure being 17.9 years (min. 6, max. 26). Patients with a cumulative exposure of 5 – <25 fibre-years were working in construction, metal or heating industry as welders, smiths, builders, etc.

Table 4. **Distribution of patients with a cumulative exposure of ≥5 fibre-years by industries**

Industry	Exposure	
	5–24.99 fibre-years	≥25 fibre-years
Foundry and furnace	4	3
Construction	27	1
Shipyard or ship engine room	1	1
Glass industry		1
Asbestos cement plant		1
Boiler room	4	
Power station	1	
Bus repair	1	
Installation	1	
Chemical industry	1	

Table 5. **Distribution of patients with a cumulative exposure of ≥5 fibre-years by occupation**

Occupation	Exposure	
	5–24.99 fibre-years	≥25 fibre-years
Smith or smith-repairer	4	3
Welder	4	2
Insulator	1	1
Tinsmith		1
Boiler man	3	
Loader or storeman	2	
Builder or construction foreman	18	
Ship mechanic	1	
Electrician	1	
Metal worker	4	
Pipe fitter	1	
Fettler	1	

DISCUSSION

We investigated the frequency of asbestos exposure among lung cancer and mesothelioma patients from their reported lifetime occupational histories. Preliminary results of this study indicated 142 (64.5%) respiratory cancer patients admitted to Institute of Oncology have been occupationally exposed to asbestos. This percentage is higher than those reported in Sweden, Germany and Hungary (5). The proportion of heavily exposed (≥25 fibre-years) patients (3.2%) was slightly less than in Hungary where 4% of lung cancer patients with an asbestos exposure of ≥25 fibre-years were found, and less than the estimates of asbestos-related lung cancers in different populations (5, 6, 10, 24).

Out of 138 exposed male patients in our study, only two never smoked. A number of studies indicated a combined (ranging from additive to multiplicative) effect of tobacco smoking and asbestos exposure in the causation of lung cancer. Therefore, according to Gustavsson et al. (3), although "preventing smoking by asbestos-exposed or formerly exposed is well warranted because of the preventive effect on future lung cancer risk, it is questionable whether the number of extra cases of disease prevented by focusing on asbestos-exposed persons is particularly large".

It is expected that due to an extensive use of asbestos in the near past and a long latency period the asbestos-related morbidity will remain at least at the same level during next 50 years, despite preventive measures and improved worker protection (4, 22). Each year 1560 or more new lung cancer cases are diagnosed in Lithuania; 125 mesothelioma cases were diagnosed in 1992–2001. Preliminary findings of our study indicate that a fraction of the lung cancer cases could be attributed to occupational exposure to asbestos. On the assumption that lung cancer cases with a more than 25 fiber-years cumulative asbestos-exposure could be attributed to occupation, 3.2% or approximately 50 cases of lung cancer could be predicted to be asbestos related every year in Lithuania.

The potential limitation of the study is the accuracy of retrospective assessment of cumulative asbestos exposure. As airborne asbestos fiber measurements before the year 1999 are not available in Lithuania, the values for different work situations were used from external sources for calculation of cumulative asbestos exposure at work. Occupational histories were obtained directly from cases using a standardized questionnaire. Detailed data on job characteristics and industry type as well as 32 specific questions addressing asbestos exposure increased the accuracy of the exposure estimates. Several interviewed patients were residents of the northern or western parts of Lithu-

Table 6. **Occupational histories of selected patients with a cumulative exposure of ≥25 fibre-years**

Year of birth	Smoking habits	Occupational history			Type of exposure to asbestos	Duration of work with asbestos	Cumulative exposure (fibre-years)
		Period	Occupation	Industry			
1941	Exsmoker, previously smoked 20 cig/day for 38 years	1962–1964	Helicopter pilot	Military		29 016 h	46
		1965–1971	Electro-mechanic	Fishing ship	Insulation of wires with asbestos cord		
		1971–2003	Smith, welder, electrician	Shipyard	Insulation of pipes, boilers and wires with asbestos materials		
1934	Current smoker, 20 cig/day for 47 years, 10 cig/day for 3 years	1950–1958	Tractor driver	Autorepair shop		11520 h	61
		1958–1965	Loco-motive driver	Railway company			
		1965–1970	Smith-repairer	Agricultural machinery manufactory			
		1970–1991	Smith-repairer	Metalurgy industry	Repair of furnaces, pipes. Insulatoin of steam boilers, pipes, turbines. Use of asbestos materials		
1948	Current smoker, 15 cig/day for 26 years	1965–1969	Smith	Electronic media manufactory		3937 h	26
		1969–1974	Fore-man	Land reclamation			
		1974–1978	Truck driver	Transport company	Transportation of corrugated asbestine cement sheets		
		1978–1997	Fore-man, driver	Construction	Pipe insulation with asbestos powder mixture		
		1997–2001	Assembler	Construction			
		2001–2004	Smith-repairer	Machine tools production			

ania where asbestos cement industry and shipyards are located. This should be also considered in interpreting the results.

No asbestos-related occupational cancers have ever been diagnosed in Lithuania – they remain undetected. This could be explained by the insufficient recognition by workers and physicians of the occupational etiology of cancer: occupational cancers have multiple potential causes, including life style factors, and the long latency period makes it difficult to establish whether the condition is work-related. The too complex, long and therefore not functioning procedure of registration is another problem: clinical doctors cannot collect

appropriate work history information and so identify carcinogenic agents and the volume of their exposure. The criteria for the occupational disease certification are not clear.

CONCLUSIONS

1. Preliminary findings indicate that a fraction (3.2%) of the respiratory cancer cases could be attributed to occupational exposure to asbestos.

2. Since at least 1560 cases of lung cancer are registered every year in Lithuania, about 50 cases per year could be predicted to be asbestos-related.

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RETROSPEKTYVUS ASBESTO POVEIKIO DARBE ÁVERTINIMAS TARP 220 PLAUÈIØ VËÞIU IR PLEUROS MEZOTELIOMA SERGANÈIØ ASMENØ, HOSPITALIZUOTØ VILNIAUS UNIVERSITETO ONKOLOGIJOS INTITUTE

S a n t r a u k a

Nuo 1961 m. Lietuvoje buvo sunaudota daugiau kaip 700 tûkst. t. asbesto. Apie 7451 dirbanèiøjø buvo veikiami asbesto 1997 m., 42% jø dirbo statybø pramonëje. Në vienam asmeniui plauèiø vëþys ar pleuros mezotelioma nebuvo pripaþinta ir kompensuota kaip asbesto sukelta profesine liga. Ðio **darbo tikslas** – nustatyti asbesto poveikio darbe daþnumà tarp plauèiø vëþiu ir pleuros mezotelioma serganèiø ligoniø. **Medþiaga ir metodai**. Informacija apie asbesto poveikio trukmæ ir intensyvumà darbo aplinkoje buvo gauta asmeniðkai apklausus 218 plauèiø vëþiu ir 2 pleuros mezotelioma susirgusius ligonius, gydytus Vilniaus universiteto Onkologijos institute. Remiantis informacija apie tiriamojo turëtà darbà, veiklos rûðá, trukmæ, asbesto naudojimà darbe, taip pat duomenimis apie dulkiø koncentracijà tipinëse darbo vietose, kiekvienam tiriamajam buvo nustatyta suminë asbesto poveikio vertë, iðreikðta plauðeliø-metø dimensija. **Rezultatai**. Didesnë uþ 25 plauðeliø-metø vienetus suminë asbesto poveikio vertë buvo nustatyta 7 ligoniams (3,2%). Dar 135 ligoniams (61,2%) suminë asbesto poveikio vertë buvo nuo 0,01 iki 24,99 plauðeliø metø. Intensyviai (≥25 plauðeliø metø) asbesto darbe paveikti asmenys dirbo ðaltkalvio, suvirintojo, skardininko arba izoliuotojo darbà liejyklose, statyboje, taip pat laivø statykloje, asbestcemenèio ir stiklo pramonëje. **Išvados**. 1. Tyrimo rezultatai rodo, kad dalis (3,2%) plauèiø piktybiniø navikø Lietuvoje atsiranda dël asbesto poveikio darbe. 2. Kadangi Lietuvoje plauèiø vëþiu suserga 1560 ir daugiau asmenø per metus, apie 50 atvejø gali sukelti asbestas.

Raktaþodþiai: plauèiø vëþys, ekspozicija darbe, asbestas, profesinë liga