PLAINTIFF'S EXHIBIT
ASA

1968 Yant Award

Occupationa nd "Non-occupational" Asbestosis in Finland

By

LEO NORO, M.D.
Institute of Occupational Health
Helsinki, Finland

Preprinted from
AMERICAN INDUSTRIAL HYGIENE ASSOCIATION JOURNAL
Volume 29, May-June, 1968

HER 0000702

Yant Memorial Lecture

Occupational and "Non-occupational" Asbestosis in Finland

LEO NORO, M.D.
Institute of Occupational Health, Helsinki, Finland

Leo Noro, M.D., Director of the Institute of Occupational Health, Helsinki, Finland, is the recipient of the 1968 William P. Yant Memorial Award. This award is presented by the American Industrial Hygiene Association to commemorate the leadership and breadth of contributions of Dr. William P. Yant in the field of industrial hygiene. The award is sponsored also by the Mine Safety Appliances Company with which Dr. Yant was so long and so prominently associated. Suitable to Dr. Yant's great interest and activity in carrying industrial hygiene to other countries, the selection of recipients is made from persons who are not resident in the United States and who have made outstanding contributions to industrial hygiene.

Dr. Noro, a native Finn, was born in 1915 and received his medical degree from the University of Finland in 1941. Immediately following World War II, he came to the United States as a Rockefeller-Fellow to study industrial hygiene and occupational medicine. He returned to Finland to become a leader in these fields and to achieve international recognition. He has been Director of the institute of Occupational Health at Helsinki since 1950. His publications include topics in industrial hygiene, air pollution, public health, and epidemiology. He is a member of the American Academy of Occupational Health and he has been active on international committees of WHO, ILO, and other such organizations.

Introduction

IT IS A GREAT honor for me to have been selected as the winner of the William Yant Award for 1968 by your internationally esteemed association. I very much appreciate this honor also because I feel myself to be a scholar from the American industrial hygiene school, in which William Yant has been one of the great pioneers. I am very glad, too, to see among this very distinguished audience many of my teachers and friends from the time exactly twenty-one years ago when I was the first Finn after World War II to be sent as a Rockefeller-Fellow to the United States to study industrial hygiene and medicine for the purpose of setting-up an occupational health institute and modern occupational health services in my country.

Asbestos as a Health Problem

I have chosen asbestosis as the subject of this lecture because in recent years asbestos dust has become an object of great interest all over the world not only as the cause of an occupational disease, known since 1900, but also as a potential hazard to the health of the entire population. In publicity even "horror-propaganda" has appeared in newspapers and on television and radio broadcasts. In the *London Sunday Times* on October 31, 1965, Dr. A. Byrne wrote:

> "A disquieting *new* occupational disease capable of killing not only the exposed workmen but also perhaps his womenfolk and even people living near his place of work is the subject of intensive behind-the-scenes activity by British scientists, experts on industrial health and representatives of at least two government ministries."

This concerns asbestos and pleural mesothelioma. My good friend Henry Doyle kindly sent me another clipping from the American

HER 0000703

newspaper *Washington Post*, December 25, 1967, in which Thomas O'Toole considers:

> "A fatal cancer of the chest and abdominal cavities is cropping up among the nation's asbestos workers. So rare that twenty years ago it wasn't even in the medical textbooks, the cancer is called mesothelioma and seems almost peculiar to people exposed to asbestos. But oddly, those stricken with the deadly disease include a nurse whose father worked in an asbestos plant and a man who handled asbestos for no more than a month while he insulated the plumbing in his own house. Any attention the disease gets might come none too soon. More than one million tons of asbestos is consumed annually these days in the United States, with more than 3,000 separate uses being reported for the fiber. There are at least 100,000 asbestos workers in the United States."

It is true that asbestos is a dangerous material. But how dangerous, for example, when compared with radioactive substances, and in which circumstances? This question should be answered scientifically before the people become frightened and the existence of the asbestos industry is placed in jeopardy or at least greatly disturbed through incompetent knowledge and propaganda. Every industry has health hazards of its own, but they can be controlled as the atomic energy industry has very well demonstrated. The asbestos industry is ready to eliminate their health hazards too, if we occupational health people can only say how to do it.

Now I want to make some general remarks about asbestosis before going on to the Finnish experiences concerning this subject. The world production of asbestos is at present more than four million tons a year, half of it being Russian. According to the American estimation at least 400,000 workers are exposed to asbestos in the world, but there are no estimates of how many people are exposed non-occupationally to very small amounts of asbestos dust in their everyday living environment.

Present Knowledge of Asbestosis

Until now there have been published approximately 1,000 scientific articles on asbestosis. A list has been compiled at the Institute of Occupational and Environmental Health, Montreal. Already three special international congresses have been held concerning the subject "Asbestos and Health" (Caen 1964, New York 1965, and Dresden 1968) and many national meetings. The Canadian asbestos industry has twice invited a group of experts to discuss the problem at Antigua, West Indies. The interest is great!

Dr. Gilson describes very well the development of our knowledge of asbestos and health. The modern asbestos industry started in 1878. Asbestosis was described for the first time in 1900. Asbestos and lung cancer came into the picture in 1935. Mesothelial tumors from asbestos-producing areas were first written about in 1955 by C. A. Sleggs from South Africa, and up until now a few hundred cases of pleural mesotheliomas have been discussed in texts from the United Kingdom, South Africa, the United States, Canada, and other countries. In addition to this, Dr. Wagner has elegantly shown in his experiments how easily mesothelial tumors of the pleura can be produced by some asbestos dusts. The incidence of asbestosis cases has dropped, however, in many countries during the last twenty years. Dr. Knox mentioned some time ago that thirty years ago the incidence of asbestosis among workers was 89% after 25 years of exposure and that ten years ago it was only 3%. This is due to the better dust control. But how far should we go with dust control, if even very small amounts of asbestos dust might cause a fatal disease like mesothelioma as the newspapers and some investigations have told us? Are we at all able to prevent in this case asbestosis by industrial hygiene measures which are still economically acceptable? These are the questions which are of interest to those of us who are working in the field of occupational health.

History of Asbestos in Finland

Finland is one of the oldest asbestos producers in the world. Our asbestos is the rather rare anthophyllite asbestos, which is quarried in eastern Finland close to the Soviet border. Archeological studies have shown that as early

HER 0000704

as 2500 B.C. or 4,500 years ago people in Finland knew how to add fine asbestos fiber to raw material for pottery. The technical significance of this discovery is obvious. In the same way that asbestos is now used to improve tensile strength (in the armoring of cement products, for example) so it was once used to strengthen the sides of lightly fired pottery. When the material had been strengthened, the sides of the vessels could be made thinner. In this way cooking utensils were produced which were not only lighter in weight but in which food could also be cooked more quickly. This surprisingly mature technical invention found also a practical adaptation which commands respect for the economic instincts of those forefathers whom we often regard as very primitive people. Asbestos pottery was not limited to being a provincial specialty of eastern Finland; it spread over a wide area of Finland, Scandinavia, and Russia. The asbestos pottery as found in Finland and in neighboring countries is unique—nowhere else have discoveries of that kind been made!

This use of asbestos also illustrates that exposure of man to occupational asbestos in handicrafts has at least a 4,500-year-old history in Finland as well as the non-occupational exposures in asbestos areas. But only since 1918 have we had a modern industrial exposure of workers in quarry, mill, and factories. Our eastern neighbor, Russia, started the production of asbestos as early as 1712 during the reign of Peter the Great. Their production at present is already approximately two million tons per year, half the total of world production per year and twice as much as the United States annually uses.

Finnish Asbestos

The present production in Finland is only 11,000 metric tons per year of anthophyllite asbestos. The asbestos dust in the quarry and mill mineralogically contains:

Anthophyllite	30-75%
Talc	20-60%
Chlorite	3-13%

The theoretical chemical composition is (Mg, Fe^{2+})$_7$ [$(OH)_2$ $(Si_4O_{11})_2$]. There are small amounts, perhaps smaller than in Canadian asbestos, of some metals such as Ni, Cr, Co, which might have some cancerogenic interest.

Levels of Exposure to Asbestos Dust

Unfortunately the exposure levels at plants have been systematically measured only during recent years. Twenty years, ago, before the management of the quarry and mill changed, the dustiness was, especially in the mill, rather great. One could only see a few meters ahead. The level of dust was surely many times higher than what our threshold limits indicate it should be. This great exposure reflects in the frequency and severity of our asbestosis cases, which will be presented later.

The present situation of dustiness will be reflected in the morbidity of the next ten to twenty years. In the entire asbestos industry approximately 225 different jobs have been examined. In three-fourths of them the level of dust is under the threshold limits, but it is higher in the remaining one-fourth.

We have used: (a) gravimetric samples taken with electrostatic precipitators (MSA) and/or with membrane filter field monitors (Millipore Filter Corp., Type AA), and (b) breathing zone samples taken with an impinger (MSA) for particle counting and sizing under the microscope. X-ray diffraction methods are used also.

In the mill and quarry the total quantity of dust varies from 7.5 to 100 mg/m^3. In other working places the level of dust varies from 0.3 to 10.6 mg/m^3 or 11 to 2,400 particles/cm^3. Only 1% to 5.4% of the total dust (impinger-method) has been fibrous particles, *i.e.*, 5 μ in length, the length being three to four times the width. In this connection I would like to mention that in eastern Europe (the Soviet Union, East Germany) the threshold limits are somewhat lower than the western ones: 2 mg/m^3 or 100 to 150 particles/cm^3.

The level of industrial hygiene in Finland is not yet satisfactory, and unfortunately we must expect still more asbestosis cases.

Medical Findings

The first medical survey in our asbestos industry was made in 1946 by C. Wegelius.

HER 0000705

The results of this x-ray study tell about the health effects of rather heavy exposure during the first twenty active years of the asbestos industry. From 476 asbestos workers (industry included) 126 cases (26.5%) of asbestosis were found. However, 73% of these were of stages I or I-II, in which diagnosis was not easy because at that time only x-ray film size 24 x 36 mm was used. Pleural and pericardial thickenings were present in 36% of all cases and in connection with stages II-III and III in 100%.

Since 1954 the asbestos workers have been examined roentgenologically rather regularly. Until 1967, altogether 144 cases of asbestosis had been diagnosed in the asbestos industry, which employs approximately 500 workers. In all these cases the exposure time has been more than two years.

Among insulators 35 cases of asbestosis have been determined until now. No mesotheliomas have been found. There are approximately 400-500 insulators in Finland.

At present (1968), we are again studying the up-to-date situation in the quarry and the mill. Our preliminary study shows:

—During the last thirty years approximately 400 workers have been exposed to asbestos dust for more than one year.
—One-half of these workers have died from various causes, which are under study.
—One-fourth of them have had asbestosis (90 cases).

In 1967, 135 workers (24 pensioners included) were examined, and among them 37 cases of asbestosis were found, of which 13 were new. In four cases exposure time was less than ten years, in 17 cases it was less than 20 years, and in two cases more than 30 years. No lung cancer or mesotheliomas were found among these cases. When comparing the asbestosis cases and the roentgenologically normal people among the 135 examined, the following observations were made in connection with the clinical examination:

In asbestosis cases the following data were significantly present more often than in the non-asbestosis group:
—older age
—longer exposure time
—longer time of residence in the district
—longer and heavier history of smoking
—more pneumonia (highly significant)
—more production of phlegm
—more shortness of breath
—worse lung functions (FVC, $FEV_{1.0}$, and AS).

Smoking history is always important in connection with all occupational lung diseases. If lung cancer is an average of ten times more common among heavy smokers than non-smokers (in some age groups even 60 times more common according to some authors), this fact should always be taken into consideration when discussing lung cancer as a complication of asbestosis. The two environmental factors, smoking and asbestos, simultaneously make the risk of cancer greater too!

These epidemiological studies indicate that asbestosis is still a rather important occupational disease in Finland. Whether or not anthophyllite asbestosis is more dangerous or more cancerogenic than other asbestos types, chrysotile, crocidolite and amosite, is an interesting question, which is being studied at present. We might have the answer to this question in a few years.

"Non-occupational" Asbestos

The Finn, Raimo Kiviluoto, in 1960 presented his observations on the unusual, "Pleural calcification as a roentgenologic sign of non-occupational endemic anthophyllite-asbestosis," at the XIIIth International Congress on Occupational Health in New York. He had collected approximately 800 cases of special-looking, mostly bilateral pleural calcifications among the population in an asbestos area. Dr. V. Raunio continued the study and collected approximately 1,300 similar cases, visible in 70 x 70 mm AP-x-ray pictures, in the population of the same district. His study was based on more than 600,000 RP pictures taken in thirteen Finnish towns and 106 rural communes, which together correspond to approximately 20% of the Finnish population over the age of fifteen. In the Tuusniemi commune, where the asbestos quarry is located, this kind of peculiar pleural calcification was found in 9% of the popula-

HER 0000706

tion over fifteen years of age. Under the age of 40 years they were rare, but in persons over 65 years of age the calcifications were observed in almost 30%. In the rural population elsewhere in Finland only seven cases were found in the 265,223 people examined, but in two larger towns they were more frequent, 0.7% of the examined. Kiviluoto has later found 77 cases of calcifications in 35,000 chest x-ray pictures from the population of our second largest city Tampere.

Bilateral thickening of the parietal pleura is, however, a very common finding at autopsies in all of Finland. as Dr. Meurman stated in his study in 1965. He found them in 39.3% of his cases, equally in eastern and western Finland. In 70% of the cases the plaques were bilateral and in 72% the findings were in men. They were more common in the urban population (52.2%) than in the rural areas (31.8%). In the asbestos area the incidence and calcification of plaques were higher. Asbestos bodies were present in 57.6% of the 264 lungs studied, in men 60.1% and women 54.3%. Other findings were:

—The frequency of asbestos bodies in the lungs is higher in urban than rural populations (70%-49%).

—The frequency of asbestos bodies in the lungs of persons in the asbestos area was greater (however in 5 cases of 15 no asbestos bodies could be found).

—In farmers asbestos bodies were found in 47% and in building workers and workers of corresponding trades in 67%.

—Asbestos bodies could not be detected in plaques.

—There was a positive correlation between the occurrence of asbestos bodies in the lungs and of pleural plaques. In cases of bilateral plaques 85.7% exhibited asbestos bodies in the lungs, but, on the other hand, approximately 40% of the cases showing asbestos bodies in the lungs were free from pleural plaques.

—The plaques did not have any correlation with emphysema, heart disease, pulmonary stasis, or pulmonary tuberculosis. Chronic bronchitis was not studied.

Perhaps the most important finding is that pleural plaques are a very common disease in the entire population. Already in 1884 Curschmann described them as "sugar icing"—"Zuckerguss"—at the time when the asbestos industry was only starting in some countries. Asbestos bodies—if they are all asbestos (?)—are rather frequent in lungs: in Finnish material in 57.6%, in some other material between 5 and 50%. (It depends on what kind of method is used and in what detail the lungs are studied.) This does not mean, however, that they are "asbestosis cases," as *Chemical Week* (Sept. 10, 1966) seemed to think when it stated, "Forty per cent of all Americans have mild, chronic cases of asbestosis." We do not even know yet what materials are a part of the needles, fibers, bodies, etc. which have been found in the human body.

In the Finnish asbestos area, however, calcifications, visible in x-ray pictures, are much more common than in other parts of the country. Air pollution is not the only cause of exposure. We have made some investigations and noticed that calcifications are found outside of the area where asbestos dust spreads. Of course, the local exposure to dust (asbestos ovens, asbestos stones in the sauna, agricultural exposure from dust in fields, etc.) could be a cause. But also the entire geomicrological composition of the soil is different. In our preliminary studies in this area we have noticed great differences, for example, in the Mg-content of the drinking water, which might influence the calcification processes. The study, however, is not yet finished. It, nevertheless, seems that asbestos in the air or soil has something to do with calcification of plaques, because also in occupational asbestosis cases pleural calcifications are rather frequent symptoms (in our material of advanced cases in 100% of them).

What then is the prognosis of plaques and calcifications? Does one part of them develop into mesotheliomas and why? This is an interesting question. Our Finnish experience does not as yet prove it to be so.

You might ask, "If you find this kind of peculiar pleural changes in even 9% of the population, then what is the situation in regard to pleural malignancies and mesotheliomas in this area which already has a 4,500-year history of endemic exposure." The Fin-

HER 0000707

nish Cancer Register shows that the incidence of cancer of the lung and malignant pleural and peritoneal tumors is not higher in the "calcification area" than in the other rural districts of east Finland during the years 1953-62, as Dr. Raunio has stated. Kiviluoto came to the same conclusion. Only one case of pleural or peritoneal mesothelioma has been detected during autopsies from this district (Kiviluoto). Twelve cases of mesotheliomas of the pleura have been recorded in Finland, and not one of these was from this area. Knowing that the area has had 4,500 years of endemic exposure, which in the last 50 years has been rather heavy in occupational exposures and has been increased among the neighborhood population by industrial air pollution and knowing that every third man over the age of 65 has pleural plaques, one could already expect more mesotheliomas in this district! Or should we wait still some twenty years longer and see what will have happened when the population has aged and incubation time has been long enough and also other cancerogenic factors like cigarette smoking, exhaust gases, zinc in the drinking water, etc., have had a combined influence great enough? At present we still know too little about the danger caused by asbestos to the general population.

Summary

In summary of the Finnish experiences concerning asbestos, we feel that:

(1) Asbestos is a rather dangerous material to workers' health, just as hundreds of other agents are if they are not properly controlled in industrial use. We, however, are at present able to control it and make the use of it as harmless as the use of other dusts or toxic materials, even radioactive substances, might be. Every occupation has its health hazards, so also does the asbestos industry; as a part of the total health of workers, asbestosis can be reduced by modern industrial hygiene to a very small hazard.

(2) We cannot agree with the recent "horror propaganda" such as was written in the *London Sunday Times* by Dr. Byrne that asbestos is, "Capable of killing not only the exposed workman but also perhaps his womenfolk and even people living near his place of work." If so, the population in the asbestos area of Finland would already be dead and nobody could live there. Still at present in the asbestos area the mortality rate from cancer and other malignancies is equal to the other rural areas of the country, although in the worker population the frequency of lung cancer might be somewhat higher.

(3) As industrial hygienists we, however, have to continue our work to reach better and better hygienic conditions and dust control in places of employment as well as in the environment of factories and mines to safeguard the workers and general population.

There is enough evidence already to cause us to pay more attention to this health problem. Many questions have not yet been answered:

(1) What is the health significance of fibrous foreign bodies found in the lungs, and are they all asbestos?

(2) Does a small amount of asbestos dust, caused by construction activity, asbestos material in houses, the brake linings of motor vehicles, etc., really have any influence on the health of the population in the urban living environment? Does this kind of minimal exposure have any cancerogenic effects? What is the role of asbestos among the hundred other environmental cancerogenic agents like cigarette smoke, exhaust gases of motor vehicles, food additives, viruses, etc.?

(3) How far should we go in dust control to prevent totally the development of new asbestosis cases and what should the threshold limit be? Or is it impossible to reach the safety limit of 100% with only moderate expenditures?

These are some questions which still are waiting for answers, but I am convinced that, with the proper collaboration of industrial hygienists, whom you are representing here, and medical experts, these kinds of problems will be solved in the future.

HER 0000708

Finnish Bibliography on Asbestosis

Ahlman, Kaj: Asbestosis among Insulator Workers in Finland. *Proc. XV Int. Congr. Occup. Health*, Vienna (1966).

Aurola, E., and A. Vesasalo: Über die Asbestvorkommen Finnlands und ihre technische Verwertung. *Geologische Untersuchungsanstalt, Geotechnische Veröffentlichungen Nr 54* (1954).

Finnish Mineral (Carlsson): *The World's First Asbestos Merchants.*

Kiviluoto, R.: Pleural Calcification as a Roentgenologic Sign of Nonoccupational Endemic Anthophyllite-Asbestosis. *Acta Radiol.* (Stockholm) Suppl. 1960:194 (1960).

Kiviluoto, R.: Pleural Plaques and Asbestos; Further observations on endemic and other non occupational asbestosis. *Annals N. Y. Acad. Sci. 132:* 235 (1965).

Kiviluoto, R.: Pleural Calcifications and Asbestosis. *Brit. J. Radiology* (1967).

Laamanen, A., and V. Raunio: Observations on Atmospheric Air Pollution Caused by Asbestos. *Annual Report of the Institute of Occupational Health 1964*, Helsinki (1964).

Laamanen, A., Leo Noro, and V. Raunio: Observations on Atmospheric Air Pollution Caused by Asbestos. *Ann. Acad. Sci. 132:* 240 (1965).

Meurman, L.: Asbestos Bodies and Pleural Plaques in a Finnish Series of Autopsy Cases. *Acta Path. Scand.* Suppl. 182 (1966).

Noro, Leo: On the Histology of Asbestosis. *Acta Path. Microbiol. Scand. 23:* 53 (1946).

Noro, Leo, K. Ahlman, A. Laamanen, and M. Viikeri: Asbestose als Berufskrankheit in Finnland. *Int. Arch. Gewerbepath. 22:* 179 (1966).

Noro, Leo, K. Ahlman, A. O. Heinonen, T. Partanen, E. Rintala, E. Siltanen, and M. Viikeri: Occupational Anthophyllite-Asbestosis in Finland (A preliminary report): Second International Conference on the Biological Effects of Asbestos. Dresden 1968.

Raunio, V.: Occurrence of Unusual Pleural Calcification in Finland in *Studies on Atmospheric Pollution Caused by Asbestos.* Helsinki (1966).

Siltanen, E.: *Industrial Hygiene Aspects on Studies of Asbestos Dust at Working Places.* IVA. Stockholm (1967).

Siltanen, E.: Observations on the Asbestos Dust Measurements. Czechoslovak-Swedish-Finnish Symposium on Pneumoconioses. Prague, June 12-17, 1967.

Wegelius, C.: Changes in the Lungs in 126 Cases of Asbestosis Observed in Finland. *Acta Radiol.* (Stockholm) *28:* 139 (1947).

Viikeri, M., and K. Ahlman: Radiological Classification of Cases with Pneumoconiosis in the Light of a Group Study. *SLL 19:* 2211 (Finnish) (1964).

Viikeri, M., *et al.:* Ultrashall Examinations in Asbestosis. To be published.

PRINTED IN U.S.A.

HER 0000709