CONFIDENTIAL

Asbestos, Que.,
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George K. Foster

Saranac Report

The report on experimental asbestosis has been reviewed. The experiments and resulting conclusions are summarized in the attached report, to which I have added my own comments and recommendations.

The recommendations are for the industry as a whole. Several points need further clarification; when these have been discussed with the Saranac people I shall submit another report.

KWS/h.m.

Kenneth W. Smith, M.D.

7.

SUMMARY OF FINDINGS

A. - Various forms of asbestos fibres produce typical fibrosis in the lungs of some animals.

B. - Fibrosis is produced by the mechanical and not the chemical action of the fibre.

C. - Fibrosis is produced by the long fibres (20-80 microns) and not by the short fibres (under 20 microns).

D. - Asbestosis was produced in an atmosphere with a total dust count of 138 M.P.P.C.F. of which only 0.6% were 10 microns or longer.

E. - As the concentration of long fibres in the air is increased, the fibrosis develops in a shorter time.

F. - Fibrosis will not progress after removal from dust to normal air.

G. - Asbestosis bodies are formed around fibres to prevent further irritation.

H. - Aluminum therapy is useless in asbestosis.

I. - Asbestos dust causes no significant change in the course of pulmonary tuberculosis.


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COMMENTS

1. - Tissue and animal susceptibility was noted in the experiments. Individual susceptibility to the dust among our employees has been noted for many years.

2. - We always have believed that the action of the dust was mechanical and not chemical. If there was an added chemical effect, I believe that we would see countless cases of asbestosis because we have had hundreds of men exposed to high concentrations of dust.

3. - The theory of the action only by long fibres of 20-30 microns is, at first, hard to accept because:

(a) I personally have heard the late Dr. Gardner say that probably the most dangerous lengths of fibre for the production of asbestosis are those of 5 to 15 microns in length.

(b) In Dr. Gardner's letter to Mr. Sabourin of Feb. 25, 1944, he states: "I believe that the true hazard in asbestos plants is proportional to the amount of small, individual unscrubbed fibres in the atmosphere. I suspect that the reason only one sees little or no typical asbestosis in the mines and mills is because there is probably too little such fibre in the air of these plants. Conversely the reason for the typical disease in the fabricating plants is the fact that the processes there open the bundles of asbestos fibres and tear them into lengths short enough to be inhaled in dangerous quantities".

(c) In the U.S. Public Health Bulletin #241 entitled "A Study of Asbestosis in the Asbestos Textile Industry" it is stated that the median length of fibres range from 7 to 16 microns in the plants studied. Dust counts around the mixing pickers and cards showed the lowest percentage of fibre and the shortest lengths of fibre and it was among these men(pickers and carders) that the greatest number of asbestosis cases occured.

However, in spite of these three statements, I would prefer to believe in the action only of the long fibres and accept these recent Saranac findings because:

I - The dust counts in our mills show 65% - 90% of the fibres are 5 microns or less in length and rarely 1% are 20 microns or longer, and we have relatively few asbestosis cases.

II - The recent Saranac studies have shown that asbestosis will develop in an atmosphere of 130 M.P.P.C.F. total count of which only 0.8% were fibres longer than 10 microns. We have had many areas in our mills where such counts could have been found.

III - Saranac also has shown that, logically, as the concentration of long fibres is increased, more fibrosis develops. The fibre deposits in the Thetford area are of longer fibre than the Asbestos deposit. Although there is no data today, we might assume that the dust in the Thetford Mills has a higher percentage of the longer fibres than that in the Asbestos Mills. This might account in part for the greater number of asbestosis cases seen in the Thetford plants.

IV - The relatively small number of asbestosis cases occuring in the asbestos mines and mills as compared with the textile plants might be due in part to the percentage of fibres in the industrial atmosphere. Dust counts in various textile plants show up to 75% fibre while counts in our mills show only 4%-5% fibre.

4. - That the fibrosis of asbestosis will not progress after removal of the animal from dust to normal air can easily be believed. I have seen many men who, when transferred to non-dusty jobs, have improved physically and whose x-rays have shown no progression.

5. - We always have believed that the asbestosis bodies are not evidence of disease, but simply the fact that fibre has been inhaled and the body has shown defensive action in an effort to neutralize the irritation.

6. - I still believe that asbestos dust will not aggravate a pre-existing tuberculosis; also that the course of tuberculosis will not be altered in a man who has worked for several years in our mills as long as he has no x-ray evidence of asbestosis. However, at the moment I can neither accept nor deny the statement that asbestosis has no effect on superimposed tuberculosis.

The Saranac experiments have shown that asbestos is not an inert dust like gypsum, nor is it a very active dust like quartz. They have shown that concurrent asbestosis and tuberculosis produce more fibrosis than does either disease alone. Also it has been shown that tubercle bacilli have been found in the asbestotic fibrosis which is not the usual site for this infection. These experiments have shown that there may be some connection between non-tuberculous infection and asbestosis.

I believe that this is a fact for, although I do not think our mill workers have more respiratory complaints than the average man, I have seen several cases where pneumonia has developed on a pre-existing asbestosis. Such cases are extremely difficult to treat, show a very slow recovery and considerable fibrosis in the x-ray. The local doctors have stated that pneumonia in an employee who has worked for many years in the dust often has a fatal termination.

In view of the probable detrimental effect of asbestosis on superimposed pneumonia, I believe that the relationship of tuberculosis developing on a well-established asbestosis should have further study. Although this relationship has not been shown in the recent experiments, my opinions must be neutral until more cases of the disease among our employees have been studied.

## Recommendations

I - The air in the Asbestos and Thetford plants should be sampled and studied for fibre lengths, and these findings correlated with the experimental and human studies at Saranac.

II - Asbestosis can be controlled if:-

(a) Every effort is made to lower the dust concentration in the working area of the employee, and
(b) transfers to non-dusty jobs are effected before any disability develops, probably as soon as there are significant x-ray changes.

III - Tuberculosis would not be a problem if:-

(a) Every active case is isolated and not allowed to work;
(b) non-dusty jobs are found for apparently arrested cases;
(c) routine case-finding, examination of all contacts, etc. (an adequate tuberculosis control program) was carried out.

IV - We should have an opinion from the Saranac Laboratory on the association of asbestosis and cancer. There is a world-wide effort to find the cause and cure for cancer. The medical literature is full of suggested causes and asbestos has been mentioned as a very definite possible cause. Although in actual practice we have seen no cases of cancer of the lung among our employees, asbestos is an irritant and as such might play some role in the development of carcinoma. An expert opinion on this relationship would be worth while.

SUMMARY OF EXPERIMENTS

5 - Experimental Methods  Two techniques were used:

(a) Inhalation Method: Various animals were exposed in a dust chamber to known concentrations of fibres of known lengths. Animals were killed from time to time and the effects of the dust on their lungs studied.

(b) Injection Method: The dust, either dry or suspended in fluids was introduced into the animal's veins, abdominal cavity or trachea to determine whether or not the dust has a potential capacity to cause tissue reaction.

6 - Species Susceptibility  Asbestos dust affects only certain organs of certain particular animals. Free silica, however will produce nodular fibrosis in nearly all organs of most animals.

7 - Peculiar Characteristics of Asbestos  Most particulate matter larger than 5 microns inhaled by man is arrested in the upper respiratory tract. The smaller particles come to rest in the terminal air cells or alveoli. However, fibrous material up to 220 microns has been found in the alveoli; ability to pass to the alveoli depends on the flexibility of the fibre. Nearly all inhaled fibres are retained in the respiratory bronchioles - the small tubes just before the alveoli are reached.

8 - Rate of Tissue Reaction  Asbestos causes a tissue reaction much more quickly than does free silica. But after termination of exposure, silicotic nodules increase in size, while asbestotic fibrosis contracts.

Inhalation Experiments

These experiments covered periods ranging from 2 to 5 years. Four kinds of asbestos dust were used-

A. Kings Mountain
B. Short Fibre
C. 100% Ball-milled
D. Long Fibre Asbestos Dust

A. Kin's Mountain Experiments  Material used was short fibres and particles of various size from Thetford. The characteristic fibrosis was produced in guinea pigs but not rats or rabbits. The fibrosis did not recover after the dust was removed and the guinea pig returned to normal air.

B. Short Fibre Experiments - We supplied this fibre which was 5 microns or less in length. Small particle dusts like quartz are more active in producing fibrosis, but this short fibre produced much less fibrosis than that in the Fibre Floats Experiments. Individual susceptibility was noted. Short fibres are slower and produce less fibrosis, hence probably have only mechanical action. Small particle and active dusts like quartz have mechanical and chemical actions and producing considerable fibrosis.

C. 100% Ball-Milled Dust - The previous experiments were repeated with all dust 5 microns or less in length. Comparable results were noted, confirming the fact that short fibres are slower and produce less fibrosis than long fibres; also that the reaction is mechanical and not chemical.

D. Long Fibre Experiments - Long fibre chrysotile almost free from serpentine was used. This was a much purer form of asbestos than that used in previous experiments. Tissue reaction in the lungs developed more quickly and was more extensive with long fibres, in spite of a lower concentration than in previous experiments.

## Injection Experiments

(a) Intratracheal Technique - The ability of asbestos to produce fibrosis resides in its fibrous character. This was proven by using the following materials-

1. Chrysotile, ball-milled; unheated (5 microns) No fibrosis
2. " " " ; ignited " " " "
3. " fibrous unheated (20-30 microns) Definite fibrosis
4. " " ignited " " No reaction
5. Serpentine, ball-milled unheated (under 5 microns) No fibrosis
6. " " " ignited " " " " "

Various long-fibre dusts were compared- Arizona Chrysotile, Amosite, Crocidolite and Tremolite, all of which produce typical fibrosis. Anthophyllite produced no fibrosis. Brucite which is not a silicate but fibrous magnesium hydroxide, produced typical fibrosis and asbestosis bodies; hence the siliceous component of the fibre is not necessary to produce fibrosis.

Glass wool fibres, while resembling asbestos, produce no fibrosis because they do not bend. The flexibility of asbestos is necessary to produce fibrosis.

Long fibre and short fibre dusts were compared-

1 - With quartz, the smaller the particle the more extensive the tissue reaction; there was very little reaction to particles larger than 5 microns.
2 - With asbestos, only fibres of 20-30 microns produced significant fibrosis; there was practically no fibrosis with fibres under 5 microns.

(b) Intravenous Technique ... quartz particles 5 microns or less produced typical fibrosis all over the body. Asbestos minerals of 5 microns or less produced no fibrosis, showing that asbestos is different than quartz in its action.

(c) Intratracheal Technique ... long fibre asbestos produced definite fibrosis and some asbestosis bodies. Dust under 5 microns was inert.

## Theory of Irritant Action

The action of asbestos is mechanical, not chemical, because:-

1 - Bruzite, not a silicate, causes typical fibrosis.
2 - Free silica becomes more irritable as the particle size decreases, but asbestos under 15 microns is innocuous.
3 - Aluminum hydroxide neutralizes the irritation of quartz, but not asbestos.
4 - Serpentine is the same as chrysotile chemically, but causes no fibrosis.
5 - Many minerals with widely varying chemical composition, cause typical fibrosis.

Asbestosis is caused by the mechanical action of the fibre because of the filamented structure and associated flexibility. It is produced only in the lungs which are highly mobile, and in the peritoneum where there is some movement.

## Complications

[redacted]

1. 20 Effect of Dust on Tuberculosis

(a) Guinea pigs were infected with tuberculosis and then placed in the dust chamber. Results varied - some pigs showed no progression of the tuberculosis; most of them showed a temporary progression, then healing; some progressed continually to death. The healed lesions, however, showed more fibrosis than is characteristic of asbestos s or tuberculosis alone. In contrast, free silica causes progression to death, while a harmless dust like carbon causes no progression of the tuberculosis.

(b) Guinea pigs were allowed to develop asbestosis in the dust chamber, then infected with tuberculosis and removed to normal air. Progressive disease did not develop, but more tubercle bacilli were seen around the respiratory bronchioles in the fibrosis caused by the dust. [illegible] a natural aid for tuberculosis.

2. Non-Tuberculous Infection. No specific experiments were carried out. Intercurrent pneumonia was common, suggesting a possible effect of asbestos on non-tuberculous infection, but nothing could be proven.