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FURTHER CONTRIBUTIONS ON THE X-RAY DIAGNOSIS OF PULMONARY ASBESTOSIS

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Together with Kruger and Rostoski, I reported in 1931 on pulmonary asbestosis; my X-ray atlas on the same subject, published in 1938 by Verlag Thieme, Leipzig, was based on observations of more than 200 men and women from asbestos plants. In association with industrial physicians of Saxony, at the instigation of the regional industrial physician and in the course of evaluations in the last six months, I radiologically examined another 420 workers in asbestos plants. This extensive new investigative data makes it possible to check and partially supplement earlier statements and particularly, since these were chiefly employees who at that time had worked in a dusty atmosphere for only a fairly brief period, to critically treat the question regarding possibilities of early radiological diagnosis of asbestosis.

Breifly summarized, our definition of radiological symptoms of asbestosis was as follows:

Preliminary stage of asbestosis (0-I): Still rather uncharacteristic strong delineation of pulmonary marking, particularly in the middle and lower fields, delicate striated shadows and very pale spots in pleural recesses or angles of heart and diaphragm.

Asbestosis I: Extremely delicate network of pulmonary marking in the middle and lower fields, already permeated with very small, pale spots.

Asbestosis II: Denser pulmonary marking, numerous very small shadows of spots, beginning reduction of brightness of middle and lower fields, particularly in the sections near the heart. Broad and dense hili, generally without calcarious infiltrations.

Asbestosis III: Pronounced shading of middle and lower fields, increased x-ray permeable upper fields, borders of heart barely distinguishable, broad, moderately dense hili.

Transition stages (I-II and II-III) occur irregularly.

Today we can state that this proposed classification of pulmonary asbestosis has proved to be valid. It certainly cannot be denied that the well known forms of silicosis can be distinguished more sharply than the corresponding forms of asbestosis, since the particular morphological features of silicosis are *coarser and clearer* than those of asbestosis, whose picture elements are much softer, often blurred. Whereas with silicosis an effort has been made to limit as much as possible the intermediate forms (I-II, etc.) in the interest of facilitating identification, at present it is not possible to dispense with this when evaluating asbestosis, since numerically the intermediate forms still represent a large contingent in our classifications. In making evaluations, it happens again and again that different observers obtain somewhat different results and even the same observer, upon evaluating the same film at a different time, may make a somewhat different evaluation with regard to classifications. But certainty increases with experience; in any case, a better method of classifying radiological degrees of severity of asbestosis has not yet been found.

In consultations with colleagues and during instruction in general film evaluation, we noted again and again that the picture details of pulmonary asbestosis often cannot be sufficiently recognized. Along with other observers, particularly authors writing in English-American, Italian,



FIGURE 1. Partial X-ray (right middle field) of 29-year-old asbestos weaver; "foggy mist" structure.

and French (see details in my atlas!), we have constantly referred to the particular delicateness of asbestosic changes in pulmonary X-rays; they must often be studied with a magnifying glass! The reticular marking is very delicately honeycombed, narrowly meshed, and spotting is very delicately marked. The comparison of this spotting to the appearance of ground glass (flocculation resembling ground glass, Dhers) is most appropriate, as is Timmerman's excellent comparison of the changes to a mist of steam over a boiling pot of water, which simultaneously describes the small spots being surrounded by a light haze. The term of foggy mist is also characteristic. Dhers also speaks of "zones of delicate spotting" and of streaky shadows arranged like cobwebs (linear shadows draped in spider webs). There is little difficulty in recognizing the haziness near the borders of the heart covering the pulmonary marking, as a result of which the borders of the heart are blurred and indistinguishable in the X-ray in the case of severe changes. I find the term "felt streaks," often used

to describe this, to be less appropriate; Dhers says that the emanations from the hili, downward and outward, overlapping the borders of the heart, give them a shaggy (hairy, woolly) and felt-like appearance (velvety and felt-like appearance); the French word velu is derived from the Latin villosus. It should also be mentioned here that the changes occasionally appear more clearly in the positive processing of the X-ray than in the negative.

It seems appropriate to illustrate the asbestotic pulmonary changes in the original size in partial sections of lung X-rays.

Figure 1 is that of a 29-year-old asbestos weaver who had already worked in a dusty atmosphere for 11 years and complained of coughing and expectoration. The section of the X-ray belongs to the right middle field and shows very nicely the "foggy mist" structure of pulmonary asbestosis.

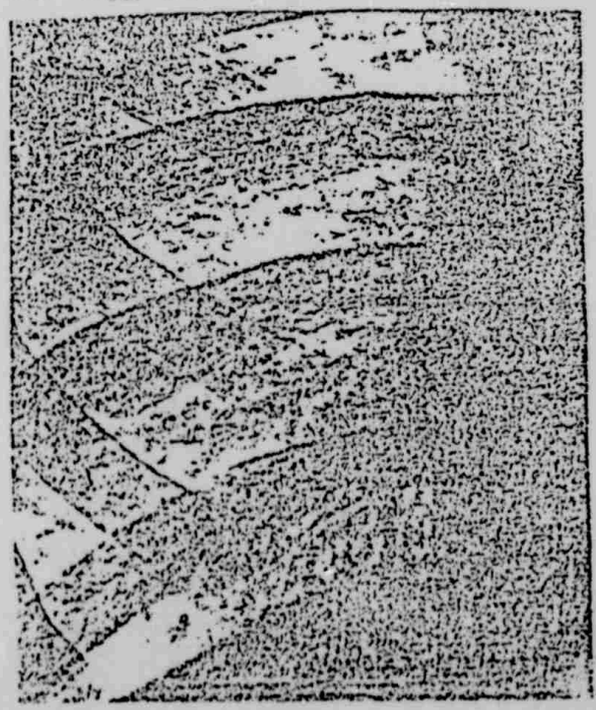


FIGURE 2. Partial X-ray (border of right middle-lower field) of a 38-year-old asbestos plate worker; very narrowly meshed, delicately honeycombed pulmonary marking.

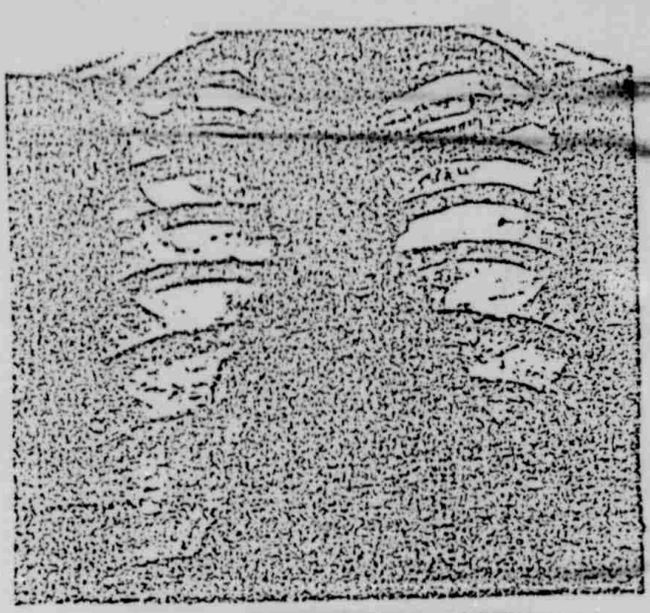


FIGURE 3a. X-ray of a 25-year-old female worker in standing position. Simulation of asbestotic changes.

In Figure 2 we showed a portion of the X-ray (border of the right middle and lower field) of a 38-year-old asbestos plate worker employed in the dusty atmosphere of a plant for 20 years. The very narrowly meshed, delicately honeycombed reticulum marking is recognizable, partially without the haziness characteristic of foggy mist.

We have previously referred to the fact that the shadows of the breasts very severely impair an evaluation of asbestosis, particularly of its severity, and can result in false interpretations. However, there is a large number of female workers among our personnel and their nutritional condition is usually quite good, therefore this viewpoint deserves careful consideration. We urgently recommend making additional X-rays in all dubious cases, since fluoroscopy has proved to be a failure with asbestosis or at most supplies useful results for more severe cases. It is best to also take chest X-rays in the prone position, in which case the breasts must be pushed to the side, which is facilitated by the weight of the trunk. Our equipment permitted us to also take these X-rays in the prone

position as teleradiographs from a focused distance of 1.50 meters; all other conditions remained the same. We also took X-rays of the lower sections of the lungs on a format of 15 x 40 cm (transversal format) in a standing position; in this instance, the female workers used the fingers to lift the breasts with the elbows raised high on the sides. This technique is not so advantageous as that in the prone position, but it can be used when, for some reason or other, the X-ray cannot be taken vertically with the subject in a horizontal position. Partial X-rays on an even smaller format may also be made in this way. As is well known, asbestosis diagnostics requires relatively soft lung X-rays; but the distorting shadows of the breasts are particularly noticeable in such X-rays. Since the more severe forms of asbestosis create haziness predominantly over the lower halves of the lungs, breast shadows can simulate such haziness and lead to an overestimation of actual changes; we also made such errors previously, but have become very cautious in this respect.

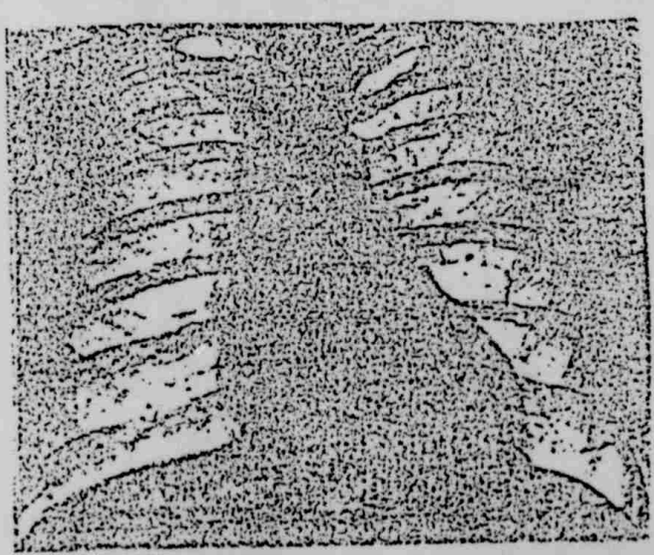


FIGURE 3b. X-ray of same female worker in prone position. No asbestosis.



FIGURE 4a. 42-year-old female asbestos spinner, X-rayed in standing position: the picture could be interpreted as asbestosis III.

Figures 3a and 3b show the X-rays of a 25-year-old female worker employed as a spinner in the plant for the first time for a good six months. Based on the X-ray taken in the standing position, it would have been possible to conceive of asbestotic pulmonary changes, although this seemed rather unlikely considering the brief period of work in the dusty atmosphere. A reexamination with an X-ray taken in the prone position under the same conditions shows only a slight coarsening of the pulmonary marking over the lower fields, whereas there have been dark shadows in the upper fields and accumulated shadows in the same place. There was no asbestosis.

Figures 4a and 4b were taken in the case of a 42-year-old woman employed chiefly as an asbestos spinner and referred for an opinion on occupational illness; she complained of shortness of breath, coughing, expectoration, occasional mild nocturnal perspiration, scratching in the throat and chest pains. Delicate rale over both lower fields, clear functional disorders. The X-ray in the standing position would probably

readily justify the assumption of form III of asbestosis; the chest X-ray taken in the prone position reduces the initial overestimation to the correct degree, in this case stage II of asbestosis. Appearing in the upper fields are structures that make it possible to conceive of the existence of fibrosis in this instance as well. The right to compensation was judged to validly exist, since reduction of employability had to be set at 50%.

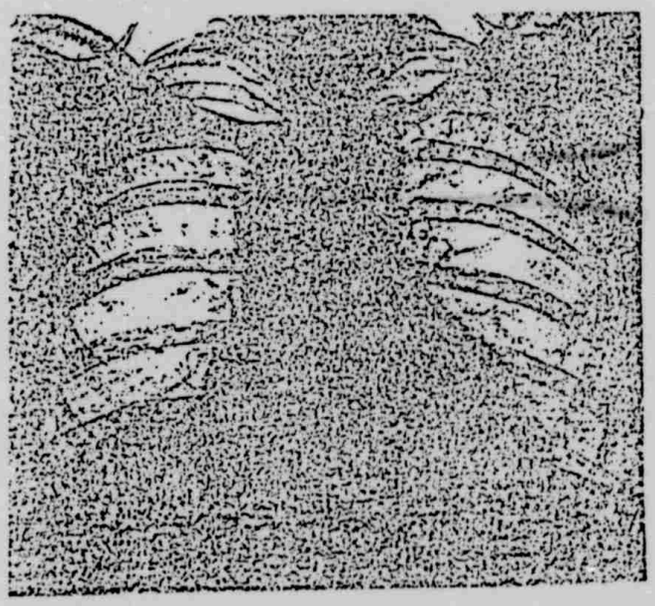


FIGURE 4b. The same female patient, X-rayed in prone position; only asbestosis II.

Very generally, it can be stated that normally in the prone position the diaphragm is higher, the heart and vascular band appear broader, the lower fields are brighter in contrast to their appearance in the standing position, and the upper fields usually appear darker. With asbestosis in women, in the standing position, indistinguishable or poorly distinguishable heart shadows may become more or less clearly distinguishable. A particularly developed layer of soft chest tissue in fat men can also play a role very similar to that of breast shadows in women, but this is relatively rare and thus the

evaluation of asbestotic pulmonary changes is generally much easier with men than in the case of women. Tense pectoral muscles in both sexes may have the same effect of breast shadows. In taking all X-rays, therefore, great care must be taken to see that the muscles of the shoulder girdle remain completely relaxes, which by no means always happens and is also difficult for some subjects, namely sick patients who must use a support to stand up straight. The combination of pulmonary changes with the breast muscles perhaps occasionally explains the difference in radiological data as to whether the middle or lower fields are preferably affected by asbestotic fibrosis. We must also consider the fact that certain combinations occur through the lateral parts of the thorax, since in this area, in proportion to lung diameter, larger stretches of soft tissue must be penetrated by the X-rays. We consider it likely that shadow combinations can also even facilitate visualization of an actual asbestotic fibrosis; thus occasionally with a change in position asbestotic changes seem to become visible in places where they were not evident before. In view of the possibilities of deception thoroughly discussed above, it would be well to exercise the greatest discretion in this respect. With proper caution and the absolutely necessary consideration of the preliminary case history, it would be rare that healthy lungs X-rayed with soft rays and a very sharply focused tube would be interpreted as being asbestotically altered. We must always bear in mind that the image of "normal" pulmonary marking is subject to great individual variations and that technical X-ray factors can also have a very great effect.

If for any reason there is no further opportunity to take one of the aforementioned supplementary X-rays of women with highly developed breasts, it will be necessary for the evaluation to examine those parts of the lungs in which deceptive shadow combinations play no role or only a slight one; precise determination of the degree of asbestosis can, of course, remain impossible.

In Figure 5 we are dealing with moderately developed breasts, which darken the lower fields, particularly on the side. The definitely [redacted] sufficiently well in the area of the middle fields, which appear to be altered like an extremely fine honeycomb. The X-ray is that of a 48-year-old female worker employed as a winder and spinner in an asbestos plant for approximately nine years, without expressing any notable subjective complaints. In the X-ray diagnosis, however, we had to identify this as form II.

With regard to early diagnosis, like some other researchers we have also referred to the fact that the initial changes may occasionally be observed in the form of fine striated shadows running transversally in the pleural recesses; very fine haziness and stippling is also observed in these places. As an illustration, in Figures 6a and 6b we show the pleural recesses in the X-ray of a 33-year-old woman who had worked in a dusty atmosphere as an asbestos spinner and carder for 11 years; nevertheless, only the first beginnings of asbestosis were observable; which may simultaneously be considered an indication of the significance of predisposition. The still relatively bright left diaphragmatic breast wall angle exhibits only slight cloudiness with some

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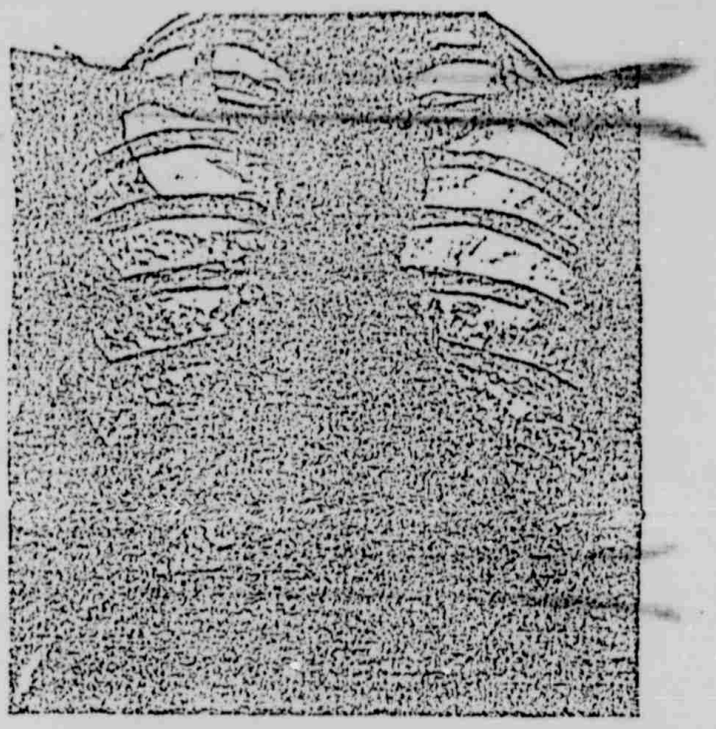


FIGURE 5. 48-year-old female asbestos worker with asbestosis II; the evaluation must be made in the middle fields not overlaid by the breasts.

irregular striated shadows and fine dots, whereas the right angle approximately resembles the picture of foggy mist.

As in the pleural recesses, the same changes are also observed in the heart-diaphragm angles; only here it is necessary to be quite cautious with the evaluation. The right heart-diaphragm angle is slightly cloudy in many patients; in addition to normal findings, slight callous formations may exist costo-mediastinally and interlobarly or there may be an accumulation of fat epicardially; as is well known, the "fat rump" at the apex of the heart is a very frequent finding on the left side. Care must be taken to note the extent of changes toward the side, their lateral boundary, and the internal structure of any haze and then the correct evaluation will generally be made.

There are still a few remarks to be made concerning the earliest time at which beginning asbestotic changes are observed in the X-ray. We

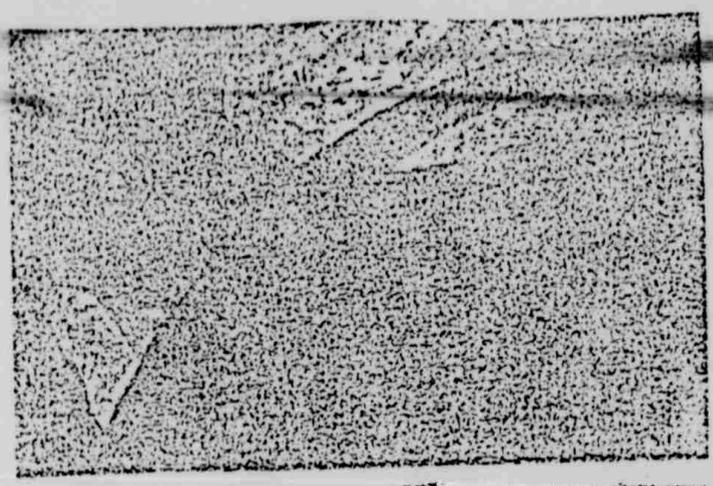


FIGURE 6a. Partial X-ray (right pleural recess) of a 33-year-old female asbestos spinner and carder. "Foggy mist picture."

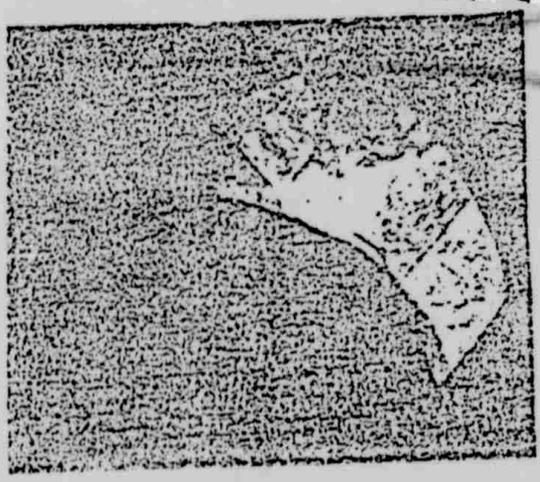


FIGURE 6b. Partial X-ray (left pleural recess); first beginnings of an asbestotic pulmonary change.

found it striking that in a number of cases after just 3-4-6 months a definitely enlarged, often shady and narrowly meshed pulmonary marking was discovered. We consider it unlikely from general pathogenic standpoints that this could already be a sign of actual fibrosis of tissue; we believe rather that this abnormal appearance of pulmonary marking is predominantly the result of vascular hyperemia or bronchitis. It is well known that subjective complaints are often made by workers in asbestos plants at the very beginning of the work and that a symptomless stage then follows, thus probably a stage of habituation,

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and only later, usually after several years, depending on dust exposure and personal predisposition, does pulmonary fibrosis occur. However, we did not clinically detect a regular occurrence of the aforementioned early changes in X-ray pulmonary marking and early catarrh; only continuous observations can clarify this matter. But we do not doubt that just a 9-10 month period of work in a dusty atmosphere under unfavorable conditions can lead to visible pulmonary fibrosis; we consider suspect cases with an even shorter work period too uncertain for interpretation; therefore, [illegible]scuss this more in detail at this point. We consider this viewpoint so important, however, that we would like to document it by an observation:

The 26-year-old female worker Kathe G. had worked as a winder for nine months in a dusty atmosphere; there had been no special complaints and the objective findings were insignificant. The X-ray (Fig. 7) showed a strikingly enlarged, shady, narrowly meshed, already somewhat delicately spotted pulmonary marking over the middle and lower fields, accentuated and intensified downward as a result of the combination with the shadows of the breasts. We wrote in the evaluation that the findings resembled mild asbestosis, but made no definite diagnosis; today we are convinced on the basis of increasing experience that mild asbestosis can be assumed with these pulmonary changes, which are already quite typical. In this case as well, the severity of the changes is exaggerated by the combination of shadows with those of the breasts.

As yet, we have not observed an acute form of asbestosis.

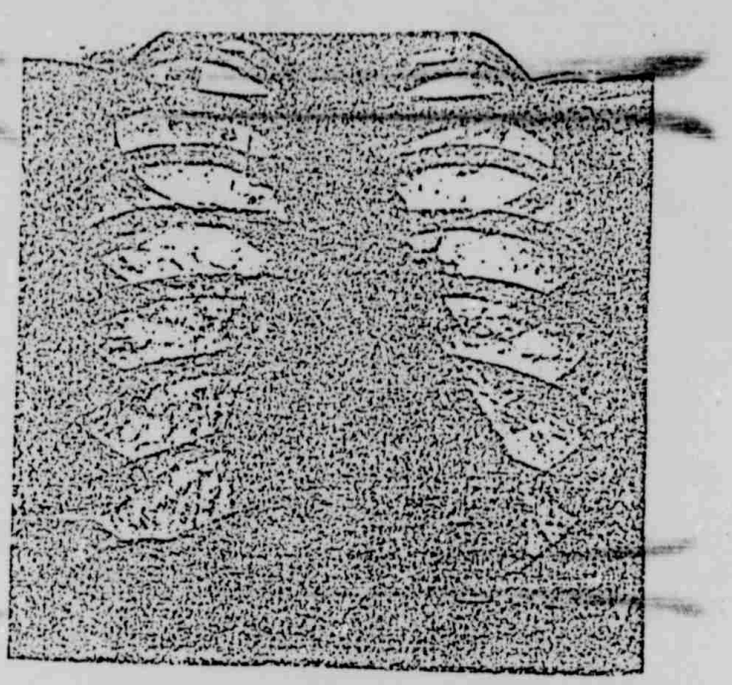


FIGURE 7. 26-year-old female winder; after 9 months of work, greatly enlarged, narrowly meshed, partially already delicately spotted marking in the area of the middle and lower fields; probably beginning asbestosis.

In our large new study series, we have also given careful consideration to whether fairly close correlations exist between asbestosis and tuberculosis; as before, such relationships could also not be established at the present time to any notable degree, which concurs with other German observations, but conflicts with the views of some foreign authors. As yet we have also not succeeded in discovering occupational cancer of the lungs in asbestos workers (Nordmann). Of course, this does not mean to say that we do not believe in such cancer. The vast majority of our subjects are far too young for such cancer to have been able to develop. All occupational cancers have a long latent period. Occupational invalids would particularly have to be examined and lung cancer with simultaneous asbestosis would have to be observed in hospitals during autopsies on patients who died.

The following observation is also worth noting: in the case of a 45-year-old man, formerly a construction worker and mechanic and who had worked for the last two years as an asbestos mixer in a highly dangerous atmosphere, we discovered an enormous emphysema of the right lower pulmonary field (Fig. 8). The remainder of the right lung could easily be atelectatic; however, there were also signs in both pulmonary fields indicating mild asbestosis. The man had no notable complaints whatsoever. We cannot answer the question of whether the emphysema was related to the work or to the mild asbestosis. But it should be pointed out that in severe cases of asbestosis increased x-ray permeability precisely over the lower pulmonary fields has also been observed.

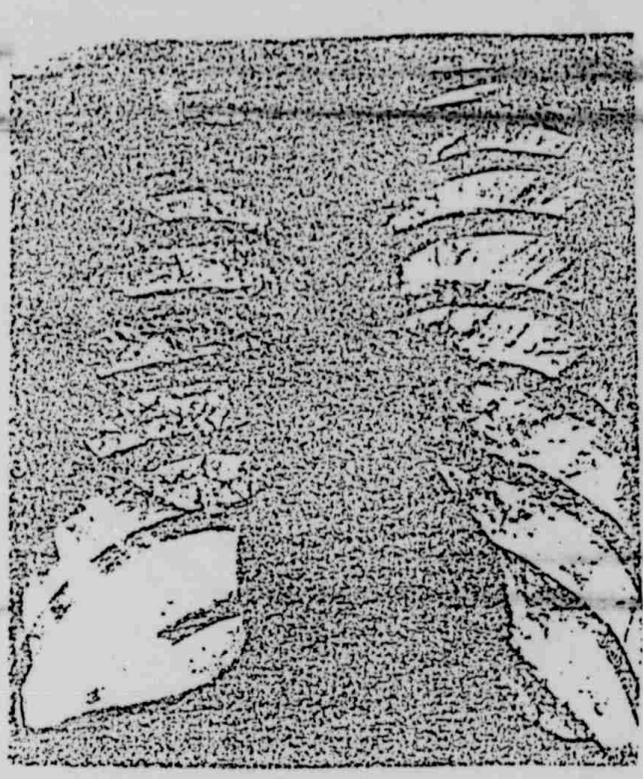


FIGURE 8. 45-year-old man, employed as an asbestos mixer for only two years; atypical, enormous emphysema of the right lower pulmonary field. Mild atelectasis of middle and upper sections of right lung? Also mild asbestosis (I-II?).

We reported earlier on the combination of asbestosis and silicosis and also mentioned that in relatively rare cases the radiological characteristics

of asbestosis can appear quite similar to silicosis. Figure 9 shows a 36-year-old man, formerly a postman and streetcar conductor, who then worked for 11 years in the carding section of an asbestos plant. He had complained of shortness of breath, coughing, and nocturnal perspiration. The X-ray showed a considerably enlarged, strikingly coarsely meshed, spotted pulmonary marking; fine stippling was observed in only a few spots. Without knowledge of the previous work history, silicosis would have been much more conceivable than asbestosis. In another observation, with continuous monitoring, strikingly coarse cord-like shadows developed in the left middle field in a case of asbestosis II, which can also be termed unusual.

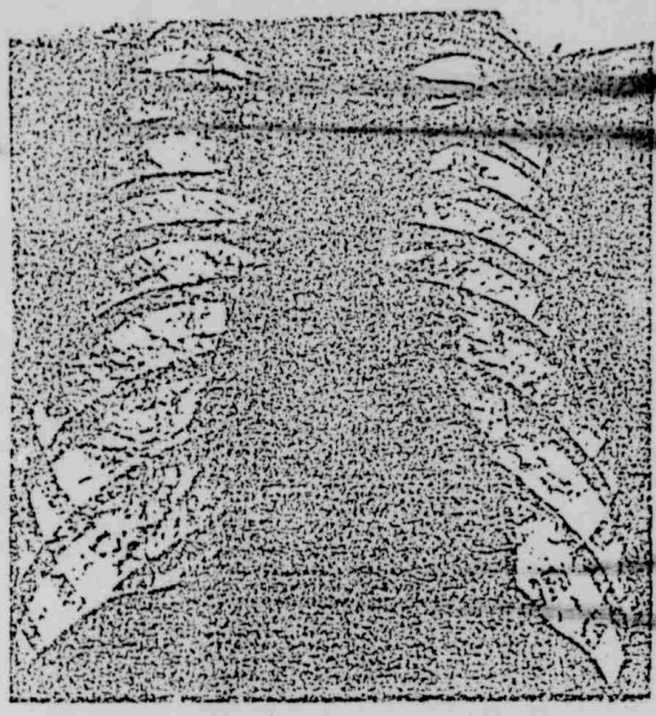


FIGURE 9. 36-year-old worker, employed as a carder in an asbestos plant for 11 years. The asbestotic structures of the pulmonary X-ray are coarser than usual and could be interpreted as silicosis with no knowledge of previous work history.

Figure 10 illustrates the fact that inversely silicosis can also appear quite similar to asbestosis. We have reproduced the left lower

field in the original size in order to illustrate the extremely fine focal shadows. However, some coarser spotted shadows can also be seen, leading to the diagnosis of silicosis. From a purely radiological standpoint, a combination of asbestosis and silicosis would have been conceivable. The man had never worked with asbestos. He was a miner and had operated a dry drill in slate, sandstone, and aggregate as a stone miner for approximately 25 years and had been disabled for seven years due to considerable difficulty in breathing.

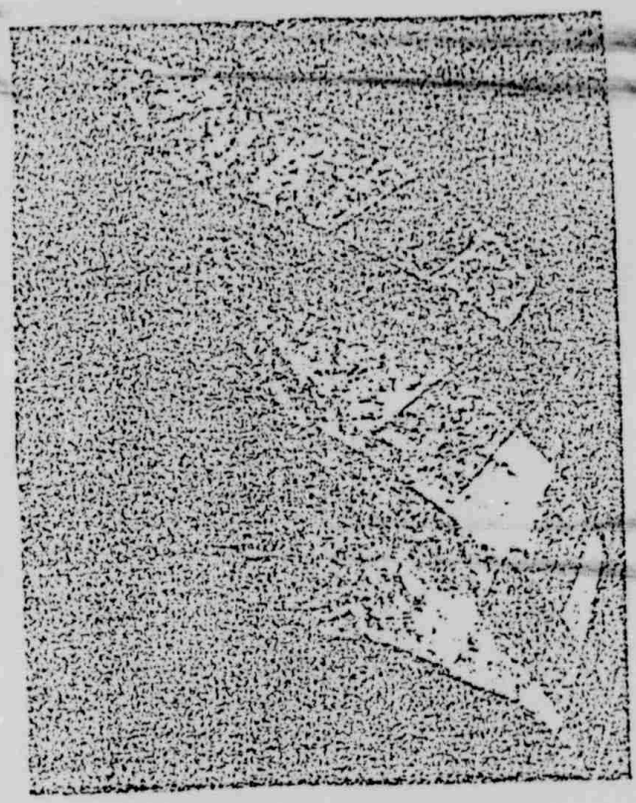


FIGURE 10. Silicosis. This X-ray picture is reminiscent of asbestosis in some places.

The importance of the preliminary case history is evident from this last case as from many other observations as well. Although the X-ray of asbestosis shows quite characteristic traits, errors can happen in a different way. Stressing the necessity of drawing on preliminary case or clinical data sounds extremely trivial, of course, but practice shows

again and again the urgency of this necessity. We have repeatedly emphasized the difficulty in distinguishing between asbestosis and pulmonary congestion.*

The respective publications have been thoroughly considered in my asbestosis atlas and could therefore be omitted in this essay.

SUMMARY

The author reports on a new study series that includes a group of 420 male and female workers from asbestos plants (including some cases referred for medical opinion). The characteristic traits of the pulmonary X-ray of asbestosis are illustrated by X-ray reproductions in their original size. Since in the case of women the combination of shadows with highly developed breasts hampers the evaluation to an exceptional degree, a chest teleradiograph in the prone position is recommended for dubious cases; a partial X-ray on a 15 x 40 film (transversal format) with the breasts raised can also serve the purpose. These technical aids show the actual extent of asbestotic pulmonary fibrosis, whereas their severity is slightly overestimated using the usual chest X-ray technique with women. The early signs of pulmonary asbestosis are discussed; the assumption is expressed that very early changes in the pulmonary marking are probably caused only by hyperemia and bronchitis and not by actual pulmonary fibrosis, corresponding to some degree to the initial subjective

*Wedler's monograph on the treatment of pulmonary asbestosis, published during the proofing, also could no longer be used.

complaints in the beginning of work in a dusty atmosphere, which disappear later as a result of habituation. After approximately 9-10 months, the first visual radiological signs of asbestotic fibrosis are considered possible in certain unfavorable cases. As yet, we have not observed an acute form. The combination of asbestosis with tuberculosis is also definitely infrequent on the basis of the new study data. As yet the author has not observed occupational cancer in asbestos workers; examinations of occupational invalids and autopsy cases would have to further clarify this matter. Some comments are made on distinguishing between asbestosis and silicosis. The statistical and industrial medicine evaluation of the study data will be made by others; the author considers here only radiological aspects of pulmonary asbestosis.

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