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The Frequency of Lung Cancer in German Asbestos Workers
by H. Bohlig and G. Jacob

Since the links between lung asbestosis and lung cancer have become known (Gloyne, Lynch and Smith), there were also in Germany, from 1938 on, observations of lung carcinoma with a simultaneous asbestosis (LKA)-lung cancer asbestosis-. (Nordmann, Lintbach, and Wedler, Welz, Boenke, Jacob and Bohlig). Since then, the LKA is assumed by the German literature to be the most frequent complication (Holstein) of asbestosis. In spite of this, till 1954, there were only 16 cases of malignant tumors in the chest cavity with a simultaneous asbestosis published for Germany (Jacob and Bohlig).

In 1956, a 5. LKA (man, 63 years old, asbestosis I, small-celled carcinoma on the right lower lung) was dissected in Dresden (Scheid, written notification 1956). A further LKA was observed by Bohme, Bochum, written notification 1957) and dissected by diBiasi, but was not published, so that from 1938 till 1956, 18 LKA were observed in Germany. This is not a large number for a time span of almost 20 years and an overall number of presently around 4000 German asbestos workers.

The frequent occurrence of the LKA which was assumed up to now, had been calculated solely from dissection statistics of the literature (Behrens). The statements vary from 12 to 17% (literature in Bohlig and Jacob). The most frequent occurrence is reported time and again from England (Doll). Cartier (Canada) observed in ten years eight lung cancers in asbestos workers, three of which did not have asbestosis. Only few cases were published in the U.S. In Italy, the first LKA was not published until 1955 (Rombola). Wegelias (copy almost illegible) and Noro did not observe any LKA among the asbestosis patients up to 1947 in Finland. Drost (?), George and Miller did not find any case up to 1956 among the Danish asbestosis patients; the same, there have been no reports so far about LKA's from the Soviet Union or South Africa. Therefore, the correctness of the frequency value of about 13% that was calculated from the dissection statistics has to be seriously doubted. Up to 1956, the world literature overall lists, together with Doll's cases and our own 5 LKA's approximately 80 cases (literature in Bohlig, Jacob, and Kallabis). This low number reinforces the opinion of the authors, that the statements about the frequency especially from the English dissection statistic, cannot be generalized, since the dissection material does not represent selection-free material.

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The chances for a person to develop lung cancer has risen in the last decades through the increase in frequency of the bronchial carcinoma; therefore, today a frequency of lung cancer of 12 in 10,000 living men has to be expected, or one in 10,000 living women respectively, per year, during the age in which carcinomas can be developed (Schinz, ill 1).

Comparative studies, which were done in 1954 with the help of the Dresden patients of 313 asbestosis cases, have shown that the number of the then known LKA's for the overall number of the asbestos dust risk cases does not present an increased danger of lung cancer in comparison to the frequency of lung tumors in the rest of the population. The conditions were somewhat different, though for the female asbestos workers. As far as the few data allow an opinion, the surmise has been uttered that the chances for a female asbestos worker to develop LKA are the same as they are for a man who has asbestosis.

This difference to the women in the overall population who is not exposed in a job-related way, as well as the more frequent attack of the lung lobes of the LKA, point in the direction of the opinion that there are real causal links between lung asbestosis and carcinoma (Jacob, Bohlig). Whether these causes are of physical or chemical nature, and in how far the patient's potential for carcinomas might be of relevance, cannot be stated at the present status of the knowledge about carcinoma genesis. It is a fact that the increased frequency of the LKA in female asbestos workers leads to the assumption that all people have generally an approximately even potential for carcinomas, which will probably rise parallel to the rising life expectancy of the population. Probably, the conditions of the environment are responsible for the localization of the carcinoma in this or that organ. The search among the patients in Dresden for other carcinomas points in the same direction: Up to 1954 there was only four other carcinomas found beside the LKA (Jacob and Bohlig). These results confirm Peller's interesting opinion about "inverse association."

In order to study the frequency of the LKA in asbestos workers, and in order to check our own results, the scope of the studied cases was enlarged till 1956. All cases of asbestosis were checked which were registered up to the end in 1956 with the silicosis Information Centers in Dresden, Jena, Zwickau (director Dr. G. Sepke). The overall number is 517 cases. The asbestosis patients come from the asbestos processing industries in Saxony and Thuringia of all in all 2000 workers. Thirty-four cases are since deceased, eleven were dissected which disclosed 5 LKA's. Twenty-nine cases have been missing since February 1945: since all of those cases are from Dresden, these cases, too, have to be presumed dead in all probability. The three cases of death which were quoted by Saupe and Normann are probably included in the number of the missing patients.

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If it is allowed to treat as the same - for reasons of comparison - a number of about 500 cases of asbestosis, which were observed during 20 years, and 10,000 living people of the normal population in one year, then the 500 asbestosis patients which were first studied at an age beyond fifty (Jacob and Bohlig), have to expect, according of the risk of the higher age groups as per Schinz, within the following 20 years, a rate of death from normal bronchial carcinoma in 6.3% of the cases - that means that the actual observed five LKA's were in fact still below the normal expectancy for lung cancer of the studied group of patients (ill. 1 and 2).

West German authors who were contacted in the question of the frequency of the LKA, confirmed that they did not encounter a special frequency of the LKA (Bohme, diBiasi, Worth). Which company physician, who takes care of the workers in any large company, would not be able to report about several cases of bronchial carcinomas among his workers?

In order not to overlook any LKA's among the former workers in the asbestos processing companies that were accessible to us within the German Democratic Republic, all bronchial carcinomas in the districts of Gera and Dresden were checked - with the kind assistance of the district manager - in the respective tumor treatment centers in all areas from which the workers of the asbestos processing industries in the German Democratic Republic come predominately. The mentioned tumor treatment centers listed since 1952, 1013 bronchial carcinomas, out of which 22 persons could be found that had once worked in the asbestos industry. The inquiry at the companies gave the result that only four cases represented a real dust exposure. Two out of these were dissected and were found free from asbestosis. For one further case we have a detailed series of x-rays, from which no x-ray indications for an asbestosis can be deducted. Due to the lack in documentation, the fourth case could neither be determined in that there was an asbestosis, nor could it be excluded, so that this case has to remain inconclusive. But even if this case had been a true LKA, it still could not be proven that LKA is an especially severe risk for the asbestos workers, or that it is the most frequent complication of the asbestosis.

In summary, the following can be said concerning the problem of the LKA: The frequency of the LKA is not above the frequency of lung cancer in the total population; the rate is the same for women as it is for male asbestos workers.

The pathology of the LKA shows a clear preference for the lower lung lobe as the part of the lung that is the most affected by asbestos changes (Wedler, Jacob, and Bohlig); the same, it seems that the more differentiated forms, and especially the serosa tumors, are somewhat more frequent than with the forms of lung cancer that are not job-related; the age of attack is for women, somewhat lower than it is for men (Bohlig, Jacob, and Kallabis). The genesis of the carcinoma is not determined yet, but the causal links between lung asbestosis and bronchial carcinoma have to be accepted as proven. A case that was published by Leicher of a peritoneal tumor with asbestosis points in the

direction of the opinion that mechanical characteristics do not exclusively lead to the formation of tumors.

Captions:

Illustration 1:
(caption illegible)

Lung Cancer, represented as cases per year among 10,000 living persons
number of LKA Cases, rounded upwards.

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Zum Schluß möchte ich noch einige vordruckungs-
technische Hinweise geben, die zur Zeit in Frankfurt
und der Vertriebsabteilung liegen. Durch die Freigabe

Es werden die Vermögensgegenstände und Verbindlichkeiten der abgewandten Abrechnungsperiode in den folgenden Perioden betrachtet, wie die Bilanz periodisch fortzuführen ist, um die Bilanz der nächsten Periode zu erstellen.

Die bisher eingetragenen zwölf Mitglieder der LK sind ausschließlich aus den Schichtarbeiter- und Arbeitervereinen (Berufsgewerkschaften) gewählt worden. Die ersten vier sind: 1. 72 und 57% (Arbeiter) 1. Punkt und 2. Punkt. Die dritte Person ist ein Arbeiter aus der Fabrik (Dübel) (Dübel), Carl K. hat in 11 Jahren 6 Langzeitarbeiter in der Fabrik, die in der Fabrik 3 bis 4 Jahre lang, in der 1924 bis 1925 bis 1926 bis 1927 bis 1928 bis 1929 bis 1930 bis 1931 bis 1932 bis 1933 bis 1934 bis 1935 bis 1936 bis 1937 bis 1938 bis 1939 bis 1940 bis 1941 bis 1942 bis 1943 bis 1944 bis 1945 bis 1946 bis 1947 bis 1948 bis 1949 bis 1950 bis 1951 bis 1952 bis 1953 bis 1954 bis 1955 bis 1956 bis 1957 bis 1958 bis 1959 bis 1960 bis 1961 bis 1962 bis 1963 bis 1964 bis 1965 bis 1966 bis 1967 bis 1968 bis 1969 bis 1970 bis 1971 bis 1972 bis 1973 bis 1974 bis 1975 bis 1976 bis 1977 bis 1978 bis 1979 bis 1980 bis 1981 bis 1982 bis 1983 bis 1984 bis 1985 bis 1986 bis 1987 bis 1988 bis 1989 bis 1990 bis 1991 bis 1992 bis 1993 bis 1994 bis 1995 bis 1996 bis 1997 bis 1998 bis 1999 bis 2000 bis 2001 bis 2002 bis 2003 bis 2004 bis 2005 bis 2006 bis 2007 bis 2008 bis 2009 bis 2010 bis 2011 bis 2012 bis 2013 bis 2014 bis 2015 bis 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INCIDENCE OF LUNG CANCER AMONG GERMAN ASBESTOS WORKERS

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Once the correlation between lung asbestosis and lung cancer was made known (Gloyne, Lynch and Smith), several cases of lung carcinoma in conjunction with asbestosis (LCA) have been observed in Germany since the year 1938 (Nordmann, Linzbach and Wedler, Welz, Boemke, Jacob and Bohlig). Since then LCA is mentioned in the German literature as one of the most frequently observed complications (Holstein) of asbestosis. Still, only 16 cases of malignant tumors of the thoracic cavity in conjunction with lung asbestosis were published in Germany prior to 1954 (Jacob and Bohlig).

In the city of Dresden in 1956, a fifth case of LCA (63-year-old male, asbestosis I, small cell carcinoma of right upper lung) came to us for autopsy (Scheid, written report 1956). One additional case of LCA was described by Bohme in Bochum (written report 1957) and autopsied but not published by di Biasi so that between the years 1938 and 1956, 18 cases of LCA were observed in Germany. This is a fairly small number if we consider that this was for a period of 20 years and for a total number of approximately 4000 German asbestos workers at that time.

The LCA incidence which is considered to be high is exclusively based on autopsy statistics obtained from the literature (Behrens). The figures quoted ranged between 12 and 17% (literature by Jacob and Bohlig). Still the highest incidence is reported in England (Doll). Over a period of 10 years, Cartier observed in Canada eight cases of lung cancer among asbestos workers, including three which were not accompanied by asbestosis. Few cases have been reported in the United States. The

first LCA case observed in Italy was published in 1955 (Rombola). Prior to the year 1947, Wegelius and Noro did not observe any cases of LCA among persons suffering from asbestosis in Finland; the same applies to Frost, Georg and Mzller in Denmark prior to 1956. No cases of LCA have been reported as yet by the Soviet Union and South Africa. Serious doubts therefore exist with regard to the 13% rate of incidence calculated based on the autopsy statistics available.

Including Doll's cases and our own five cases of LCA, approximately 80 cases were published in worldwide literature prior to 1956 (literature by Bohlig, Jacob and Kallabis). This low number adds strength to our opinion that the incidence quoted based primarily on English autopsies is not to be generalized since the autopsy material was not selected at random.

The chance of humans contracting lung cancer has considerably increased over the past decade due to the increased incidence of bronchial carcinoma and the incidence of lung cancer is now 12 out of 10,000 living males and more than one out of 10,000 living females per year at the carcinoma-prone age (Schinz, Fig. 1).

Comparative studies performed in 1954 based on the Dresden Hospital Records of 343 cases of asbestosis showed that the number of known LCA cases against the number of persons exposed to asbestos dust at that time did not indicate a higher lung cancer hazard as compared to the total number of lung tumors among the general population. For female asbestos workers, however, the proportions were different. As far as we can judge from the small quantity of data available, it would appear that the

chance for a female asbestos worker to contract LCA is as high as that of a male suffering from asbestosis.

This difference with females of the general population not occupationally exposed to asbestos and the irregular attack of the lung lower lobes with LCA clearly indicate that there have to be correlations between lung asbestosis and carcinoma (Jacob and Bohlig). Based on the current knowledge on carcinogenesis, it is as yet impossible to determine whether these are of a physical or chemical nature and just how significant is the role played by patients' predispositions to carcinoma. However, we do know that the increased incidence of LCA among asbestos workers does show that all humans more or less have the same predisposition to carcinoma and that this should increase in parallel with the life expectancy of the population. Environmental factors could be responsible for the localization of the carcinoma in this or that organ. The search for other types of carcinoma in the Dresden Hospital records show the following: In addition to the LCA cases, only four cases of carcinoma are reported prior to 1954 (Jacob and Bohlig). These results underline well the interesting observation made by Pellers with regard to the "inverse association."

To better study the incidence of LCA among asbestos workers and analyze our own results, the number of cases studied was expanded to include all cases up to the year 1956. All cases of asbestosis reported to the silicosis statistics bureaus of Dresden, Jena and Swickau (Director: Dr. G. Sepke) prior to the end of 1956 were thus studied. On the whole, this included 517 cases. The asbestosis cases originated from the Saxon and Thuringen asbestos industry with approximately 2000 workers. Thirty-

Lung Cancer
In cases per year/10,000 living persons

KEY: 1) expectancy among total population; 2) age classification, 50-79 years old; 3) mortality among German asbestos workers, 20 deaths over a period of 20 years; 4) around 4000 asbestos workers; 5) among 500 autopsied cases of asbestosis.

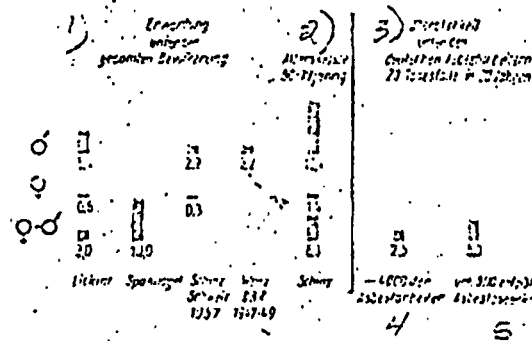
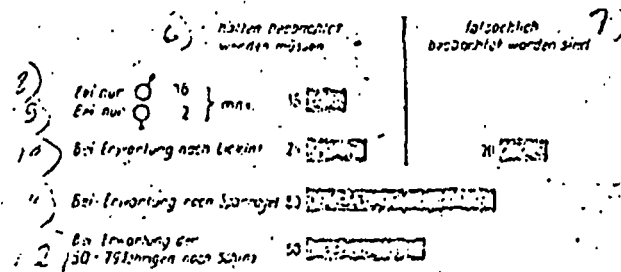


FIGURE 1.

Number of LCA cases rounded off as mentioned above.

FIGURE 2. Number of cases with lung cancer expectancy equal to that of the entire population over a period of 20 years (up to 1956) among approximately 4000 German asbestos workers.

KEY: 6) should have been observed; 7) were actually observed; 8) out of only...; 9) out of only...; 10) in accordance with Lickint's expectations; 11) in accordance with Spanagel's expectations; 12) in accordance with Schinz' expectations for 50-79-year-olds.



four-cases have already passed away; 11 were autopsied, including five LCA cases. Twenty-nine cases were missing as of February 1945; however,

since all of these originated from the Dresden region, we can assume that these very probably also passed away. The three cases observed by Saupe and autopsied by Nordmann could very well belong to the number of missing cases.

If for comparative purposes we equate the number of approximately 500 cases of asbestosis observed over a period of 20 years with 10,000 living persons of the normal population over a period of one year, we can see that the 500 asbestosis cases observed after age 50 (Jacob and Bohlig) as compared to the more endangered age classification according to Schinz, we can expect a mortality rate of 6.3 cases over a period of 20 years due to normal bronchial carcinoma; this means that the five LCA cases which were actually observed were still under the normal lung cancer expectancy of the persons examined (Figs. 1 and 2).

West German authors who were questioned with regard to the incidence of LCA have confirmed that, as far as they are concerned, there is no special incidence of LCA (Bohme, di Biasi, Worth). Now what work physician responsible for a number of workers in a fairly large plant has not reported a few cases of bronchial carcinoma among his workers?

So as not to overlook any cases of LCA among persons previously employed in the asbestos plants of the German Democratic Republic, all cases of bronchial carcinoma reported by the responsible tumor centers of all localities were studied with the collaboration of the authorities responsible for tumor control in the Gera and Dresden regions. These included mostly workers of the German Democratic Republic employed in

asbestos treatment plants. Out of 1013 cases of bronchial carcinoma reported to the tumor control stations since the year 1952, 22 were found to have worked in an asbestos plant at one time or another. Further research in other plants showed that only four cases had actually been exposed to the dust. Of these, two cases were autopsied and found to be free of asbestosis. In another case, a whole series of roentgenological images are available to show that there were no roentgenological signs of any asbestosis. In a fourth case which was further studied due to the lack of documentation, the presence of asbestosis could be neither confirmed nor denied so that this case remains questionable. However, were this an actual case of LCA, there would be no indication that said LCA in this asbestos worker would actually represent a severe danger or a frequent complication of asbestosis.

In conclusion, the following can be said with regard to the LCA problem: The incidence of LCA is not higher than that of lung cancer among the general population; as far as females are concerned, this incidence is equal to that of male asbestos workers.

The pathology of LCA shows that the point of origin definitely favors the lower lobe of the lung section most affected by asbestosis (Wedler, Jacob and Bohlig); there also seems to be more differentiated forms as well as serosa tumors with LCA than with lung cancer of non-occupational origin. Females appear to contract the disease at a somewhat lower age than males (Bohlig, Jacob and Kallabis). The carcinogenesis has not as yet been explained but we can consider the original correlation between lung asbestosis and bronchial carcinoma as a proven fact. One

case published by Leicher of a peritoneal tumor in a patient suffering from asbestosis tends to indicate that the mechanical momentum promoting the development of the tumor does not play an exclusive role.

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