Serial pulmonary function tests in patients with asbestosis

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Britton, M. G., Hughes, D. T. D., and Wever, A. M. J. (1977). Thorax, 32, 45–52. Serial pulmonary function tests in patients with asbestosis. Serial lung function tests were performed on 17 patients with asbestosis. A marked fall in the transfer factor often preceded any significant decline in the vital capacity. Changes in vital capacity and transfer factor did not appear to give any indication of the prognosis in these patients. Death was more commonly due to carcinoma of the lung than to the effects of the lung fibrosis.

The abnormalities of pulmonary function in patients with asbestosis have been well described (Williams and Hugh-Jones, 1960; Regan et al., 1971). In 1965 Bader et al. reported follow-up measurements on 13 asbestos workers using vital capacity, maximum breathing capacity, and blood gas measurements. They concluded that vital capacity was the most sensitive index of progression of the disease and correlated well with radiological changes and progression of dyspnoea in half the cases. However, reports of serial studies in patients with asbestosis are rare and we have been unable to find a study with serial measurements of transfer factor.

A retrospective study of 120 patients who had lung function tests at The London Hospital for possible asbestosis between 1960 and 1975 showed that, by 1975, 50 had proven asbestosis and nine had mesothelioma (Britton and Hughes, 1976). The 50 patients have produced a group of 17 in whom serial lung function tests were carried out over a 4- to 12-year period. The data from these patients have been studied to determine whether pulmonary function tests, especially the vital capacity and transfer factor, might be helpful in predicting the prognosis in cases of asbestosis.

Patients and methods

The 17 patients were in- or out-patients at The London Hospital and were referred to the Lung Function Laboratory for an assessment of pulmonary function. Each patient performed tests of peak flow rate, forced expiratory volume in one second (FEV₁), forced vital capacity (FVC), and Pco₂. The transfer factor was estimated twice by the single breath carbon monoxide method using a Resparameter and the mean result was recorded. The methods used in the laboratory for these tests have already been described (Hughes and Empey, 1972), and the predicted values were those of Cotes (1968).

All patients fulfilled the mandatory criteria for the diagnosis of asbestosis (Parkes, 1973) by the time of their most recent assessment. These are:

1. definite asbestos exposure;
2. bilateral basal crepitations;
3. radiological changes of diffuse interstitial fibrosis in the lower halves of the lung fields;
4. impairment of lung function.

Clubbing, pleural plaques, dyspnoea on effort, and the demonstration of asbestos bodies in the sputum provide corroborative evidence. In a few cases crepitations may be absent in the presence of early radiographic evidence of asbestosis.

The patients had tests on more than one occasion, and all of them had no further asbestos exposure after their first tests. Hence the changes shown in the serial tests represent the natural history of asbestosis rather than any changes from further exposure.

Results

The results for FEV₁, peak flow, and Pco₂ are not reported since the most significant changes were in FVC and transfer factor. In fact in no case
was the Pco₂ elevated while the FEV₁/FVC ratio was less than 70% in only two cases. Some relevant data concerning the 17 patients, including their smoking habits are shown for convenience in Table 1. All the patients had abnormal radiographs by the end of the study, and all except patients 8, 10, and 15 are known to have received a pneumoconiosis board pension.

INITIAL RESULTS
The results of the initial tests of the 17 patients expressed as a percentage of predicted values are shown in Table 2.

Assuming a normal value to be greater than 75% of predicted, the patients may be divided into the following groups:

1. three patients (3, 5, and 9) with normal values for both vital capacity and transfer factor;
2. eight patients (1, 4, 6, 7, 8, 10, 11, and 17) with a normal vital capacity but an impaired transfer factor;
3. one patient (12) with an abnormal vital capacity with a normal transfer factor;
4. five patients (2, 13, 14, 16, and 17) with impaired values of both.

SERIAL STUDIES
All the patients had lung function tests performed on a variable number of occasions (Table 1). The serial changes in each individual's vital capacity and transfer factor in absolute values are plotted either against the number of years before death in the seven patients who had died (Figs. 1 and 2) or against the date in years for those still living (Figs. 3 and 4).

In order to appreciate the interrelationship between vital capacity and transfer factor at various stages of the disease the serial tests of three patients, each a representative example of one of the three main groups, are illustrated:
- Group 1: Patient 9, Fig. 5
- Group 2: Patient 10, Fig. 6
- Group 4: Patient 17, Fig. 7

The percentages in parentheses on these graphs represent the percentage of predicted values at the time of the initial test.

Some comparisons have also been made between those patients who have died (1-7) and those patients who are still living (8-17). The changes in absolute values and percentage of predicted values for both vital capacity and transfer factor are shown in Table 2 Initial results of all patients with relationships to first exposure

<table>
<thead>
<tr>
<th>Patient</th>
<th>Time from first exposure to initial test (years)</th>
<th>Vital capacity as % of predicted</th>
<th>Transfer factor as % of predicted</th>
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<tr>
<td>1</td>
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factor are expressed as the average yearly fall. These results together with the average values of the last tests, which were all within one year either of death or the end of the study, are all shown in Table 3.

The serial results of one patient who died (5) are shown in Figure 8.

In all three patients in group 1 (with both vital capacity and transfer factor initially within the normal range) a marked fall in the transfer factor preceded any significant change in the vital capacity (Figs. 5 and 8). This is further supported by the eight patients of group 2 whose initial tests already showed an impaired transfer factor but a normal vital capacity.

After this initial fall in the transfer factor there appeared to be a steady decline in both vital capacity and transfer factor of equal proportions,
Fig. 3 Serial studies of vital capacity in living patients 8–17.

Fig. 4 Serial studies of transfer factor in living patients 8–17.
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Transfer factor

mmol min⁻¹ kPa⁻¹

Vital capacity

(00%)

[00%]

Fig. 5 Serial changes in transfer factor and vital capacity of patient 9 (the percentages in parentheses represent the percentage of predicted values at the time of the first test).

Transfer factor

ml min⁻¹ mmHg⁻¹

Vital capacity

(00%)

[00%]

Fig. 6 Serial changes in transfer factor and vital capacity of patient 10.
Fig. 7 Serial changes in transfer factor and vital capacity of patient 17.

Fig. 8 Serial changes in transfer factor and vital capacity of patient 5.
病人可能正在经历一个8-12年的持续过程。患者10（图6）显示了这些变化中的一些，这些变化在患者群体2中被看到。肺活量值在研究开始时确实下降，但预测值中只有50%；在患者群体13中，图7显示了患者17在临终时的肺活量为1.45升和一个转移因子为4毫米氧分压1 - 1 - 1（11.9毫升/分钟-1毫米汞柱），这两个测量值在一年内保持不变，作为一个例子。

胸部X光片中，第12号患者在成像时，显示了左胸区广泛的纤维化和钙化的斑块，这可能是由于两个隔膜。这可能解释了为什么在该转移因子之前肺活量下降。

讨论

虽然变化随不同的群体而变化，但对暴露于石棉90的群体而言，随着时间的推移，肺活量逐渐下降。这一变化是由于转移因子下降，这可能是由于患者年龄大于正常人。然而，肺活量下降的过程，可能与患者群体4中疾病在发展方向上相似。然而，没有在功能变化中作比较。

可能在三个主要群体的患者中，肺容差或肺容差的改变可以代表疾病过程在不同阶段的发展，可能意味着在患者群体4中疾病本身已经发展出来。然而，没有在功能改变中作比较。

文献


Regan, G. M., Tagg, B., Walford, J., and Thomson,


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