

# Pleural thickening and gas transfer in asbestosis

WOC COOKSON, AW MUSK, JJ GLANCY

*From the Departments of Respiratory Medicine and Diagnostic Radiology, Sir Charles Gairdner Hospital, Perth, Western Australia*

**ABSTRACT** Anomalies in the ratio of transfer factor to effective alveolar volume as an indicator of pulmonary gas exchange in cases of asbestosis may be related to diffuse pleural thickening. To examine the effect of pleural disease on gas transfer the plain chest radiographs of patients with asbestosis were assessed by two observers for profusion of parenchymal opacities and extent of pleural disease and the results were related to lung function. In 30 cases of category 1 profusion of parenchymal abnormality (according to the ILO international classification of radiographs for pneumoconiosis) transfer factor was independent of the degree of pleural thickening. The ratio of transfer factor to effective alveolar volume correlated directly with the degree of pleural thickening as alveolar volume fell with increasing severity of pleural disease. The results indicate that correcting transfer factor for alveolar volume does not provide an accurate reflection of severity of diffuse parenchymal fibrosis in patients with asbestosis and even minor pleural disease.

In the assessment of parenchymal lung function it is common practice to provide a measure of gas transfer per unit volume of lung by using the ratio of total transfer factor (TL) to effective alveolar volume (VA) (TL/VA, diffusion constant; transfer coefficient, KCO).<sup>1</sup> In asbestosis, however, this ratio may not be an adequate indicator of parenchymal function because of the frequent presence of pleural disease.<sup>2</sup> When pulmonary function in asbestosis has been examined without pleural disease being noted the diffusion constant has not always been reduced despite a low transfer factor.<sup>3</sup> Furthermore, the TL/VA ratio in cases of asbestos related gross pleural thickening may be raised or normal despite reduction in transfer factor.<sup>4,5</sup> This is thought to result from decreased expansion and loss of alveolar volume.<sup>4</sup> The effect of diffuse pleural thickening of lesser degree on this ratio has not previously been examined, but in the presence of parenchymal asbestosis it may be associated with reduced lung volumes, total transfer factor, and exercise tolerance.<sup>6</sup>

To determine the effect of diffuse pleural thickening on the TL/VA ratio in cases of asbestosis we examined the relationship between pleural thickening and both transfer factor and effective alveolar volume.

## Methods

We reviewed the records of men investigated for asbestosis in the department of pulmonary physiology at Sir Charles Gairdner Hospital. All had had a history of exposure to asbestos and radiographic changes of pneumoconiosis. Of the 102 patients seen since the department's inception in 1973, 91 had been exposed to crocidolite from mining in Wittenoom Gorge, Western Australia. Subjects were excluded from further study if they had had carcinoma of the lung or pleura, or if the chest radiograph showed a pleural effusion, pneumothorax, emphysema (either diffuse or bullous), progressive massive fibrosis, or only small rounded opacities (suggesting predominant silicosis rather than asbestosis, which is well recognised in the Wittenoom miners).

Standard posteroanterior chest radiographs, taken within six months of respiratory function testing, were graded by two observers according to the International Labour Office (ILO) classification of pneumoconiosis.<sup>7</sup> They were categorised into three groups according to the extent of pleural thickening: "marked" (maximum width at least 5 mm and bilateral extension of more than half of the projection of the lateral chest wall), "moderate" (maximum width less than 5 mm, bilateral, and greater than half the chest wall in extent), and "minimal" (lesser extent than the moderate group or no disease). Parenchymal changes were graded by comparison with standard films into the three major ILO

Address for reprint requests: Dr WOC Cookson, Department of Respiratory Medicine, Sir Charles Gairdner Hospital, Nedlands, Western Australia 6009.

Accepted 6 May 1983

*Pleural disease and pulmonary function (mean percentage of predicted values (SD)) in 30 cases of asbestosis with category 1 profusion (reader 1)*

	Pleural disease			<i>p</i> Marked v moderate	<i>p</i> Moderate v minimal
	Marked	Moderate	Minimal		
No of subjects	6	11	13		
Age (y)	54 (8)	51 (16)	52 (9)	NS	NS
Smoking (%)	71	83	100		
TL (% predicted)	78 (10)	81 (14)	70 (18)	NS	NS
VA	67 (10)	79 (10)	83 (10)	<0.05	NS
TL/VA	117 (11)	104 (14)	85 (19)	<0.05	<0.01
TLC	77 (9)	92 (18)	94 (13)	<0.05	NS
FEV <sub>1</sub>	73 (21)	85 (11)	79 (17)	NS	NS
FVC	73 (14)	87 (10)	85 (14)	NS	NS

The values for *p* are from least significant difference analysis. (Values from analysis of variance: effective alveolar volume (VA) *p* < 0.01; transfer factor (TL/VA) *p* < 0.01; total lung capacity (TLC) *p* < 0.05).

FEV<sub>1</sub>—forced expiratory volume in one second; FVC—forced vital capacity; NS—not significant.

categories. The films were seen without knowledge of the results of respiratory function tests.

Transfer factor for carbon monoxide (TL) was measured by the single breath method as modified by Ogilvie *et al.*,<sup>8</sup> a Resparameter Mark IV (PK Morgan) being used. Effective alveolar volume (VA) was estimated from dilution of helium during the measurement of TL. The forced expiratory volume in one second (FEV<sub>1</sub>) and the forced vital capacity (FVC) were obtained with a digital spirometer (Hewlett-Packard, Burlington, Massachusetts). Total lung capacity (TLC) was measured plethysmographically. Predicted normal values were from Cotes and Hall,<sup>9</sup> Cherniack and Raber,<sup>10</sup> and Goldman and Becklake.<sup>11</sup>

Pulmonary function in the cases with category 1 profusion of parenchymal opacities was analysed according to the degree of pleural change. Differences in total numbers reflect the different inclusion rates for the two readers.

For each index measured analysis of variance was used initially to determine whether a difference existed between the patients with the three grades of pleural thickening. If the *F* statistic indicated it, the significance of the difference between specific pairs of groups was examined by least significant difference analysis.<sup>12</sup>

## Results

When the cases of category 1 profusion of parenchymal opacities were divided according to the extent of pleural disease there were no differences in age or cigarette smoking between groups. TL was not altered by the severity of pleural disease (fig 1) but VA and TLC decreased with increasing grade of pleural thickening (fig 2). The ratio TL/VA was highest in patients with marked pleural disease and

fell with decreasing pleural thickening (fig 3). The FEV<sub>1</sub> did not differ between the various groups. The results for one of the readers are presented in the table. Although there was some difference in the distribution of cases between the different categories of pleural thickening, analysis of the results from the second reader yielded the same principal findings. The only major point of difference was that reader 2 found FVC to vary significantly with pleural thickening (marked or moderate versus minimal *p* < 0.05, analysis of variance *p* < 0.05).

## Discussion

The results show that in subjects with asbestosis and grade 1 profusion of small irregular opacities the TL/VA ratio correlates directly with the radiographic severity of pleural thickening. This is accounted for by the effect of pleural disease on lung volumes as measured by VA, TLC, and VC. TL was not affected by increasing extent of pleural thickening within this category of parenchymal asbestosis.

Our patients with "marked" pleural thickening resemble those with massive pleural thickening ("benign asbestos pleurisy"<sup>4</sup> and "lung en cuirasse"<sup>5</sup>), in whom the TL/VA ratio has previously been shown to be preserved or raised in the presence of reduced TL. Pleural thickening of the degree seen in our patients with "moderate" disease has not previously been shown to change TL/VA. This suggests that reports that TL/VA is not always reduced in cases of asbestos induced parenchymal fibrosis may be explained by unrecognised pleural disease.

As TL does not vary with the amount of pleural disease in patients with grade 1 profusion of parenchymal opacities, it appears that pleural disease of the range of severity seen in these subjects does not

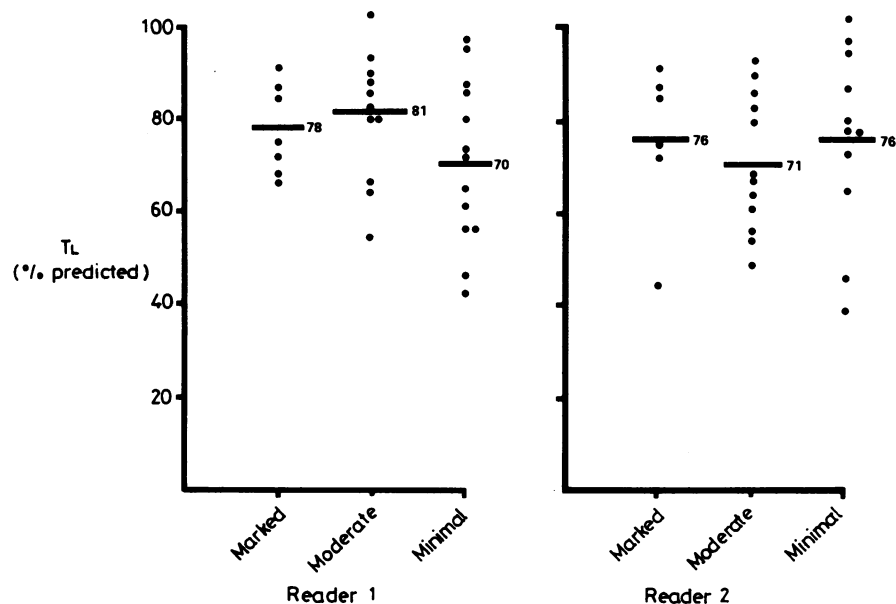


Fig 1 Transfer factor (TL)—category 1 profusion: subjects divided according to degree of pleural thickening. Horizontal bars show mean values.

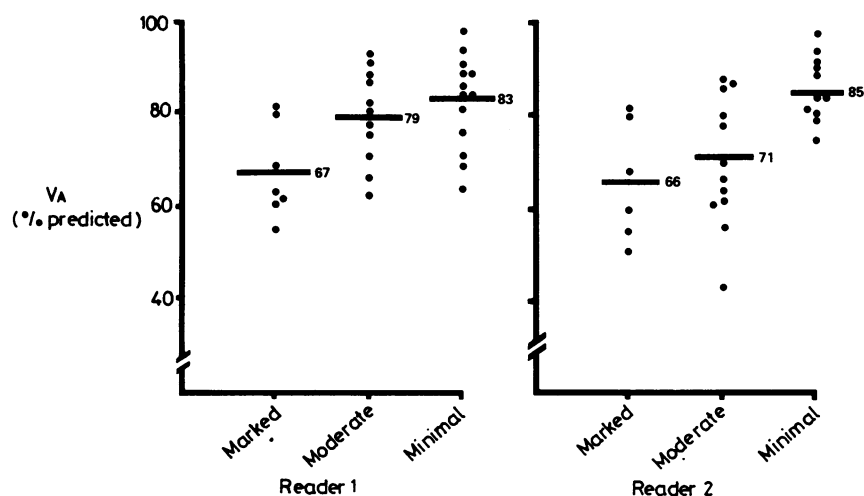


Fig 2 Effective alveolar volume (VA)—category 1 profusion. Horizontal bars show mean values.

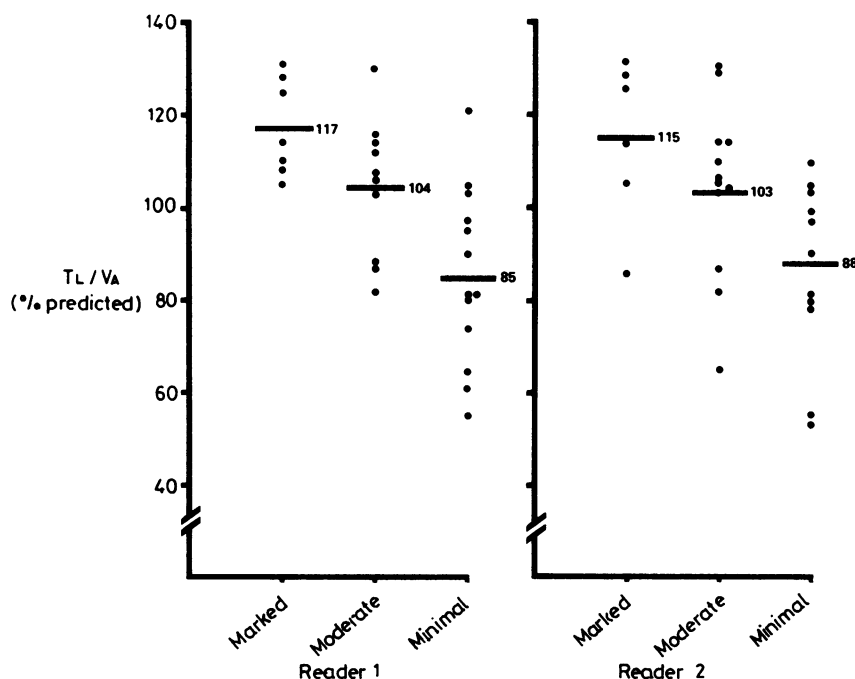


Fig 3 Transfer factor/effective alveolar volume ratio (TL/VA)—category 1 profusion. Horizontal bars show mean values.

per se affect total gas transfer, and that a reduced TL in patients with asbestos induced pleural disease suggests covert parenchymal asbestosis. This conclusion is at variance with reported observations on patients with benign asbestos pleurisy who were thought not to have parenchymal asbestosis.<sup>4,5</sup> TL/VA in these cases was raised<sup>4</sup> or normal<sup>5</sup> in the presence of a TL of about 70% and 58% respectively of the predicted levels. These reductions in transfer factor, however, are greater than might be expected from a simple reduction of alveolar volume,<sup>13</sup> and pathological investigation indicates that radiologically recognised pleural disease is consistently associated with some degree of parenchymal asbestosis.<sup>14</sup>

This study shows that if TL is to be standardised for VA in the interpretation of parenchymal function in asbestosis it is necessary to recognise apparently minor degrees of pleural thickening on the chest radiograph. Pleural thickening with grade 1 profusion of parenchymal opacities does not influence TL.

We wish to thank Dr G Ryan for his help with the manuscript and Mr B Murphy (Raine medical statistics unit, University of Western Australia) for his advice on the analysis of results.

## References

- <sup>1</sup> Davies NJH, Denison D. What does the transfer of carbon monoxide mean? *Br J Dis Chest* 1982;**76**:105–24.
- <sup>2</sup> Sheers G, Templeton AR. Effects of asbestos in dockyard workers. *Br Med J* 1968;iii:574–9.
- <sup>3</sup> Wright PH, Hanson A, Kreel L, Capel LH. Respiratory function changes after asbestos pleurisy. *Thorax* 1980;**35**:31–6.
- <sup>4</sup> Sterling GM, Herbert A. Lung en cuirasse: restrictive pleurisy associated with asbestos exposure. *Thorax* 1980;**35**:715.
- <sup>5</sup> Enterline PE, Weill H. Asbestosis in asbestos cement workers. In: Bogovski P, Gilson JC, Timbrell V, Wagner JC, eds. *Biological effects of asbestos*. Lyon: International Agency for Research on Cancer, 1973:179–83.
- <sup>6</sup> Lumley KPS. Physiological changes in asbestos pleural disease. In: Walton WH, McGovern B, eds. *Inhaled particles IV*. Oxford: Pergamon Press, 1977:781–8.
- <sup>7</sup> International Labour Office. *Guidelines for the use of ILO International Classification of Radiographs of Pneumoconiosis*. Geneva: International Labour Office, 1980. (Occupational Safety and Health Series, No 22.)
- <sup>8</sup> Ogilvie CM, Forster RE, Blakemore WS, Morton JW. A standardised breath holding technique for the clinical measurement of the diffusing capacity of the lung for carbon monoxide. *J Clin Invest* 1957;**36**:1–17.
- <sup>9</sup> Cotes JE, Hall AM. The transfer factor for the lung;

normal values in adults. In: Arcangeli P, ed. *Normal values for respiratory function in man*. Torino: Panminerva Medica, 1970:327-43.

<sup>10</sup> Cherniack RM, Raber MB. Normal standards for ventilatory function using a wedge spirometer. *Am Rev Respir Dis* 1972;**106**:38-46.

<sup>11</sup> Goldman HI, Becklake MR. Respiratory function tests. *Am Rev Tuberc Pulm Dis* 1959;**79**:457-67.

<sup>12</sup> Snedecor GW, Cochran WG. *Statistical methods*. Iowa:

Iowa State University Press, 1972:258-72.

<sup>13</sup> Rose GL, Cassidy SS, Johnson RL jun. Diffusing capacity at different lung volumes during breath holding and rebreathing. *J Appl Physiol* 1979;**47**:32-7.

<sup>14</sup> Hourihane DO'B, Lessof L, Richardson PC. Hyaline and calcified pleural plaques as an index of exposure to asbestos. A study of radiological and pathological features of 100 cases with a consideration of epidemiology. *Br Med J* 1966;i:1069-74.