THE INCIDENCE OF SIDEROSIS IN IRON TURNERS AND GRINDERS

BY

MONAMY BUCKELL, JESSIE GARRAD, M. H. JUPE,
A. I. G. McLAUGHLIN and KENNETH M. A. PERRY

From the Factory Department, Ministry of Labour and National Service, and the Department for Research in Industrial Medicine (Medical Research Council), The London Hospital

Doig and McLaughlin (1936) drew attention to the x-ray changes in the lungs of electric arc welders, and suggested that, amongst other possibilities, the iron oxide particles inhaled from the welding fume might be opaque to x-rays and produce the picture without the presence of pulmonary fibrosis, or congestion. They were unable to confirm this theory with necropsy material but Enzer and Sander (1938) produced proof of its validity by histological studies of the lungs of a welder whose x-ray chest film had shown similar changes. Since then the picture has been observed by many more workers, including Britten and Walsh (1940), Harrold, Meek and McCord (1940), Sander (1944) and Groh (1944). Pendergrass and Leopold (1945) recorded an account of four cases of siderosis or 'benign pneumokoniosis' occurring among 50 grinders of bearings made of chrome vanadium and chrome molybdenum tool steel containing 98 per cent. iron, about 2 per cent. alloy and not more than 0.2 per cent. silica. Artificial abrasive wheels composed of bakelite,

silicon carbide (carborundum) and aluminium oxide (aloxite) had been used exclusively in the works for the previous 17 years. The four workers who showed radiological changes had been employed for twelve, thirteen, fourteen and seventeen years respectively. The dust to which they were exposed had a concentration of 4.9 million particles per cubic foot of air. 96.5 per cent. were less than 5μ in size, and 99.5 per cent. less than 10μ . The average percentage of silica, as quartz, in the dust was 0.43. McLaughlin, Grout, Barrie and Harding (1945) further showed that a similar x-ray picture can be produced in workers using iron-oxide (rouge) to polish silver; one of the workers died and they showed that, after 40 years, there was no fibrosis present in his lungs. These authors reviewed the literature of siderosis which was first described by Zenker in 1866, but he used the term with the implication that iron and iron oxide dust causes fibrosis in the lungs. The industrial implications of the condition, however,

TABLE 1
DETAILS OF PROCESSES

Shop	Light machine Gallery	V.S.O.	No. 2 Turnery	No. 1 Turnery Grinding section	No. 1 Turnery Heavy bay
Type of machine	Turret lathes	Hydromatic milling machines	Centre lathes Turret lathes	Internal grinding	Planers, plano mills, borers, and milling machines
Metal	Cast iron	Mainly cast iron	Cast iron	Cast iron	Cast iron and steel
Speeds	37 to 312 r.p.m.	68 Spindle speed	Various	1,500 r.p.m.	Various
State of castings	Castings turned completely clean. In almost all cases fettled	Fettled before milling	Turned clean	Castings fettled or shotblasted	Fettled
Wet or dry ..	Dry	Dry	Dry	Operation completed with dust extractors	Cast iron—dry Steel—water
Other dusty processes ..	None	None	None	None	None

FIG. 1.—Male. Aged 43. Iron turner for 18½ years.

were not seriously considered in England until 1923, when Collis pointed out that skiagrams of the chests of haematite miners showed the presence of shadows suggestive of fibrosis of the lungs, though 'the opacity of oxide of iron to x-rays rather detracts from the significance of these findings.' Harding (1945) confirmed this by producing radiographic stippling or fine nodulation in the lungs of rats by intratracheal injection of rouge. No fibrosis was detectable in these lungs as a result of the presence of iron oxide for some eight months. The fact, however, that fibrosis is not produced does not justify the presence of large quantities of iron or iron oxide in the atmosphere, because it is unlikely that the lung can become a physiological dust trap and retain completely its elasticity and function.

In continuation of the work described above it

was thought desirable to study the radiological state of the lungs of men and women who had been exposed to dust in iron turneries. In the factory chosen for the investigation the work of turning and grinding cast iron was carried on in five shops. Details of the machines and turning speeds are given in Table 1. It will be seen that turret lathes, milling machines, centre lathes, planers and borers were used as well as grinding machines. The speeds of turning varied from 37 to 1500 revolutions per minute, turning at high speeds being much dustier than at low speeds. Before the castings came to the turning shops adherent sand had been removed by shotblasting and by fettling with pneumatic hammers. Some of the castings had been weathered and had a deposit of rust on them. The turning was done dry in the case of cast iron, but sometimes

turning of steel castings was done in these shops, and then liquid coolants were applied to the cutting tools of the machines. Grinding of cast iron by abrasive wheels was performed under exhaust ventilation. There were no other dusty processes in the shops.

A sample of dust obtained from a rafter above the 'Wider Top Cutter' had the following composition:

	Per cent.
Combustible matter (carbon, oil, bits of fibre)	12.2
Total silica	5.4
Silicate residue	1.3
Metallic iron	37.1
Iron oxide (calculated as Fe_2O_3)	23.3
HCl. soluble matter other than iron	20.7
	100

It is realised that rafter dust does not necessarily

represent the dust inhaled by the workers, but it gives a good indication of the type of dust present in the general atmosphere of the shop.

There were employed in the turneries 50 women and 161 men, of whom 33 women and 138 men volunteered to be x-rayed. Their ages were noted, as well as the length of time they had worked in turneries. The radiographs were studied and occupational histories were obtained from all those who showed any abnormality, in order to be certain that they had not had previous employment in a dusty occupation. They were also asked if they had had any symptoms such as shortness of breath, cough or wheeze.

In no instance, was nodulation seen in the x-ray films, and for the purpose of this report the cases showing reticulation were only regarded as abnormal if the changes were agreed to by three of us (M. H. J.,

FIG. 2.—Male. Aged 53. Iron turner for 30 years.

FIG. 3.—Male. Aged 46. Iron turner 29 years. Contact print of right lower lobe.

A. I. G. McL., and K. M. A. P.) studying the radiographs independently. The reticulation found was never gross, and was of a peculiar, fine character, the 'stippling' or individual components of the reticulation being so fine and so closely sown as to produce a ground glass appearance such as is seen in cases of asbestosis. In what may be called early cases of siderosis the ground glass effect appears first in the lower lung fields, possibly because iron dust is heavy (figs. 1, 2, and 3). The changes were present in 15 cases; the highest incidence was among workers who had performed this work for more than 20 years—5 out of 34. It will be seen (Table 3) that the changes began to appear in the x-ray films in workers who had been exposed to the inhalation of the dust for six to ten years, but that none of the seven workers who had worked in the turneries for 11 to 15 years, and only one out of 11 of those who had worked for 16 to 20 years showed the changes. The reason for this is obscure, though individual variations in dust-eliminating mechanism of the lung may partly account for the discrepancy. The incidence by age (Table 2) was 5 out of 44 in the thirties, 5 out of 40 in the forties, and 4 out of 23 in the fifties. One man had previously been exposed to silicosis risk; for six years before starting work in the turnery, he had been a fettler in an iron foundry. There were no positive cases in the 15 men over 60 years of age. In the interpretation of the chest films of elderly people it is

necessary to remember that changes are often present in normal individuals due to chronic bronchitis and the degenerate process of ageing, and it is possible an over conservative interpretation was made in this group. It is probable, therefore, that the changes are caused by the iron dust inhaled at work, and they are clearly not primarily related to age, but rather to length of exposure. No symptoms appeared to be related to the changes; of the 15 men only one complained of shortness of breath, and none of wheeze, though six complained of cough. The cough could not necessarily be attributed to the dust; the symptom is extremely common in the middle-aged male population; it may equally well be attributed to the present-day heavy consumption of tobacco. None of the women, all of whom were young, and none of whom had been working in the factory longer than five years, showed abnormal x-ray changes. The full details are given in Table 2 by ages, and Table 3 by length of exposure.

In a few cases x-ray evidence of other diseases in the lung was found. Arrested pulmonary tuberculosis was found in five cases, but in no instance was there any clinical evidence to suggest recent activity, and no active cases were observed. Emphysema was present in 8 cases, one of which showed a large bulla at the left apex.

Differential diagnosis of the various types of dust disease is not possible on x-ray evidence alone. The radiologist cannot distinguish between

TABLE 2

INCIDENCE OF SIDEROSIS, DISTRIBUTION BY AGE

FEMALES

Turnery	No. of workers	Age				
		29 and under	30-39	40-49	50-59	60 and over
No. 1	17	14	3	—	—	—
No. 2	16	15	1	—	—	—
Total ..	33	29	4	—	—	—

MALES

No. 1	44	8	15 (1)*	13 (2)	5	3
No. 2	94	12 (1)	25 (4)	27 (3)	18 (4)	12
Total ..	138	20 (1)	40 (5)	40 (5)	23 (4)	15
Combined Total ..	171	49 (1)	44 (5)	40 (5)	23 (4)	15

* Previously fettling iron castings for six years.

Figures in brackets indicate number showing x-ray reticulation.

TABLE 3

INCIDENCE OF SIDEROSIS, DISTRIBUTION BY LENGTH OF EXPOSURE

FEMALES

Turnery	No. of workers	Length of exposure in years					
		Under 2	3-5	6-10	11-15	16-20	Over 20
No. 1	17	17	—	—	—	—	—
No. 2	16	13	3	—	—	—	—
Total ..	33	30	3	—	—	—	—

MALES

No. 1	44	—	16	14 (1)*	4	2	8 (2)
No. 2	94	3	23 (3)	30 (5)	3	9 (1)	26 (3)
Total ..	138	3	39 (3)	44 (6)	7	11 (1)	34 (5)
Combined Total ..	171	33	42 (3)	44 (6)	7	11 (1)	34 (5)

* Previously fettling iron castings for six years.

Figures in brackets indicate number showing x-ray reticulation.

the x-ray nodulation associated with the fibrosis produced by silica and that caused by opaque substances such as iron oxide or barium (Arrigoni

1933; Pendergrass 1938; Preti and Talini 1939). The symptoms produced by siderosis are negligible, whereas the shortness of breath caused by silicosis may be disabling. It is important, therefore, to differentiate between the two conditions, and this can only be done by means of a detailed occupational history and a first-hand knowledge of the environmental conditions to which the worker is exposed.

Summary

One hundred and seventy-one individuals (33 female, 138 male) exposed to iron dust in iron turneries were radiographed in order to gauge the incidence of changes in their lungs due to iron oxide. These changes, in the form of reticulation, were present in 15 instances. In 5 cases the man had been working in this occupation for more than 20 years. The changes were not gross, symptoms were few, only one complaining of shortness of breath though six said they had some cough.

The dust obtained from rafter samples contained 37.1 per cent. metallic iron, 23.3 per cent. iron oxide, while the total silica content was 5.4 per cent. and the silicate residue 1.3 per cent.

Acknowledgments

We are indebted to Messrs. Ruston and Hornsby for allowing us to carry out the investigation in their works, and to Miss Barbara Sharpley, and Miss A. A. A. Crosthwaite, H.M. Inspector of Factories for their helpful collaboration. To Mr. H. T. Ferrier and Mr. J. MacLagan our thanks are due for the high standard of radiography.

REFERENCES

- Arrigoni, A. (1933). *Med. et Lavoro*, 24, 461.
 Britten, J. A., Walsh, E. L. (1940). *J. industr. Hyg.*, 22, 125.
 Collis, E. L. (1923). *Proc. roy. Soc. Med.*, 16, 85.
 Doig, A. T., McLaughlin, A. I. G. (1936). *Lancet*, 1, 771.
 Enzer, N., Sander, O. A. (1938). *J. industr. Hyg.*, 20, 333.
 Groh, J. A. (1944). *Industr. Med.*, 13, 598.
 Harding, H. E. (1945). *Brit. J. Industr. Med.*, 2, 32.
 Harrold, G. C., Meek, S. F., McCord, C. P. (1940). *J. industr. Hyg.*, 22, 347.
 McLaughlin, A. I. G., Grout, J. L. A., Barrie, H. J., Harding, H. E. (1945). *Lancet*, 1, 337.
 Pendergrass, E. P. (1938). *Lanza's Silicosis and Asbestosis*. London p. 137.
 Pendergrass, E. P., and Leopold, S. S. (1945). *J. amer. Med. Ass.*, 127, 701.
 Preti, L., Talini, P. C. (1939). *Ber. 1938 int. Kongr. Unfallmed. Berufskrankh.*, vol. II, p. 963.
 Zenker, F. A. (1866). *Dtsch. Arch. klin. Med.*, 2, 116.