THE EFFECT OF THE USE OF CALCINED ALUMINA IN CHINA BISCUIT PLACING ON THE HEALTH OF THE WORKMAN

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The serious morbidity and mortality from silicosis among china biscuit-ware placers and oddmen and china biscuit warehouse workers, when flint was the placing medium for the biscuit firing, have been fully recorded by Arlidge (1892), Sutherland and Bryson (1926), Middleton (1936), and Meiklejohn (1947 and 1949). So alarming was the hazard that ceramic chemists and practical potters urgently strove to discover a safe placing medium, which could be used as a substitute for flint. About 1929 (Plant, 1939) laboratory researches and practical trials proved that calcined alumina (corundum) could be used satisfactorily in the manufacture of fine china. Later, following a carefully planned survey (Industrial Pulmonary Diseases Committee, 1936) among a group of furnacemen engaged in the manufacture of alumina, Sutherland, Meiklejohn, and Price (1937) concluded that "there was no evidence of pneumoconiosis or of any other form of pulmonary disease arising from the considerable dust to which these workmen were exposed". Assured by the practical and medical evidence, china manufacturers in increasing numbers adopted alumina as a medium for biscuit placing. Meiklejohn and Jones (1948) carried out a survey among china biscuit ware workers in North Staffordshire and reviewed the furnacemen who had been examined in the inquiry 10 years previously. They reaffirmed that alumina (corundum) as used in the pottery industry had no adverse effect on the health of workmen. Finality was reached when, under the Pottery (Health) Special Regulations, 1947, the Minister of Labour and National Service prohibited the use of powdered flint or quartz with or without the addition of other materials in the placing of ware for the biscuit fire. These regulations became effective on January 7, 1948. Between 1952 and 1954 the Mass Radiography Service at Stoke-on-Trent radiographed (35 mm. film) 248 out of ap-

proximately 280 china biscuit placers and oddmen. The results accorded with previous reports: all cases of pneumoconiosis which were detected had worked in flint for varying periods or had been exposed to other forms of siliceous dust.

Then in 1955 King, Harrison, Mohanty, and Nagelschmidt reported the results of laboratory experiments, which they had conducted on the effect of alumina, aluminium phosphate, and corundum stack fume on the lungs of rats. They concluded that certain forms of alumina, particularly hydrated alumina, can produce fibrosis of the lungs nearly as severe as can be produced by quartz. They emphasized, however, that the doses of dust used in these animal experiments vastly exceeded those used in the prophylaxis of human silicosis. Commenting on these findings Middleton (1955) wrote: "the results of the present experiments are disturbing and a reassessment of the dust exposure and control in the china branch of the pottery industry appears to be indicated."

Present Investigation

The Mass Radiography Service at Stoke-on-Trent immediately arranged to conduct an enquiry at the china factories in north Staffordshire. China manufacturers in the area were asked to provide lists of all biscuit placers and oddmen in their employment, who started work after the change-over from flint to alumina and who, in addition, had no other history of exposure to dust in any other industry or process. Forty-one firms among 43 firms cooperated: the exceptions were two small firms employing only a few workmen. Twelve firms stated that none of their workmen fulfilled the requirements of the investigation. The remaining 29 firms (Table 1) provided data of 117 men of whom 99 attended for x-ray examination. The response

TABLE 1

YEAR OF CHANGE-OVER FROM FLINT TO ALUMINA FOR PLACING IN 29 CHINA FACTORIES IN STOKE-ON-TRENT

Year of Change-Over	Number of Firms
1930-1934	2
1935-1939	18
1940-1944	9

(84.6%), though not ideal, may be regarded as fairly satisfactory.

One of us (E.P.) interviewed each workman and, in addition to clinical facts, recorded his employment history in detail. It emerged that employers in making returns had not restricted themselves to alumina workers but had included some men who had worked with flint or had been exposed to harmful dust in other industries and processes. This notwithstanding, all the 99 workmen, who attended, had radiographs taken on full-sized film (17 in. × 14 in.). The films of the workmen with "mixed exposure" proved to be useful in avoiding bias in the reading of the radiographs, which was made without knowledge of the employment history.

Interpretation of Films

A. Meiklejohn read the films in Glasgow on three separate occasions at intervals of several days and E. Posner read them twice at Stoke-on-Trent. Two films were rejected as technically unsatisfactory; the remaining 97 (Table 2) were reported on according to the classification of the Pneumoconiosis Research Unit, Cardiff (Fletcher, Mann, Davies, Cochrane, Gilson, and Hugh-Jones, 1949; Fletcher, 1955). Table 2 gives the numbers of these cases exposed to different dusts. Both observers were in complete

TABLE 2

EXPOSURE TO DUST OF 97 CHINA BISCUIT PLACERS AND ODDMEN RADIOGRAPHED IN 1956

Alumina only	40
Flint and alumina	15
Ex-coal-miners	19
Ex-earthenware workers and tile workers	23
Total	97

agreement except in four cases. In one case they disagreed on whether or not the radiographic changes amounted to category 1, simple pneumoconiosis. In the other three—all simple pneumoconiosis—they differed by one category. These four films were submitted to A. L. Cochrane and W. E. Miall of the Pneumoconiosis Research Unit for decision.

Pneumoconiosis Present

Pneumoconiosis was diagnosed in 10 cases (Table 3). All 10 had been exposed not only to alumina dust but to other dusts known to cause pneumoconiosis. Four men had been exposed to flint dust as china biscuit placers before the change-over to alumina. In one of these (Case 9) the period of exposure to flint was very short—four years—but this is not inconsistent with category 3 simple pneumoconiosis, especially after the lapse of many years.

Pneumoconiosis Absent

Eighty-seven men showed no radiographic evidence of pneumoconiosis. Indeed a noteworthy feature was the large number of films which could unhesitatingly be read as normal. Calcified tuberculous foci, usually in the hila, were present in

TABLE 3

OCCUPATIONAL HISTORY AND RADIOLOGICAL CATEGORY OF CHINA BISCUIT PLACERS AND ODDMEN (10 CASES) WITH PNEUMOCONIOSIS

Case	Age (years)	Exposure to Alumina (years)	Exposure to Flint (years)	Coal-mining (years)	Other Exposure in Pottery Industry (years)	Occupations without Dust Risk (H.M. Forces, Labourers, etc.) (years)	Radiological Category*
1	48	9	—	10	—	15	1/-
2	55	6	—	24	—	10	2/-
3	67	16	18	—	—	18	2B
4	42	10	—	—	10	7	1/-
5	47	16	—	—	16	—	1/-
6	49	12	15	—	—	—	2B
7	55	4	—	33	—	2	2/-
8	56	6	—	25	—	5	1/-
9	52	16	4	—	6	12	3/-
10	58	15	20	—	(China dipper)	6	2/-

* The Pneumoconiosis Research Unit classification of the radiographic shadows in pneumoconiosis is based on the size, distribution, and profusion of the opacities throughout the lung fields. Two major classes of film are recognized: (1) Pneumoconiosis with discrete opacities, 0.5 to 5.0 millimetres in diameter; simple pneumoconiosis; (2) pneumoconiosis with coalescent or massive shadows; complicated pneumoconiosis.

In simple pneumoconiosis there are three categories of increasing abnormality denoted numerically 1, 2, and 3. There is a further

miscellaneous group referred to by the letter X. In complicated pneumoconiosis larger shadows are superimposed on a background of simple pneumoconiosis. Four categories of increasing abnormality are identified by the capital letters A, B, C, and D. For convenience of recording a system of notation has been devised. From left to right the code in its simplest form represents category of simple pneumoconiosis/category of complicated pneumoconiosis/for example, 1/-; 2B (Fletcher *et al.*, 1949; Fletcher, 1955).

several cases but there was not a single case of active pulmonary tuberculosis.

Supplementary Enquiries

In addition to the foregoing radiological survey several other sources of information were investigated. Dr. W. W. Jones, senior medical officer of the Pneumoconiosis Medical Panel, Stoke-on-Trent, was asked about his experience of the problem since 1944. He reported that the Panel had not observed pneumoconiosis in any china worker who had been exclusively employed in alumina. Dr. R. Lockhart, medical officer of the North British Aluminium Company, Ltd., kindly followed up the furnacemen examined in the 1936 inquiry at Kinlochleven (Sutherland *et al.*, 1937). No evidence of pneumoconiosis had been noted among these workmen and several of them had been employed in the manufacture of alumina for nearly 40 years. Confirmation of this was obtained from Dr. J. Black, senior medical officer, Pneumoconiosis Medical Panels for Scotland, who stated that no case of pneumoconiosis in alumina workers had come to the notice of the Panels.

Meanwhile in a personal communication (Jan., 1957) E. J. King wrote:

"You may be interested to know that we have since [that is, following the article cited above—A. M.] done some work which seems to indicate that heating alumina at a high temperature to dehydrate it thoroughly greatly reduces its fibrogenicity. This work is in process of being written up. It would seem probable that alumina used in potteries is thoroughly dehydrated [1,300° C. is minimum temperature aimed at in pottery ovens for china—A. M.], and so might be expected not to be nearly as fibrogenic as the Gardner alumina (XH 1010), which we used."

H.M. Inspector of Factories at Stoke-on-Trent, in reply to an enquiry, stated that no dust counts in china biscuit placing shops had been made in recent years. Some, however, are likely to be included in the Health Survey which is in progress for the Industrial Health Advisory Committee of the Ministry of Labour and National Service.

In 1948 Meiklejohn and Jones (*loc. cit.*) recorded that the conditions of work with alumina, including intensity of dust cloud and particle size under 2 microns, were not materially different from those which had existed when flint was used; in fact the workmen then stated that alumina tended to "fly", thereby producing a dustier atmosphere than flint.

Discussion and Summary

The substitution of alumina for flint for china biscuit placing in the pottery industry in Great Britain has been regarded as one of the major

achievements in the prevention of silicosis. Indeed Plant (1939), a leading china manufacturer and humanitarian, described 1937 as the "annus mirabilis". That alumina might cause pneumoconiosis or other disease was not overlooked but careful investigations seemed to give the assurance that it could reasonably be regarded as safe. Since alumina came into general use a critical watch has been maintained for danger signs. None was observed until King and others' (1955) experimental findings and Middleton's (1955) comment came as a challenge which could not be ignored. In presenting the results of our subsequent investigations we recognize that the data are neither statistically nor scientifically adequate to enable us to state categorically that alumina, as used in china manufacture, is entirely free from risk. Judged comprehensively, however, the evidence from the various sources is reassuring.

During the next few years the critical period of exposure—20 years (Table 4)—will be reached. The problem will be kept under vigilant observation.

TABLE 4
TIME WORKED WITH ALUMINA OF 87 CHINA BISCUIT PLACERS AND ODDMEN WITHOUT RADIOLOGICAL EVIDENCE OF PNEUMOCONIOSIS

Time Worked with Alumina (Years)	Number of Workmen
< 5	7
5-9	37
10-14	29
>15*	14
Total	87

* Maximum period 18 years.

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