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SURVEILLANCE OF HIGH-RISK GROUPS—A SURVEY OF ASBESTOS WORKERS: THE PRESENT POSITION IN THE UNITED KINGDOM

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The first study of a group of workers at high risk from asbestos exposure was that of Merewether and Price in 1929.[1] Their report recommended "the control of the disease by periodic medical examinations of the workers by which those unfitted by health reasons are prevented from entering the industry, and cases of fibrosis and pulmonary tuberculosis are detected at the earliest possible moment. The ultimate and only reliable test of the effectiveness of the preventive measures adopted by the industry will be found in the statistics derived from the records of periodic medical examinations of the workers. . . ."

A scheme for initial and periodic medical examinations was proposed soon thereafter.[2] At that time, workers at high risk were considered to be in special occupations designated as "scheduled areas." These areas were defined as: "breaking, crushing, disintegrating, opening or grinding of asbestos and the mixing or sieving of asbestos, or any mixture of asbestos and all processes involving manipulation of asbestos or incidental thereto; all processes in the manufacture of asbestos textiles including preparatory and finishing processes; the making of mattresses composed wholly or partly of asbestos and processes incidental thereto."

Persons in such employment were medically examined initially before the end of the second month of employment, and periodically thereafter every two years, or as directed by the Pneumoconiosis Board. The latter is a governmental statutory body of medical experts in pneumoconiosis, responsible for confirming diagnosis and assessing disability. The members of this group form a "Panel" of experts who are responsible for initial and periodic medical examinations, performed either in industrial locations or in regional offices. The original arrangements given legal force in 1931 were updated in 1957.[3] These regulations still apply.

Although the definition of "scheduled areas" has been more widely interpreted as the years have passed, there were many workers in the asbestos industry who escaped the net. As I pointed out at a conference of The New York Academy of Sciences in 1964, only 6% of workers in one factory fell within the strict definition of scheduled areas.[4] The major members of the asbestos manufacturing industry made early arrangements for the medical surveillance of a far greater number of their workers, providing radiologic and clinical examinations for most workers in manufacturing processes.

Under various Acts of Parliament, workers outside the scheduled occupations could claim compensation for asbestosis. The Workmans' Compensation Act used in the1930s and 1940s was superseded by the Industrial Injuries Act of 1948. Even these statutes did not cover all workers exposed in the past who had a claim to benefit, so in 1966 the Pneumoconiosis, Byssinosis and Miscellaneous Diseases Benefit Scheme plugged the gap.[5] As workers' claims for benefit were upheld by confirmed diagnoses, it became clear that more cases were arising in occupations outside the scheduled areas. In other words, many more workers were in high-risk groups than the original investigators had believed.

0077-8923/79/0330-0525 $01.75/0 © 1979, NYAS

TABLE 1
PAST OCCUPATIONS AND PROCESSES THAT INVOLVE ONLY OCCASIONAL EXPOSURE TO ASBESTOS*

Lagging and delagging	Electricity generating, steel
Furnace insulation	Heavy engineering
Heat and sound insulation	Loco building, railway carriage building
Heat insulation	Boiler making
Manufacture of filter papers and grinding of rollers	Paper
Insulation wiring and preparation of insulation panels	Electrical engineering
Used as a filler	Linoleum, floor tiles, rubber, paints, plastics, adhesives, roofing compounds
Incidental grinding in assembly of brake and clutch parts	Motor assembly
Repairs to brake and clutch parts	Motor vehicle repair
Trimming of asbestos/cement sheets and insulation boards	Building trade
Substitute for plywood	Furniture
Insulation	Scientific
Making of asbestos washers and gaskets	Light engineering
Contractors performing work that involves use of asbestos may be found in	Large building projects, generating stations, installation of plant, dockyards, shipbuilding, ship repair
Other asbestos exposures may occur in	Certain aircraft maintenance activities, disposal of asbestos/cement waste, car body undersealS, asbestos/asphalt mixes

*From Reference 7.

In the early 1960s, Her Majesty's Factory Inspectorate undertook a survey to estimate the number of workers employed in processes that involved the use of asbestos or products with an asbestos content. The survey indicated that at that time, there were about 300 registered factories to which the then-current Asbestos Industry (1931) Regulations applied.[6] The estimate of persons employed in asbestos processes, or otherwise at risk, was approximately 12,000. The factories concerned were engaged in the manufacture of asbestos cement products, asbestos textiles, and asbestos friction materials, including brake and clutch linings.

Many more factories used either asbestos or products that contained asbestos intermittently. The former Asbestos Industry Regulations[6] specifically excluded the application of those regulations to any factory where no person was employed in the use of asbestos for more than eight hours in any week. In the survey referred to previously, Her Majesty's Factory Inspectorate identified an additional 228 factories that could be considered to be included in that category. TABLE 1, taken from Table 4 of the memorandum of the Senior Medical Inspector's Advisory Panel,[7] gives some indication of the wide variety of industries and processes in which the occasional use of asbestos may have been encountered. Industrial experience teaches that workers exposed only occasionally to any hazard are much more likely to ignore protective measures than are workers familiar with the dangers, despite the old adage that familiarity breeds contempt. Occasionally exposed workers, even today, are more likely to forget that exposure dose is a product of concentration multiplied by time;

because the latter is short, they may well experience high levels of the former. The number of roughly 1000 such workers in 1968 was stated to be regarded as a considerable underestimate.

The former Asbestos Industry Regulations did not apply to lagging and delagging or other insulating operations that employed asbestos. Therefore, no precise information of the numbers of insulation workers exposed to asbestos was available. An estimate made by the Thermal Insulation Contractor's Association put the number at 7500 directly employed in insulation. An additional 1000 insulators worked in Her Majesty's dockyards. The numbers at "high risk" in 1968 were therefore estimated to be about 20,000 (in the memorandum of the Senior Medical Inspectorate Advisory Panel). Lower degrees of exposure risk in so-called para-occupational pursuits could not be estimated.

In 1964, McVittie reported to The New York Academy of Sciences[8] that of 247 new cases of asbestosis diagnosed by four Pneumoconiosis Medical Panels, 102, or 41%, were engaged principally in insulation work. These figures covered the years from 1955 to 1963. In the ensuing six years, the same four Pneumoconiosis Medical Panels diagnosed 473 new cases, reflecting the greater use of asbestos in the postwar years. Of these new cases, the proportion from insulation workers had risen to 51% (TABLE 2).

It was clear that the hopes of reduced incidence expressed in the Merewether and Price report[1] had not been fulfilled. There were three reasons:

The former regulations dealt with the then-existing position and were not extended to cover the uses of asbestos developed since 1931.

The necessary statistics could not be obtained from the system of periodic medical examinations introduced. Examinations covered a limited field of asbestos workers, and there was no official record of the total number of exposed persons.

There was no standard method of measuring the workplace environment. Exposure levels were highly speculative and were linked to broad occupational categories rather than particular processes. The idea of personal monitoring had not even been conceived.

To compensate for the deficiencies of asbestos hazard control inherent in the former Asbestos Industry Regulations,[6] a new set of regulations came into force in 1970 throughout the United Kingdom. The Asbestos Regulations of 1969[9] revoked the previous statutory regulations and imposed requirements for the safety and welfare of persons employed in factories and in other premises and places where processes are carried out that involve asbestos or any material composed wholly or partly of asbestos and capable of giving rise to asbestos dust. For the regulations, "asbestos dust"

TABLE 2
NEW CASES OF ASBESTOSIS DIAGNOSED IN 1955–69 BY PNEUMOCONIOSIS MEDICAL PANELS IN FOUR UNITED KINGDOM AREAS, ANALYZED BY PRINCIPAL OCCUPATIONS

Principal Occupation	Cases 1955–63	Cases 1963–9
Opening, disintegrating	41 (17%)	45 (10%)
Insulation	102 (41%)	244 (51%)
Textile	53 (20%)	65 (14%)
Slab and pipe making	20 (8%)	18 (4%)
Brake lining	4 (2%)	10 (3%)
Miscellaneous	27 (11%)	91 (19%)
Total	247 (100%)	473 (100%)

TABLE 3

PRODUCTS THAT CONTAINED ASBESTOS AND THEIR PRINCIPAL PAST USES

Products that Contained Chrysotile or Amosite or a Mixture of Amosite and Chrysotile (Building, Shipbuilding, and Construction Industries)		Approximate Asbestos Content (%)
Asbestos Cement		
Corrugated sheets	Roofing and external wall cladding in factories, farm buildings, garages	10–12
Flat sheets	External wall cladding in offices, schools, hospitals, factories; infill panels	10–12
Moulded and extruded products	Rainwater pipes and gutterings; flue pipes and fittings; ventilation ducts and dust extractors; cold water storage cisterns; bulkheading for banks of waterways; miscellaneous building components	12–15
Pipes	Pressure pipes for water main supplies; pipes for sewerage and drainage cable conduits	12–15
Low-density panels	Fire-resistant partitions, doors and ducting, infill panels for curtain wall cladding systems	25–40
Asbestos Insulation Board		
Building applications	Fire-resistant partitions and ceilings in schools, hospitals, office blocks, shops, warehouses, multirise housing; industrial drying and curing ovens, molten metal moulds and troughing; casting for fire protection of steel structures	25–40
Marine applications	Fire-resistant bulkhead linings, ceilings, doors	25–40
Sprayed asbestos insulation	Treatment for structural fire protection, thermal insulation, acoustic correction, anticorrosion and condensation control, thermal insulation for industrial plant and equipment	50
Thermal Insulation		
Asbestos pipe sections, slabs, and ancillaries	Insulation of all types of pipework and hot surfaces	55
Calcium silicate or magnesia pipe sections and slabs	Insulation of all types of pipework and hot surfaces	12–15
Asbestos cloth	Outer covering for thermal insulation	85–100
Asbestos mattresses	Removable covers for locomotive fire boxes, boilers	85–100
Asbestos rope lagging	Wrapping steam pipes as thermal insulation	85–100
Asbestos compositions, self-setting cements, and hard-setting compositions	Protective finishes and coatings on thermal insulation	45
Sprayed asbestos	Thermal insulation of buildings, plant, and machinery	50
(calcium silicate insulation material that contains up to 14% asbestos is white in color)		
Other Products		
Asbestos millboard	Automotive cylinder head gaskets, ironing board pads; interior panel lining for fireproof doors; acoustic insulation for motor vehicle floors	45–98
Asbestos-based friction materials	Brake linings and clutch facings for all types of vehicles, factory equipment, cranes	30–70

TABLE 3 (*Continued*)

Products that Contained Chrysotile or Amosite or a Mixture of Amosite and Chrysotile (Building, Shipbuilding, and Construction Industries)		Approximate Asbestos Content (%)
Asbestos paper for floor underlay	High-temperature flexible insulation; in electrical equipment as fire-resistant barriers, contact mountings, air circuit brakers, washers and spacers for terminal units	70–95
Asbestos fiber	Mechanical reinforcement in mouldings and in bituminous and fireproof paints; reinforcement in electrical mouldings, filtration purposes and packing of steam cocks, filling for mattress insulation	100
Asbestos Textiles that Contained Chrysotile Asbestos Only		
Asbestos silver	Covers for electrical conductors; wire covering for many other electrical applications, such as fire-extinguishing and deicing circuits in aircraft	85–100
Asbestos roving	Covers for resistances in electrical circuits, heating elements operating up to 450°C	85–100
Asbestos yarn	Weaving into electrical cable braiding, patent glazing, valve and tap packing, cords for packing fireplace joints, sealing switch boxes	85–100
Asbestos cloth	Thermal insulation as the outer cover wrap on steam pipes, outer envelope for mattress insulation; protective clothing, fire blankets and curtains; plastics reinforcement, clothing for laundry clenders and presses; filtration diaphragms for electrolytic cells	85–100
Aluminized asbestos cloth	Protective clothing; finishing wrap on lagged piping and plant installations, heat shields	85–100
Asbestos webbing	Wrapping of exhaust pipes and insulation of hot and cold pipes; wrapping of electric cables, lining of switchbox and fuse leads; sealing joints in hot air ducts and smoke extraction systems; wicking for oil lamps and heaters	85–100
Asbestos solid-woven webbing	Brake-lining fabrics and conveyor belting	85–100
Asbestos tape	Wrapping for field and armature coils	85–100
Asbestos tubing	Insulation and induction coils and leads for switch gear	85–100
Products that Contained Crocidolite (blue) Asbestos (blue asbestos fiber is no longer imported into the United Kingdom)		
Bitumen-bonded battery boxes	Automotive industry.	10–20
Blue asbestos-reinforced plastics	Oil and acid applications	60
Blue asbestos yarn packings, plaited packings, and rolled cloth packings	Acid- or oil-resistant applications	85–100
Blue asbestos cloth	Flue curtains; locomotive mattresses; acid- and oil-resistant covering for insulation	85–100
Blue asbestos millboard	Acid- and oil-resistant joints and gaskets	85–100

denotes dust that consists of or that contains asbestos to such an extent that it is likely to cause danger to the health of employed persons. The regulations were designed to cover all uses of asbestos, present or future, in which asbestos dust, as defined, could arise (TABLE 3 lists the asbestos content of various products used in the past. This definition answered the first criticism of the old regulations.)

To answer the third question, the Health and Safety Executive issued a Guidance Note[10] that gave suggestions, not legal directions, on the manner in which Her Majesty's Inspectors of Factories would define "asbestos dust." The technical data note might be revised from time to time but also gave up-to-date explanations of methods of measurement and descriptions of currently available instruments. Samples were to be taken in the operator's immediate breathing zone for short periods and, by means of a portable sampler worn on the head, shoulder, or lapel, for longer-term sampling. The sampling strategy has been planned to account for variations in work habits among individuals, variations among factories in the same industry group, systematic differences within existing job categories, seasonal variations, workload variations, and variations between shifts and days.

TABLE 4

ASBESTOS SURVEY POPULATION AT MAY 18, 1977*

	Males	Females	All
Examined medically at least once, with readings on at least one x-ray	18,050(12,831)†	1767(1342)	19,817(14,173)
Examined medically once, awaiting results of x-ray‡	3188(2406)	194(280)	3382(2686)
Included in the mortality study only	1019(717)	95(46)	1114(763)
Total population	22,257(15,954)	2056(1668)	24,313(17,662)

*From the Employment Medical Advisory Service Report 1975–6

†August 1976 figures are shown in parentheses.

‡Chiefly new entrants to the survey. There is a period of time between the taking of the x-ray and the final recording of the films, because each has to be read independently by a panel of three readers.

The 1969 regulations were concerned mainly with protecting the health of the workers. To test the effectiveness of those regulations, and also to derive the necessary statistics that would determine the natural history of asbestos exposure, an ongoing survey was instituted. This survey continues under the control of the Employment Medical Advisory Service of the Department of Health and Social Security.

The survey was planned in three stages.

Phase I was a feasibility study of the ILO U/C reading of serial x-rays of asbestos workers who had been under continuous surveillance by the Pneumoconiosis Medical Panel of the Department of Health and Social Security for a period of over 10 years.

Phase II began in 1971 as a prospective study of asbestos workers in certain major factories of member companies of the Asbestosis Research Council and at the Devonport Dockyard, where works medical officers were employed.

Phase III extended phase II to include all workers subject to the 1969 Asbestos Regulations. It covers a large number of factories and installations that each employ a few workers. The total number of workers in the study in May 1977 was 24,313. TABLE 4 gives a breakdown of that figure.

The medical examination in the survey is biennial and comprises an exposure history, a clinical examination for the presence of persistent crepitations, completion of a standard respiratory symptom and smoking questionnaire, and a full-size posteroanterior chest x-ray. Representative environmental measurements of asbestos fibers in the air are performed by the Industrial Hygiene Unit. The type of fiber, mixture of fiber types, or mixture of fibers with other materials is recorded. There are 99 coded jobs in industrial production and use of asbestos products. The workers' jobs at each examination are recorded.

All workers in the survey, past or present, are included in the mortality study. Although each worker is offered the complete medical examination, including x-rays, some decline medical and/or x-ray examinations and therefore can be included only in the mortality study. This group totaled 763 in August 1976 and 1114 in May 1977 (TABLE 4).

Of the total survey population, 16,840 are still exposed to asbestos and subject to biennial examinations. In this total population, 11,214 were exposed before the new regulations came into force and will offer a group for comparison with the 5626 who have been exposed only since the new regulations were enforced. Because a wide range of exposure levels is being monitored in the survey, it should be possible in the future to assess the effectiveness of different hygiene standards, by studying mortality and morbidity data on workers included in the survey whose exposures have always been below the appropriate level.

The survey will also provide evidence of the dose-response relationship involved in the adverse effects of exposure to asbestos dust. There should also be an opportunity to confirm the effect of smoking. However, the problem of individual susceptibility, which may well be revealed by the survey in the future, can be studied only by intensive methods of individual investigation.

The incidence and severity of asbestosis vary with the concentration of fiber inhaled, the length of exposure, and the time since first exposure. The relationship is not, however, absolute. The well-documented evidence of the effect of smoking, not only on the incidence of bronchogenic carcinoma but also on the incidence of asbestosis per se,[12] is highly significant. Clearly, smokers have formed a high-risk group in the past. Whether additive or multiplicative, the synergistic effect of tobacco, if still present under present-day conditions, should become more clear-cut as the survey progresses.

Variations in response to the inhaled material will be revealed by the survey, but the problem of individual susceptibility can be studied only by intensive investigation of patients and controls. Immunologic antibodies, in the form of antinuclear antibodies and rheumatoid factor, have been reported[13], their presence appears to become more pronounced as asbestosis progresses. It has been suggested that a genetic predisposition to asbestosis exists. HLA-27 antigen is found more frequently in patients with asbestosis than in controls.[14,15] In other studies,[16] the association with HLA-27 antigen has not been confirmed, but subjects with HLA-13 antigen tend to have advanced pulmonary fibrosis, and asbestos workers without pulmonary fibrosis have unexpectedly high titers of HLA-W5 antigen. Whether the latter antigen protects against the development of pulmonary fibrosis is a matter for speculation, but it is becoming increasingly clear that there are measureable degrees of susceptibility. If susceptibility is genetically determined, it is evident that we must consider a new factor in our definition of high-risk groups.

Reduction of risk by control of the environment is now possible. Amelioration of the effects of smoking involves education of workers and constant presence of informatory brochures in the workplace. Work continues throughout the British Medical Research Council to discover indicators of susceptibility to asbestos-related

diseases.[11] A fervent wish of every industrial physician concerned with preemployment examinations of asbestos workers would be granted by the success of such endeavors to identify individuals at high risk due to factors of susceptibility.

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