The Newcastle Papers in Industrial Medicine over the Last 21 Years

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The Chair of Industrial Health in Newcastle upon Tyne was first filled in March, 1946. For about the first 12 years diseases of coalminers posed the main clinical and research problems. They stimulated surveys of pneumoconiosis in the Durham and Northumberland coalfields and led to studies of x -ray viewing techniques and of the relationship of radiological appearance to symptoms in dust disease of the chest. A section of medical statistics, now headed by a professor, was one of the earliest elements of the department to be inaugurated, and this was followed by a section of pulmonary physiology. The emphasis on industrial pulmonary disease, on which 14 papers have been published, has gradually widened and become transferred from coal to beryllium, asbestos, and antimony. Coalminers with nystagmus were shown to be socially similar to miners without the disease but psychologically less stable. They also suffered from a breakdown of their binocular vision. A darkness-induced nystagmus was experimentally produced in kittens, with increasing difficulty as they became older. Decompression sickness has become an important interest.

In the build-up of the department demands for occupational hygiene soon led to the formation of a section which started work on the decalcification of teeth by organic acids in a fruit salt factory. Lead poisoning in shipbreakers and smelters, and vanadium poisoning in fitters and gasmakers were studied jointly with clinicians. The thermal decomposition of protective coatings and welding rods has also attracted research, as also have the noise levels in a glassblowing school and in several power stations.

All medical, engineering, and public health undergraduates are taught by the department, and also the honours chemists. All medical undergraduates and honours engineers are examined in industrial health.

The departmental budget (including the field service) is about £54,000, and the department inhabits 12,660 sq. ft. of space.

To write what one intends to do in the years ahead (Browne, 1947) is hazardous, but to check back and see how actual performance has fitted forecast may seem to some to be positively rash. There are, however, three reasons at the present time which suggest such a step. The first is sentimental, and probably the most strongly operating, because it is the department's twenty-first anniversary year; the second is financial, to show how industrial medicine has used the available resources; and the third reason is to indicate the range of work which such a department can do when it is embedded in a heavily industrialized region.

The Pneumoconioses

Twenty-one years ago coal-mining in the north-

east of England employed 44,000 men in Northumberland and 100,000 men in County Durham. When outpatient work started 69 of the first 100 patients were coalminers, nearly all of them with respiratory symptoms (Browne, Beck, and McCallum, 1949), and 21 of these showed radiological evidence of pneumoconiosis. Up to that time, this radiological appearance had been said, by both chest physicians and radiologists, to be almost unknown in this part of the country. This provides an interesting example of how the apparent prevalence of a disease tends to rise in an area which contains someone who is interested in it. To obtain an accurate estimate of the prevalence of the condition, standard film surveys of four collieries in County Durham (McCallum, 1952; McCallum, Browne, and Campbell, 1955) and three in Northumberland (McCallum and Newell, 1958) were carried out which demonstrated, in general terms, that in County Durham

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FIG. 1. The proportion of coalminers in Northumberland and Durham, by age and category of pneumoconiosis.

by the time they were 50 years old 50% of coalminers showed the radiological appearances of pneumoconiosis, and 40% in Northumberland (Fig. 1).

At about this time, mass miniature radiography was being widely introduced, and it became necessary to find out whether the radiological opacities of pneumoconiosis could be identified as accurately on the smaller films as on the larger. Newell and McCallum (1954) therefore undertook an investigation which showed that it was more difficult to identify pneumoconiosis using 4×5 in. (10.2×12.7 cm.) than when using the standard 15×12 in. (38.1×30.5 cm.) film. There was also more disagreement among the viewers when using the smaller film.

It had already been noticed in outpatient work that there appeared to be little relationship between respiratory symptoms and the radiological appearance of the chest film, and a correlation of the symptoms and radiographs of 5,117 consecutive miners led to the conclusions that in coalminers there was no association between respiratory symptoms and the radiological appearance of the chest for fixed age (Fig. 2) and, moreover, that coal-face workers had more symptoms than non-face workers at all ages.

This led us to suggest (Newell and Browne, 1955) that there was, in fact, an occupational disease, *i.e.*, bronchitis, of coal-face workers which was not

indicated by the chest radiograph. This finding was so unpopular at the time that it was necessary to publish it very discreetly. The debate, moreover, is still on with Pemberton and Lowe (1968) showing, on the one hand, that for some industries there is an increased prevalence of bronchitis, and the Medical Research Council's conclusion, on the other, that, at any rate in coalminers, dust concentration does not appear to be a very significant factor in determining the prevalence of bronchitis (Medical Research Council, 1966).

In a study of the mechanical properties of the lungs in coalminers with pneumoconiosis, Leathart (1959) pointed out that men with early progressive massive fibrosis, and also those with symptoms but without radiological abnormality, both suffered from reduced ventilatory ability. This was due to expiratory obstruction and was found more often in elderly men without radiological pneumoconiosis. This finding confirmed the previous symptomatic study and suggested that most of the respiratory problem in coalminers, as in steel, cotton, and flax workers, is due to bronchitis and emphysema which shows in the symptoms and physiological tests but not in the radiograph. When dealing with industrial respiratory disease, therefore, it appears that seeing is not always believing.

Superadded tuberculosis was thought to be one of the reasons why some men with pneumoconiosis develop large areas of massive fibrosis in the lungs.

FIG. 2. The proportion of over 5,000 coalminers with respiratory symptoms, by age and x-ray category of pneumoconiosis. For fixed age there is no relationship between symptoms and the radiographic appearance of the chest. In general, symptoms increase with age.

It was decided to conduct a therapeutic trial of antituberculous drugs in this condition on 75 men with an equal number of controls, but it was found (McCallum, 1961) that they were without effect.

The department played a part in developing international agreement in the reading of chest radiographs (*Archives of Environmental Health*, 1966), as one of its members took part in the study of the International Labour Office classification and then took part in a radiographic reading exercise with a group of observers from the United States. Reading methods and standards were compared by exchanges of chest radiographs on two occasions, one before a joint meeting and discussion, and one after. Significant differences were found between the American and British groups and also within each group. This exercise led to modification of the categorizing and reading methods which it was hoped would bring about a more standardized interpretation.

A contribution to the study of the natural history of asbestosis was made by Leathart in 1960, when he showed that the two classical signs of finger clubbing and basal râles were, in fact, due to a gradually developing bronchiectasis. It was also shown that there was no correlation between radiological and clinical states. Physiologically, the asbestotic was shown to have a lowered steady-state diffusing capacity for carbon monoxide. The maximum voluntary ventilation, the vital capacity, and the compliance of the lungs were all low also. It was suggested that a decline in vital and diffusing

capacities in asbestos workers, which is out of line with their ages, may be an early warning sign that their lungs are becoming affected by the mineral. Four years later the International Conference on the Biological Effects of Asbestos (1964) recommended that these tests be made an essential part of the supervision of all workers with asbestos. The year before, Leathart and Sanderson (1963) pointed out that nearly half the certified cases in the previous two years had occurred in pipe and boiler ladders (insulators) who were not covered by the Asbestos Regulations drafted 30 years previously. The Law, therefore, in this case a responsibility of the Ministry of Labour, was lagging behind the ladders whom it should be redesigned to protect.

Antimony has been smelted near Newcastle for many years, and a radiological survey of the chests of the process workers in a Tyneside smelting works suggested that about 10% of them showed minor changes in the lungs, but without any disability. More accurate methods of determining the position and weight of antimony in the lungs are at present being developed (McCallum and Day, 1965) with the help of the Department of Medical Physics and with the support of the Medical Research Council.

In 1952 a young woman chemist aged 27, who had worked for about two years in a factory which made fluorescent lighting tubes, came under our clinical care. She prepared the internal coating of the tubes from a beryllium compound. Two years

after leaving work symptoms of lung disease began to show, and she was found to have a large cyst on the right lung which was removed. Biopsy showed the presence of the chronic granulomatous condition, berylliosis, of which at the time only about eight examples had been described in this country (McCallum, Rannie, and Verity, 1961). This young woman died not long afterwards from a rapidly progressive emphysema.

Coalminers' Nystagmus

This condition is now nearly part of the history of medicine, but 20 years ago it was common in the British coalfields and 40 years ago was more common than pneumoconiosis. The introduction of the Davey safety lamp greatly diminished the number of mine explosions but probably increased the prevalence of nystagmus, because the intensity of the light which it supplied was almost certainly below the threshold to which the retinal cones could respond. But 20 years ago this was by no means clear, and discussion centred round whether the condition was due to lack of light or whether it was primarily psychological. A series of studies was therefore planned to shed light on this point. A three-pronged attack was adopted, one towards the social and psychological differences between miners with and without the disease; the second was an attempt to develop an experimental and quantitative approach, using an appropriate experimental animal; and the third was an investigation of the

whole binocular function of men with the disease to supplement the previous solely monocular approach. A matched medico-social comparison (Browne and Beck, 1954) showed that, socially and physically, the men with the disease were not significantly different from those without it. Both at work and at home they seemed the same sort of men, as judged by a simple medico-social history-taking technique. The development, however, of numerically scorable objective tests of emotional stability provided a new psychological approach of increased sensitivity. With the help of these it was found (Lion, 1958) that men with nystagmus were less stable than those without the disease (Fig. 3). Further work (Lion, 1960) suggested, moreover, that coalminers may not be quite so emotionally stable as railwaymen of comparable status.

It is not difficult to produce experimentally a light deprivation nystagmus in new-born kittens (Browne, 1951), and it has been shown (Loveless, 1960) that the older the cat, the longer it takes to produce. A few cats, however, appeared to be resistant. There was thus experimental confirmation of the time relationships of the observed condition in man, in whom it takes a very long time to develop. It was hoped to explore the possibility that the critical lighting intensity for the production of nystagmus might be the retinal cone threshold, but the extremely long time relationships of the experiments made this impracticable.

A controlled study of the binocular vision of miners with nystagmus made the interesting point (Smith and Browne, 1953) that the men who had

FIG. 3. Instability scores of coalminers with and without nystagmus.

a tremor of the head as well as oscillation of the eyes also possessed a better visual acuity than those with only a single one of these physical signs. Indeed, a slow-motion cinematograph showed that as the eyes turned to the right the head turned to the left, with the result that the eyes, in fact, maintained a constant position in respect to an external object. In addition, it was found that only half the men with the disease had full stereoscopic vision compared with 93% of the control group.

Decompression Sickness

This was first reported from Tyneside in 1904 during the construction of the High Level Bridge over the river, and no more cases were seen until 1948 (McCallum and Walder, 1953), when a tunnel was being driven under the Tyne. Two cases were then described in circumstances sadly similar to those of 44 years before (McCallum, 1953). Since this time interest has focussed on the classification of the disease into types of severity and on the bone lesions (McCallum, Stanger, Walder, and Paton, 1954; McCallum, Walder, Barnes, Catto, Davidson, Fryer, Golding, and Paton, 1966) which it causes. These have been shown to be situated mostly round the hip and shoulder joints and, if in the head, neck, or shaft of the long bones, they are usually symptomless. The likelihood of a bone lesion relates to the number of decompressions, the height of the pressure, and to the number of attacks of 'bends' for which treatment is given. It has been established that radiology of the bones does not reveal the full extent of the lesions which affect about one-fifth of the men at risk. It is beginning to look as if Haldane's original decompression rates are rather too rapid to prevent disease of bone, but further evidence on this point must await the findings of the Medical Research Council's Decompression Sickness Registry which is situated in the Newcastle department and is administered jointly with the Department of Surgery. The whole position has recently been reviewed by McCallum (1968).

Metal Poisoning

Lead There are a number of shipbreaking yards on the north-east coast in which lead poisoning is still both an actual and a potential danger. McCallum (1963) has drawn attention to the importance of this for he showed that the atmospheric concentration of lead during the breaking up of a ship was 25 times greater below deck than on deck, and, moreover, that naval ships carried a higher lead risk than merchant ships. He emphasized that more preventive care should be

taken to protect shipbreakers from lead poisoning.

Over the years interest has focussed less on the diagnosis and treatment of lead poisoning which, however, has been undertaken from time to time in the course of clinical work, than on the development of screening tests of increasing reliability for lead workers. This interest has directed attention to new methods of analysing lead in blood and urine, and to the biochemistry of the precursors of haemoglobin, and also to methods of estimating these when they spill over into the urine. A good deal of statistical thinking has also been necessary in this work to help identify the most useful substance or substances to be estimated, and with what frequency. The first step was to develop a rapid method for the micro-estimation of lead in urine (Dick, Ellis, and Steel, 1961), in which the very small volume of urine needed considerably reduced the time required to ash the sample. In this method the use of a single lead-free reaction vessel for all stages of the estimation eliminated external contamination. An interesting contribution was made by Mehani (1966), who demonstrated that in lead workers 80% of the total coproporphyrin was isomer III, whereas it was only 40% in unexposed controls. But at the same time she showed that in lead workers there was much more of both isomers in the urine, which suggests that lead intensifies coproporphyrin metabolism as a whole. Another methodological contribution was also made by Mehani (1964) with the development of a rapid colorimetric method for the determination of delta amino-laevulinic acid in urine. This compound is one of the precursors of haemoglobin and tends to spill over into the urine when haemoglobin synthesis is blocked by lead. The method is sensitive to half-a-microgram of the acid and is much quicker than the pre-existing standard techniques. In a study aimed at developing more reliable screening tests for workpeople who are exposed to lead, Ellis (1966) showed that as the concentrations of lead and coproporphyrin rise in spot samples of urine, so also does the scatter of the values in both cases. Moreover, this scatter is increased by adjusting the values either to a constant specific gravity or to a constant creatinine concentration. From time to time both these corrections have been suggested by workers in this field. To help overcome the problem of variation and to give early warning of lead poisoning in the individual workman, Ellis has devised a technique based on the method of quality control which is used in industry.

Vanadium Over the years vanadium has been encountered in three different situations. As an acute clinical phenomenon which called for immedi-

ate advice by members of the departmental staff, an outbreak of vanadium pentoxide poisoning (Browne, 1955) took place among a group of men who were dismantling a heat exchanger. Through this had been flowing the exhaust of a gas turbine which had been using residual oil as a fuel, and a vanadium-containing ash was deposited within it which was converted into a respirable dust by the blows of the tools used by the men in the dismantling process. A situation with some similarities was later encountered in an oil gas plant (Browne and Steel, 1963) in which crude residual oil was passed over a heated catalyst. After a time this became covered with a vanadium-containing ash. When the catalyst was shovelled out, sieved, and changed, a very irritant dust rose up which produced the symptoms of vanadium pentoxide poisoning in the workmen. Some experimental work has also been performed on the physics and chemistry of the exhaust of an omnibus diesel engine in relation to the type of fuel used. This led to the development of a new kind of exhaust filter (Steel, 1963).

The work on metal poisoning led naturally to an interest in surface coatings (Steel, 1966) because these nearly always contain metals which are often heat-vaporized in high-temperature cutting or welding, and they may therefore present an environmental problem, particularly when combined with other ingredients, such as plasticizers and solvents, which may themselves undergo a heat degradation. It has been estimated that about one-sixth of the cases of lead poisoning are due to paints. In modern large-scale steel fabrication, as of ships, it is now the practice to spray on a lead-containing priming undercoat before the plate is cut to shape in a flame-cutting machine before being electrically welded into position. Thermal degradation, with the production of fumes and gases, will take place in both these situations. One paint which was tested even produced phosgene. Steel and Sanderson (1965) have developed a standardized method of thermally testing protective coatings. The coating to be tested is sprayed to a known thickness onto steel plate which is then placed in a large aluminium box fitted with sampling points. An automatic flame cutter travels along at constant speed and cuts a strip off the painted steel plate while all the gases and fumes are collected and analysed. Modern surface coatings are formulated in a highly sophisticated fashion and may contain such things as a metal combined with a synthetic resin. When it is realized that the temperature of cutting and welding steel is high enough for the nitrogen and oxygen of the air to combine to form an irritating mixture of oxides of nitrogen, and that these will be mixed with metal fumes and the break-

down products of synthetic resin, it can be seen that a potentially highly irritant mixture may be formed. A similar method has been adopted by Steel and Sanderson (1966) in the study of welding fumes. We are now approaching the position (reached many years ago in the case of food and drink) where standardized methods exist for the testing of materials which are likely to pass down the trachea as well as down the oesophagus.

Occupational Decalcification of Teeth

It was noticed that soon after starting work in Newcastle, a number of girls from a 'health' salts factory showed decalcification of those teeth which were naturally displayed on talking or smiling (Elsbury, Browne, and Boyes, 1951; Boyes, Hartles, Slack, Stones, and Steel, 1959). An occupational hygiene survey—the first to be carried out by the department—revealed that a tartaric acid dust was present in the air and that it possessed a pH of 3.8 when in solution on the teeth. Following this survey, an *in-vitro* experiment was set up in which unit areas of extracted normal teeth were exposed to tartaric acid in a mechanical tooth gnasher at different concentrations and at different pH values (Steel and Browne, 1953). The weight of calcium liberated per square centimetre of dental enamel per 24 hours was estimated, and it was found to be a function rather of the pH of the acid than of its concentration. A range of common acids was tested in this way. Citric was found to be the most destructive. Tartaric, acetic, hydrochloric, and nitric were equal second. Sulphuric was the least active, largely because of the insolubility of the resulting calcium sulphate (Steel, 1960).

Noise and Occupational Deafness

Noise, both as a nuisance and as a potential cause of deafness, tends to increase with the power of machinery. Electricity generating stations contain the most powerful machinery in the country, but the large modern stations require a very small number of men to be exposed to noise of undesirably high intensity, because remote control is now the rule. In a survey of 21 power stations, Acton and Coles (1967) showed where the noise was generated and how it was propagated, and drew attention to both the engineering and the architectural features in station design to which future attention should be directed. In a study of a very powerful water pump which is used to force cooling sea water through condensers (Acton, Bull, Hore, and Schwarz, 1967) it was shown that less noise would be made if the initial design of the electric motor was slightly

different, and that a further improvement would follow if the cooling air inlets and outlets were baffled.

Another published project on noise (Sanderson and Steel, 1967) in the glass-blowing workshop of a large University Department of Chemistry showed that it was loud enough to cause occupational deafness in the glass-blowers and that the sound level could be reduced by changing the design of the glass-blowing torches.

The Organization of the Department

It may now be of interest to describe the background organization of the department from which these papers have come. They represent less than one half of the total published output over the years, since papers from the sections of medical statistics and ergonomics have not been included.

The department is divided into six semi-autonomous subsections: Clinical Industrial Medicine, Clinical Respiratory Physiology, Medical Statistics, Occupational Hygiene, a field service—the North of England Industrial Health Service—and, finally a section of Ergonomics. All the sections are serviced by two workshops, one for heavy and one for light (including electronic) work.

The section of Clinical Industrial Medicine is staffed by the Professor and Reader, both of whom hold consultant contracts with the teaching hospital and also with the Regional Hospital Board. Out-patient sessions are held once a week at the teaching hospital and at Dryburn Hospital, Durham. Up to half-a-dozen beds can be used at the teaching hospital, if required. The patients are referred from many different sources—from family doctors as cases of suspected industrial disease, from industry (with the agreement of the family doctor)—and for a number of different reasons, but usually connected with fitting the man to the job after recovery from illness. Medico-legal problems, and patients in whom there has been a difference of diagnostic opinion, both add their quotas. The Medical Research Council's Decompression Sickness Registry is jointly attached to the clinical section and to the Department of Surgery. It is staffed by a physician and a secretary, and contains clinical and radiological details of all known cases of decompression sickness in the country. A research assistant with a Medical Research Council grant, who is a graduate in physics, is attached to the clinical section for work on the radiation physics of antimony in the lung.

Interest in pulmonary physiology was sparked off by the importance of industrial pulmonary disease in the region, and it has led to the depart-

ment providing a service laboratory for, and in, the teaching hospital, which is now seeing about 400 patients a year, nearly all referred by other members of the consultant staff. This laboratory is staffed by a physician who, again, holds consultant contracts with both the teaching hospital and the Regional Hospital Board to whom he acts as adviser in pulmonary physiology. He is a senior lecturer (clinical) on the University staff and has attached to him the appropriate technical and secretarial staff and a second research laboratory in the Medical School. In this laboratory a senior research associate (clinical) with a grant from the Regional Hospital Board is working on the use of radioactive xenon in the study of the physiology of the lungs.

The occupational hygiene unit is staffed by a lecturer and a chemical analyst, with a strong supporting staff of chemical and haematological technicians. As well as taking its share of teaching and research, this unit provides the hygiene component of the North of England Industrial Health Service, which is the department's field service. From time to time research assistants are attached to the department for special purposes. Two such, in recent years, have been a study of the vanadium content of the exhaust gas of a diesel engine burning a residual fuel, and a noise survey of power stations.

The section of medical statistics is headed by a professor, and this section, like the others, contains a blend of teaching, research, and service responsibilities. Research assistants are also attached to it, and the medical statistician to the Regional Hospital Board is an honorary member of the section, while the Professor of Medical Statistics is consultant in his subject to the Regional Hospital Board and to the teaching hospital.

Embedded in the University department is the North of England Industrial Health Service. It possesses a physician, technical assistant, occupational hygienist, administrator, and other technical staff of its own, and, in addition, it draws on the academic staff when necessary. The Professor and Reader in Industrial Health act as Honorary Director and Secretary, and the Lecturer in Occupational Hygiene as Hygienist. The Service has its own management committee and the same accountants as the University, but a separate account.

Teaching

All undergraduate medical students, mechanical and marine engineers, and honours chemists are taught in regular courses. Postgraduate teaching is

directed to candidates for the Diploma in Public Health, for the Diploma in Public Health Engineering, and in *ad hoc* courses to industrial medical officers. A regular course is given to student nurses, and hardly a year goes by without the department being asked to mount one or two national post-graduate courses for industrial nurses.

Over the last few years the Newcastle Medical School has introduced a medical curriculum of new design. At the beginning of it, the Department of Industrial Health gives three lectures on the relation of work to the structure and function of the body. Ten hours of occupational hygiene are taught in the paraclinical stage, culminating in a lecture on the occupational history. In the clinical stage, members of the department share with other colleagues the teaching on the musculo-skeletal and haematological and respiratory systems, and on the skin. In the second clinical year, two in a series of clinical mid-day lectures are given, one on lead poisoning and the other on the pneumoconioses. Measurement in medicine, or the statistical aspect, is taught to all the medical students by the department's section of medical statistics.

In the examination at the end of the paraclinical stage II all the students have to answer a written question on occupational hygiene and medical statistics, and, in addition, a random proportion of them are asked oral questions on these subjects. Sometimes questions on industrial health appear in the written part of the clinical examination, and a member of the department is always present among the other physicians and surgeons in the team of oral examiners.

Accommodation and Finance

At its birth, the department was allocated 2,100 sq. ft. in the Medical School which, at that time, seemed more than adequate. Twenty-one years later, 12,660 sq. ft. is in use, since two houses and two workshops have been added to the original allocation which has all been converted to laboratory use.

The most recent copy of the University Accounts for the year 1966-67 shows that the departmental expenditure for that year was £38,500 of recurrent University Grants Committee money. To this should be added about £4,000 of outside grant for research. The field service last year earned £11,500 and made a surplus of a few hundred pounds. The total turnover of the department and service was therefore approximately £54,000. At the time of writing, the department and service are staffed as shown in the Table.

TABLE
STAFF EMPLOYED IN THE DEPARTMENT OF INDUSTRIAL HEALTH

<i>Academic</i>		<i>Technical</i>		<i>Secretarial/ Administrative</i>	
Professors	2	Chief		Senior	
Industrial health	1	technicians	1	clerical	
Medical statistics	1	Senior		officers	2
Readers	1	technicians	3	Secretaries	6
Senior lecturers	1	Technicians	6		
Physicians	2				
Lecturers	1				
Graduate assistants	1				
Research assistants	5				

Conclusion

In 1947 the importance of the statistical approach was given what has turned out to be the correct emphasis, but it was visualized that it would be used chiefly on short-term sickness and accidents in industry. Curiously enough, however, no major piece of work on either of these subjects has been done. More interesting topics soon crowded in and saturated the staff. Work on what is now called 'ergonomics' was foreseen, and has been carried on ever since, but with differing emphasis at different times. Clinical work with a sociological component was planned and, indeed, performed for many years, but the pressing demand for scientific assistants in a department with a limited number of established posts made us reluctantly relinquish the social assistant's establishment in exchange for that of a chemist.

Twenty years ago coalminers' pneumoconiosis was just being discovered in the north-east, and a large number of suspected cases were referred to the department. At this time, however, the decline of tuberculosis was beginning to leave the Chest Service underemployed, and in coalmining areas the vacuum was filled by the Ministry of Health which routed cases of pneumoconiosis to it. This reduced the clinical load on the Department of Industrial Health and decreased the emphasis on inpatient clinical work.

Two of what are now the most active components of the present department's work were, at the start, almost wholly unforeseen—occupational hygiene and pulmonary physiology, and their attached services, the North of England Industrial Health Service and the Pulmonary Physiology Service to the teaching hospital and region. Both these sections started from research problems which presented in the field, and both are headed by staff who, in

effect, were self-selected. There is not—or should not be—any such thing as ‘academic’ industrial health uninformed by field practice. An attached service stands in the same relationship to such a department as do the hospital beds to its purely clinical counterparts. It provides a good deal of the basic material on which the department runs.

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