Evolution of Concepts in Industrial Medicine*

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This is the fourth Apothecaries' Lecture before the Society of Occupational Medicine, but it is a comment on the width of interest covered by medical intervention in industry that I am the first lecturer who has devoted a professional lifetime to the specialized practice of industrial medicine. If faults can be found with my historical record I make no apology, because I am concerned not so much with events but to trace the evolution of ideas which give rise to them.

Recording of Occupation

To Hippocrates' interrogation of a patient Ramazzini (1700) added the question 'What occupation does he follow?' In the mediaeval period men worked as craftsmen, engaged with their journeymen and apprentices in jealously guarded skills. Toxic substances employed were limited, and environmental hazards were traditional. Modern technology, which started with Perkin's discovery of mauvine in 1856, employs an immense number of substances, which are being modified and added to almost daily. Very detailed knowledge of industrial process is needed to recognize what may affect a man. To Lipworth's plea (1965), repeating Ramazzini's instructions of some two and a half centuries earlier, I would add, especially for malignant, degenerative, and long-term disease, the request that occupational histories should be taken in as great detail as possible and should certainly extend beyond a mere description of the industry. Experience in the Survey of Respiratory Disease in Foundrymen, now being completed by H.M. Medical Inspectorate of Factories, is that workmen, if given time to write down their occupational history on a specially designed form, achieve a very high degree of accuracy.

Early Conditions

The harnessing of the steam engine to the mills in

1781 disrupted the pattern of work. Men, their wives, and children were forced to live in squalid houses built around the mills and, after labouring for long hours each day, to drink, breed, and die. Mrs. Gaskell's historical novel *Mary Barton* (1848) illuminates the consuming fatigue and the devastation of families by long hours of labour. Kinder Wood (1783-1861), practising as a surgeon in Oldham, in evidence before the Commission on the Employment of Children in 1816 advocated that the ceilings of mills should be high so that children caught in machinery might revolve without being crushed. Events must be judged by the standards of the times and not by the standards of today. Life was hard in early industrial Britain and, as in many parts of the world today, you survived or died.

The first legislative response to the demands for relief was the Health and Morals of Apprentices Act of 1802. By our standards it was timid but it paved the way for the Act of 1833. The 1833 Act prohibited the employment of children under 9 years of age, limited the hours of employment of children under 13 years of age to eight hours a day, provided for the certification of age of children by physicians or surgeons, and required the attendance of children at school for at least three hours on six days a week; but the cost of schooling might be paid for by the deduction of a penny in every shilling of wages paid to the child. The Act further provided that 'It shall be lawful for His Majesty by Warrant under his Sign Manual to appoint during His Majesty's Pleasure four persons to be Inspectors of Factories'. I like to think that the most notable action of William IV, in his reign of seven years (1830-1837), was that he made these appointments. Though the 1833 Act was remarkable for its foresight, it was limited to specified processes in cotton, wool, flax, and hemp mills. The Act of 1844, famous as the 10-hour Act, widened the scope of legislation and attempted to define a factory, and allowed Superintending Inspectors to appoint certifying surgeons for the purpose of certifying the age of children. May I remind you that this was four years before the first Medical Officer of Health, William Duncan of

*Based on the Apothecaries Lecture given before the Society of Occupational Medicine on March 25, 1966.

Liverpool, was appointed. Schedules to the Act specified the form of the surgical certificate of age, of the general register to be kept by each mill or factory employing young persons or children, and of notices about such matters as meal times (which included breakfast, dinner, and tea). Notice of accidents causing bodily injury had to be given to the Certifying Surgeon within 24 hours; no provision was made for first aid. Though this recitation may seem wearisome, these early acts created a system of factory inspection which persists unaltered in its main principles and many of its details today. The urgent need was to prevent abuse from long hours of work, to stop children being harmed by employment at too young an age, and, when this had been done, to prevent mutilation from accidents. Early inspectors did this efficiently and impartially, but from the beginning the system was orientated toward accident prevention. Robert Baker (1803-1880) was the first medical man to be employed as one of H.M. Inspectors of Factories but, reading Lee's most admirable history of his life, I cannot help thinking that his humane feelings rationalized his desire to escape from the practice of medicine. Lee (1964) records Baker as writing, 'After attending many cases [of cholera], I took the disease and it so unnerved me that I gave up my profession, and followed factory work . . .'. At the beginning of his career as a factory inspector, Baker wrote on medical matters with sense and sensibility, but before very long his writings had lost the clearness, precision, and willingness to accept responsibility which characterize the practice of medicine. In 1837, registration of births became statutory. Subsequently, much argument was deployed, some of it based on personal and professional animosity, to show that the examination of young persons was superfluous. Redgrave, one of Baker's colleagues, who became first Chief Inspector of Factories in 1878, saw no reason why medical men should go into factories. Baker defended the intervention of certifying surgeons by advocating medical supervision of workers of all ages on the grounds that efficiency would be increased. Two points have topical significance. First, Baker was advocating medical intervention on the grounds of efficiency; secondly, in many developing countries, as in mid-Victorian Britain, from birth to death the only time men and women of the labouring classes see a medical practitioner is when they are examined on starting employment.

Medical Pioneers

Charles Turner Thackrah (1795-1833) is especially significant in the history of industrial medicine. Thackrah had many achievements, and it is sad

that the Medical School at Leeds does not hold an academic department of industrial medicine to commemorate its founder and the author of the first British textbook (1831) on industrial medicine. This may be a hasty judgment, because Thackrah, so far as I judge his book, thought of medicine as a whole. The important thing is that what we now call industrial medicine should be part of medicine, fertilized by developing medical concepts and in turn contributing to medical knowledge.

Dr. Ronald Owen has shown me a fascinating monograph by J. C. Hall, published in 1865, on *The Trades of Sheffield as influencing Life and Health* (Fig. 1). After an introduction lamenting the destruction of forests to produce charcoal, Hall records that 5,750 persons were engaged in file cutting processes, describes very accurately the hazards of the work, and ends by giving directions for the prevention of file cutters' disease—which might be taken as a model today for the prevention of lead poisoning.

The second part of Hall's monograph deals with Sheffield grinders' disease. At 164 wheels (132 steam driven, 32 water driven) there were employed 290 persons, classified into age groups extending from 21 to 75 years. Hall ascribes the disease to the dusts of sandstone wheels, and thinks dry grinding more dangerous than wet. He ends by quoting his own writings of 1857: 'To send a boy of eight or nine years into a grinding hall is an act of refined cruelty which the powerful arm of the law ought to restrain. The application of the Factory Act to the grinders of Sheffield would . . . be most wise and salutary.'

Whilst Whitelegge, who was medically qualified, was H.M. Chief Inspector of Factories from 1896 to 1917, medical practitioners (and occupiers) were required to notify lead poisoning, phosphorus poisoning, arsenical poisoning, mercurial poisoning, anthrax, and toxic jaundice to the Chief Inspector.

Thomas Legge, who was appointed first Medical Inspector in 1898, expressed strong views in 1929 that medical practitioners should notify diseases to H.M. Senior Medical Inspector of Factories, 'who is on the same plane as his informant, and can enter into his mind'. Legge drew the parallel of notification of infectious diseases to the Medical Officer of Health.

It may not be important to whom diseases are notified except that to remove notification from the medical procedure familiar to medical practitioners may result in deficiency in reporting, and it may be that too great a load is being placed on the memory of medical practitioners. Another difficulty is that notification must apply to known conditions; notification of carcinoma of the renal tract would not indicate whether unknown carcinogens may be acting.

During Legge's tenure as H.M. Senior Medical Inspector of Factories, periodic medical examination of workmen engaged in defined hazardous processes was introduced. Today, some 25 processes are included within the scope of required periodic medical examinations. These medical examinations were intended as a protection for individual workmen; this was a valid procedure when cases of lead poisoning, of the severity illustrated by Meiklejohn (1963), were frequent. In 1961, I reviewed the 37 notified cases of lead poisoning occurring in scheduled processes. In all but one, the register had been marked A1 (which in the classification then used meant free from symptoms and signs of lead poisoning or constitutional disease) at the immediately preceding periodic medical examination. We shall need to consider, in the near future, the strategy of periodic medical examination.

Clinically recognized disease is the tip of the iceberg of morbidity, while below the surface lies the bulk of asymptomatic disease, involving abnormal or exaggerated response by the human organism, which may or may not be harmful in the long term. We are, in the words of Logan (1961), facing the need for assessment of sickness and levels of health.

Legge's book *Industrial Maladies* was published posthumously in 1934; S. A. Henry, Legge's close friend, acted as editor. The inscription to the book, 'He who cures a disease may be of skillfullest, but he that prevents it is the safest physician', is ascribed to Thomas Fuller. In correspondence which I had with Henry in 1951, he was not able to identify its origin, and I am left wondering whether the verse arose in the mind of Legge or Henry; but whatever its source, the verse is a perfect memorial to both of them.

The demand for munitions in 1914 led to long hours of work, which, to the surprise of many, did not result in proportionately increased output. The Industrial Fatigue Research Board, whose name is, I think, very prophetic, was set up. Its investigators, Vernon, Wyatt, May Smith, Greenwood Wilson and others, in monographs of exceptional clarity, laid the foundation of industrial psychology. Between the two wars, industrial medicine developed slowly. Whilst men like L. P. Lockhart, T. E. A. Stowell, Donald Stewart, Maurice Goldblatt, and others who founded the A.I.M.O. in 1935 for unpretentious talk between friends, saw industrial medicine as an exercise in ecology, to many employers it was a means of keeping their employees well, and hence efficient. In the second world war, the reduction of absenteeism, including sick absence, provision of immediate treatment to minimize the effect of injury and, in particular, to avoid sepsis

(and, may I add, penicillin did not become generally available until late in the war), and the prevention of fatigue became vitally important. Professor Sir Frederic Bartlett's work (1943) culminated in his crucial experiments studying skill fatigue. Today, the successors of these pioneers are proceeding to the study of interaction of men and machine, so necessary if the full benefit of automation is to be obtained.

Young Persons

The period between the two world wars was one of disappointment, strife, and fear. The appalling truth was that any job, if you could get it, was better than no job at all. In 1932, 2.9 million persons were wholly unemployed, most for a very long time. Whole towns did nothing, and the sun, cleared of the pall of smoke, rose and set on men, women, and children doing nothing. The diet of two-thirds of the nation was deficient in some respect, and for one-third diet was deficient in every respect. Those used to the socio-economic conditions of today will not credit that I myself have seen poorly-clad, miserably nourished children standing on horses' dung in the Rotherham Road to keep their bare feet warm in the snow. The major problem facing works medical officers was how to provide food and warmth to persons of all ages, not least to young persons. Many employers instituted Oslo breakfasts, free or subsidized meals, and home welfare schemes.

Pathetic scraps of humanity left school at 14 years of age and, if they were lucky enough to get a job, presented themselves to the examining surgeon. There was not much a good doctor could do, because the important thing was to have a job—but at least general examination of Young Persons made sense, as it does today in developing countries. If I were required to ascribe the improvement in the nation's health to one thing, it would be to the school meals service. Introduced at the beginning of the first world war, very hesitatingly and reluctantly, with meals to be given on medical recommendation only, school meals did not become generally available to all children until the second world war. In truth, improvement in health was the result of general advances in socio-economic conditions, wages, housing, food distribution, and education.

It is greatly to the credit of factory occupiers and examining surgeons that the provisions of the Factories Acts, legislatively isolated from general medical development, have been used to the individual benefit of so many young persons. Today, however, such benefits as there may be are largely the fringe activities of a system designed 122 years

ago, when children presented for employment were frequently under-age, starved, and deformed.

Last year, over half a million (522,085) examinations of young persons were performed by Appointed Factory Doctors. One thousand four hundred and sixty-five certificates of refusal were given; of these, 572 were for having nits, which is not a valid ground for rejection. Twenty-one thousand two hundred and sixty-five conditional certificates were given. A vast amount of medical effort is being directed to identifying relatively few conditions, which might affect a young person's fitness. With few exceptions, all the young persons will have been observed by the School Health Service, with opportunity for consultation with parents and teachers over a period of at least seven years. Clearly, here is an opportunity to integrate the two services, and to provide continuing medical observation during the vital transition from learning to earning.

National Health Service

The National Health Act, 1946, was an event of great significance to industrial medicine; even though it received no direct mention, the Act empowered the Minister to provide services for the 'prevention, diagnosis and treatment of illness'. Against an entirely new, and largely unknown, background of state-organized medical treatment, the function of industrial medicine had been left undefined. This was a situation which had to be resolved, and the Dale Committee (1951, Cmnd. 8170) was appointed in 1949. Its report, if I may say so with respect to my fellow members, was inconclusive for the simple reason that we were asked to solve a then unsolvable problem coming as it did at a time when many members of the medical profession still thought suspiciously of the National Health Service as socialized medicine. The Dale Committee did, however, recommend that 'In our view, it is desirable that there should eventually be some comprehensive provision for occupational health covering not only industrial establishments of all kinds, both large and small, but also the non-industrial occupations referred to in the Report of the Committee of Enquiry into Health, Welfare and Safety in Non-Industrial Employment (Gowers Committee). This, however, is a long-term view which cannot be made effective without much more experience to be gathered from future surveys and experiments'. The Committee went on to recommend experiments in the provision of industrial medical services and, in particular, the setting up on a trial basis of group health services. Through the generosity of the Nuffield Foundation in providing £½ million, this has now been done. These experiments have demonstrated the assistance to industry

that can be rendered by group services. No-one would deny their value, but there are three general conclusions. First, very considerable financial pump priming is needed, to set up a group service, of the order of £60 thousand for each service. Secondly, if the country were to be covered by such services, a minimum estimate of 1,750 to 2,250 doctors (against a yearly output from all medical schools of about 1,600 medical practitioners a year) would be needed, with 3,150 to 4,400 nurses; and thirdly, judging from the reports of some of the services (where sufficient information is given), about 85% of medical and nursing time is spent in treatment. Indeed, it is the provision of therapy which attracts factory occupiers and workers. In developing countries, as has been most recently pointed out by the W.H.O. Seminar on the Health Aspects of Industrialization (1964), the provision of treatment in countries where few persons see a doctor may be the most important reason for starting a medical service, though to call it industrial medicine would be wrong. The I.L.O., in a report on Work on Plantations (1953), has gone so far as to say that medical services devoting most of their energy to treatment, as in the presence of infectious and vector-borne disease, malnutrition, and high infantile and maternal death rates they must, are the stumbling blocks to the development of preventive medical services in industry (Table). The opposite is true in Britain, where all persons have a general practitioner, and medical services are freely available. Persons of working age (15 to 65 years) are medically a low risk group, demanding only one service from their family doctor compared with two or three services to persons below and above these ages.

What, then, are the essential interests involved? As I see it, there are three:—

First Aid and Treatment First, treatment in industry must be in co-operation with the National Health Service, including family doctors and hospitals. Indeed, the B.M.A. (1964) notes for guidance of industrial medical officers preclude treatment over and above primary treatment or first aid, except by consent of the patient's general practitioner. May I here add that the first aid provisions under the Factories Act, including the training of first-aiders, represents an adequate, not to say high, level of requirements. The claim for increased treatment facilities in industry rests on the avoidance of loss of working time after first aid has been given. This may be so, but I know of no unequivocal evidence in peace-time that it is—and I should have thought that, in the light of the many claims put forward, validation would not be so difficult to come by.

TABLE
WORLD POPULATION AND NUMBER OF PHYSICIANS (ADAPTED FROM LLOYD DAVIES, 1958)

	<i>Estimated Population (millions)</i>	<i>Area (sq. km.) (millions)</i>	<i>No. of Physicians*</i>	<i>Population per Physician</i>
West Europe	251	5	276,874	907
Anglo-Saxon America	184	19	236,761	777
Australia, New Zealand, Oceania	14	9	12,427	1,126
East Europe	449	33	526,062	853
U.S.S.R.	121	1	79,975	1,513
	200	22	273,600	731
Spain, Portugal, Philippines, Latin America	321	23	353,575	907
India and Nepal	238	21	118,277	2,012
China, Korea, Hong Kong, Singapore, Formosa, Mongolia	386	3	52,312	7,378
Burma, Ceylon, Thailand, Vietnam, Cambodia, Laos	634	11	80,611	7,864
Japan	80	2	7,231	11,063
North Africa, Egypt, Middle East, Turkey, Pakistan, Malaya, Indonesia, Afghanistan, Brunei	90	0.4	89,885	1,001
Tropical and South Africa	332	19	36,047	9,210
North Borneo, Sarawak, Netherland New Guinea	131	20	12,690	10,323
	3	0.6	124	24,193
Total	2,664	133	1,276,814	20,786

*Doctors or medical graduates

Prevention of Disease and Promotion of Efficiency Secondly, the State's interest is that all citizens should enjoy the greatest individual well-being. In industrial terms, this has two facets; the prevention of ill-health arising from industrial circumstances, and assisting individuals to achieve equilibrium with their work. This is a restatement of the fact that industrial medicine is an ecological study.

Specialist Practice of Industrial Medicine In my view, the specialist practice of industrial medicine is the use of medical skills to study human beings at work. On the basis of such studies, and in the light of the best medical knowledge of the time, it is the function of industrial medicine to give advice to others whose job it is to control environment about how to secure human efficiency and health, and to give advice to vulnerable persons, who may be vulnerable either because of the hazards they encounter at work or because of personal illness or disability. In particular, the specialist practice of industrial medicine is concerned to promote biological efficiency of workmen, to anticipate and identify hazards to health and biological efficiency operating in the working environment; to define (so far as

possible) the limits beyond which health and biological efficiency deteriorate; to stimulate the provision of suitable conditions of work; to continue medical and biological observations on the effects of environment, and, lastly, to provide medical and laboratory examinations of workmen where hazards cannot be measured or controlled by environmental estimations. This description differs from the definition of industrial medicine given by Merewether in 1948. Merewether defined industrial medicine as based on law. Action to correct faulty environment has always, and will always, need ultimate penal sanction. My most important submission today is that medicine is advisory, helping men, women, and children to adjust themselves to each other and to their environment. Enforcement of statutory provisions controlling environment is another discipline. Medicine deals with people; as the place of enforced inspection grows less, the opportunities and benefits of preventive medical advice in industry increase.

John Snow stopped cholera by removing the Broad Street pump handle, but it is too often forgotten that John Snow studied the epidemiology of the cholera outbreak. If he did not know of the cholera vibrio, he had good reason to suppose that water spread cholera. Action unsupported by

detailed medical studies may achieve its intended effect, but it does so only by accident. Maybe it is for this reason that the many reports on dust in cardrooms have not eliminated byssinosis, however much they have—and everyone agrees that they have—improved the amenities of cardrooms. Because of the formalization of the duties of Appointed Factory Doctors in successive Acts of Parliament, the medical machine for epidemiological studies has been lacking. Alongside epidemiological studies there must be environmental studies; in the past, physicians have necessarily undertaken both, but, in the future, I hope specialist hygienists will study environment. But there is one important qualification; such studies must be orientated to finding out biological effects (and hence planned in co-operation with physicians) as well as towards engineering needs. As with periodic medical examination, the strategy of sampling needs review.

Organization The medical contribution needs to be locally—or at least regionally—organized and closely linked to the therapeutic and preventive services. Increasingly, diagnosis (which must be the basis of intervention) will need to be made precisely at the pre-symptomatic stage of response by the human organism to environment. Laboratory services, whether these are physiological, pathological or statistical, will become more and more important if objective measurement of health and efficiency are to be made. As individuals are found to have sustained abnormal responses (or, alternatively, exaggerated normal responses) to environment they will need investigation by the therapeutic services; laboratories are the point of linkage between industrial medicine on the one hand and N.H.S. and preventive services on the other. By allowing co-operation between industrial medicine to develop by linkage of laboratory services, foci of interest will arise naturally.

Medical manpower must be used economically; not only are unnecessary medical examinations, especially those of an ill directed clinical type, wasteful of medical skills, but they lead to bad doctoring. Except where the School Health Service observes a defect which is likely to interfere with a young person's fitness or safety, the fact of starting work in a factory is not a reason for medical examination. For healthy school-leavers entering a properly controlled factory, such an examination is meaningless. If a factory is hazardous, restrictions need to be placed on the factory rather than on the young person.

Vulnerable Groups In a sense, young persons reported by the School Health Service as having

defects (estimated as about 5 to 10% of school leavers) form a vulnerable group: other vulnerable groups are those of all ages who, because of individual factors such as bronchitis, arthritis, return after illness, disablement, and old age, need individual advice about their work or who, because of the nature of their work, are at special hazard. Periodic medical examinations are traditional in some industries, but this is no excuse for continuing them when better methods of control have become available. Equally, there are many hazards where medical examination does not take place, largely because of the accident of legislation and regulations. Where medical intervention is likely to be profitable, this should be possible, but always on a selective basis, which it can only be if medical time is not wasted on out-dated medical examinations. For every spell of sickness (for which benefit is paid) due to prescribed industrial diseases, there are 300 spells from non-industrial disease. The patient's general practitioner is responsible for determining fitness for work after an illness. No one would challenge this, and, equally, the majority of patients return to work successfully. There remains, however, a burden of distress, where selected patients would be helped by skilled advice, not about their illness but about how their work is affected by their illness. How big this burden is I do not know, but I suspect it is very considerable.

Training The medical and other staff intervening in industry—and by industry I mean all forms of work—either by way of study or advice must be highly trained and disciplined. These specialist practitioners, whether engaged full-time or part-time, should all have available to them the facilities of an advisory medical service. Training is the job of universities, who will no doubt, as now, provide postgraduate education and refresher courses. Professional status will be won not by the size of the cadre of specialists employed in industrial medicine but by the excellence of their advice. For some time toxicological problems will be the main forms of interest, partly because we still, as Schilling (1963) said, have to catch up years of inaction, and partly because of technological development. I look forward to the declining importance of toxicology, so that resources can be concentrated on the study of fatigue, efficiency, reablement, and psychological and social adjustment in the automated era now starting.

Group Health Thirdly, O'Dwyer's delineation (1963) of the health of the enterprise may not have received the attention it deserves, possibly because of the emotions that the idea engenders. O'Dwyer

did not mean that individual interest should, as in the armed services in war, be subordinated to the fighting efficiency of the unit, but there is in industrial organizations a justifiable interest in group health and group efficiency. Large factories differ from small factories by being large. In general, this is a question of balance of individual and social objectives, of turning adaptive societies into an established society (Mayo, 1945). As an operational force medicine has little part to play, but it can provide management with the indices by which success or failure may be judged. More and more, happiness and efficiency are blended from judicious juxtaposition of industry and the community of which it is part. Because medicine is an empirical discipline, neither encouraged nor discouraged by the foibles of human beings, it can help man to turn mutual ignorance to mutual comprehension, provided always that the independence of the doctor-patient relationship is not abused. Unless an industry is scientifically based, it cannot hope to survive, but, as it becomes more scientific, so do its managers become cleverly illiterate and unable to express their thoughts in a meaningful way to the people whose work they direct. For their part, workpeople respond to social goals, unconcerned that changing science may mean disappointment. The great divide does not lie between humanists and scientists; at their best, both are seeking poetic truth. The divide is lack of comprehension in doing, living, and being.

Conclusion

In this lecture I have tried to outline some of the ideas of the past which seem to me to be significant to the further development of industrial medicine. Medical intervention in industry covers three separate and distinct activities: first, what has been called general practice in industry; secondly, the highly skilled and specialist medical advice about work and people at work; and thirdly, medical indices for the health of the enterprise. Any forecast that I may have given of the future is mine and mine alone; should I revisit the scene of our labours in 20 or 30 years, I hope that whatever we may build now will have evolved—into what, I dare not hope. All that I hope is that the medical contribution to industry will have evolved in response to the needs of men at work. Alice Hamilton, the American pioneer of industrial medicine, wrote in her book *Industrial Toxicology* (1934), 'Controversy in the

field of industrial medicine can seldom be kept on a strictly scientific plane.' I have tried to preserve the unemotional involvement of a good physician. Industrial medicine deals with man-made disease; many painful judgments will be needed to distinguish real needs from ephemeral fashions. May I remind you of the General Confession, 'We have left undone those things we ought to have done, and done those things we ought not to have done, and there is no health in us.' The frailty of human beings will ensure that health eludes us, but I pray that we may be granted the humility to do what we ought to do.

My colleagues in the Ministry of Labour, and in particular in H.M. Inspectorate of Factories, encouraged me in the preparation of this lecture, and what I have to say owes much to them, though the views expressed are my own.

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