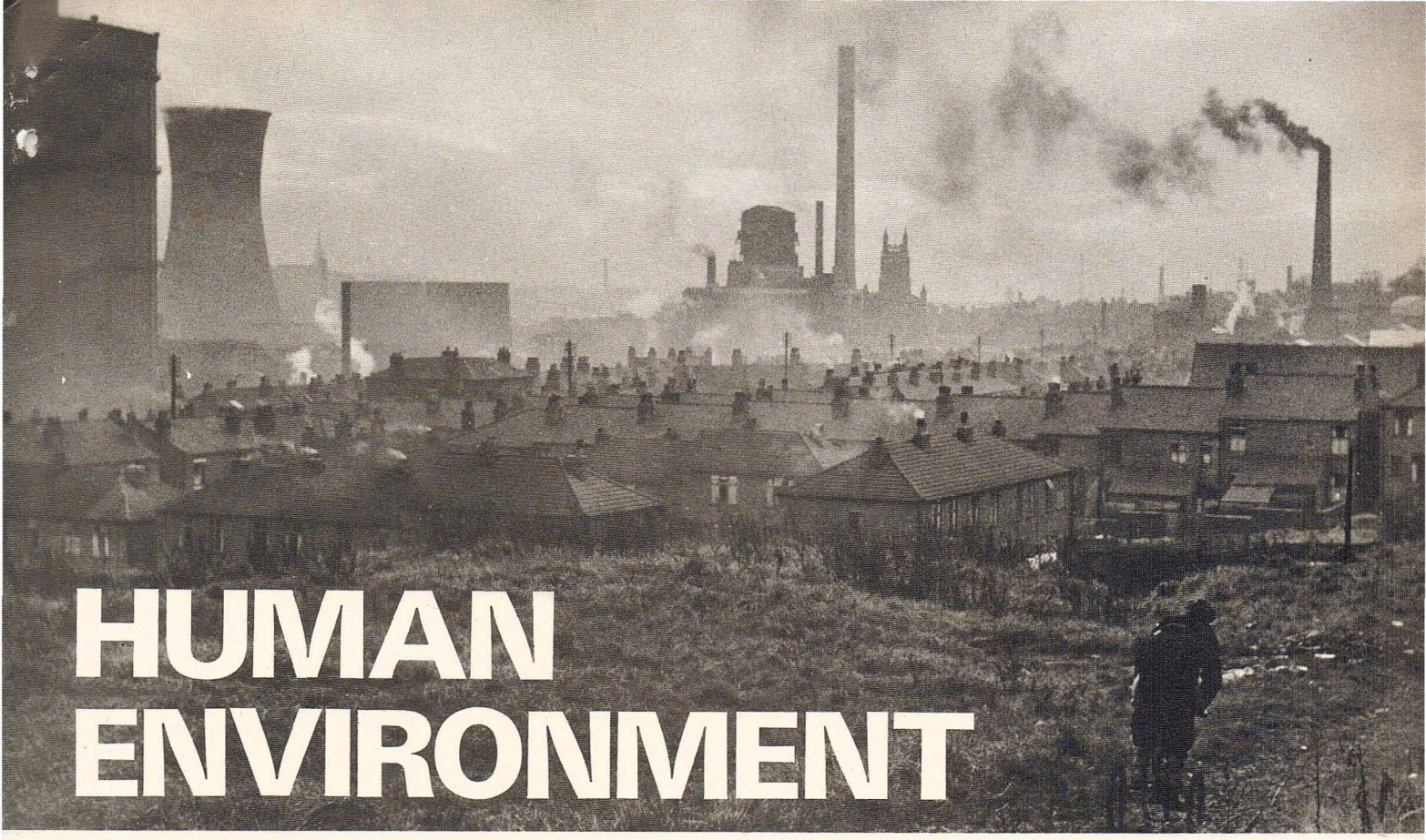

HUMAN ENVIRONMENT

Occupation, Stress and Disease

Harold Hillman

THE aim of this series of articles is twofold: first, it is desired to identify aspects which should be of medical educational interest to doctors; second, it concerns itself with the interface between human biology and medicine.

Occupation and Health

Occupation may affect health in several different ways. It may be affected by exposure to particular noxious agents or industrial accidents. For example, mining subjects men to a greater risk of pneumoconiosis or silicosis; boiler-makers become deaf; soldiers suffer orthopaedic lesions or death. Second, the way of life due to an occupation may affect the health of the patient: nurses and airline pilots frequently have their circadian rhythms disturbed. Third, the 'socio-economic status', i.e. the income and way of life, grossly determines the likelihood of disease. For example, people in social class I, 'the professions, commissioned officers, and well-to-do people concerned with finance, shipping, etc.' have a significantly lower incidence of stillbirths and nutritional deficiency than other classes.

Harold Hillman, MB, B.SC, PH.D, *is Reader in Physiology at Surrey University, Guildford.*

Relationship Between Occupation and Ill-health

The interpretation of apparent relationships between occupation and disease must be tempered by subtle considerations. MacMahon (1967) summarises some of these. The diagnosis and treatment of some diseases occurs much more among some occupations, like nurses or doctors, than others. In countries without health insurance schemes, a much smaller percentage of poorer people are treated (see Table 1). Entry to some occupations may be limited or encouraged in respect of sex, ethnic group or geographical location; women do not usually become bus drivers in Britain; many young immigrants have no alternative to taking manual work; a higher proportion of the population of London than of the Upper Clyde is involved in sedentary jobs.

Minimum health requirements for servicemen, taxi-drivers, airline pilots, etc. means that not only are these people selected for entrance to their jobs as being healthy, but they are likely to represent a healthier population for the rest of their lives. On the other hand, some situations selectively attract people with poor health or handicaps; caretakers are often invalided ex-servicemen; blind people may take up physiotherapy. ▷

Table 1. Percentage distribution of patients by social class in USA survey.[1]

Conference decision	Social class II	III	IV	V
No treatment recommended	11.8	9.6	22.2	64.3
Assigned to staff	35.3	17.3	2.8	.0
Assigned to resident psychiatrist	29.4	38.5	30.6	2.4
Assigned to medical student	.0	9.6	26.4	23.8
Assigned to other therapist (social workers, psychology students)	5.9	7.7	9.7	7.1
Referred to other agencies	11.8	17.3	4.2	2.4
Unknown	5.9	.0	4.2	.0
	100.1	100.0	100.1	100.0

[1] Myers, J. K. and Schaffer, L., *Amer. Sociol. Rev.*, 1954, **19**, 307.

Disease itself may cause a patient to lose his job. A man who is struck by multiple sclerosis cannot continue as a taxi-driver; a typhoid carrier will be dismissed from catering work; a soldier who has had an amputation will leave the Army. This reminds us that ex-servicemen in the UK and those countries which have participated in recent wars represent a large pool of handicap and ill-health. In World War I, it was gas poisoning, amputations, chest diseases, and blindness. Victims of World War II in Britain were not subjected to gas, but otherwise suffered the same disabilities. It should also be remembered that the indirect psychological effects of losing a father must have been great on the children of that generation.

Thus although the precise relationship between incidence of disease in a population and its occupation is extremely complex, there are clearly secular trends. For example, an investigation of the US Department of Health, Welfare and Education (1963) found that tuberculosis was twice as common among coal miners as among agricultural workers; influenza and pneumonia occurred twice as often among meat workers as among workers in the medical services; heart disease struck entertainers twice as often as agricultural workers, coal miners suffered ten times as many accidents as medical workers (see Table 2). Mortality rates from heart disease vary very much between classes (see Table 3).

Occupational Diseases

The increased mortality ratios in particular occupations are usually not due to occupational diseases. Their preventive treatment and diagnosis is the responsibility of the industrial medical officer, but small factories and workshops do not have doctors, and some diseases should always be suspected of having an industrial cause. These may be classified according to the organs they mainly affect. Some of the important ones are shown in Table 4. This list illustrates the wide variety of agents and industrial processes which can cause disease. They can be seen to affect mainly the skin, the lungs, the eyes, and the nervous system.

Occupational Hygiene Services

The laboratories in the regional centres (Figure 1) are concerned with the analysis of post-mortem specimens, urine, blood, etc., to identify industrial hazards. Browne, Steel and Leathart in the Newcastle Papers (University of Newcastle upon Tyne, 1956–1961, 1968) summarise some of the important analyses; these are now fairly routine, and their availability should be more widely known:

1. Urine samples can be examined for suspected lead or mercury intoxication.
2. Air samples can be examined for benzene, antimony or mercury, from industrial processes.
3. The blood carbon monoxide can be measured rapidly.
4. Post-mortem tissue can be taken for beryllium, lead or arsenic assays. ▷

Table 2. Mortality in particular occupations compared with the national average in the USA.[1]

Disease	Agriculture	Coal mining	Meat products	Medical health services	Entertainment recreation services	Engineering; miscellaneous professional
Tuberculosis all forms	99	192	137	86	146	54
Influenza and pneumonia	114	126	164	79	132	102
Arteriosclerotic heart disease, including coronary disease	70	107	99	112	141	138
Cirrhosis of liver	52	99	123	116	191	154
Accidents at work	114	229	59	23	69	
Suicide	125	129	112	118	119	116
Homicide	155	175	172	69	110	

[1] US Department of Health, Education and Welfare, 1963.

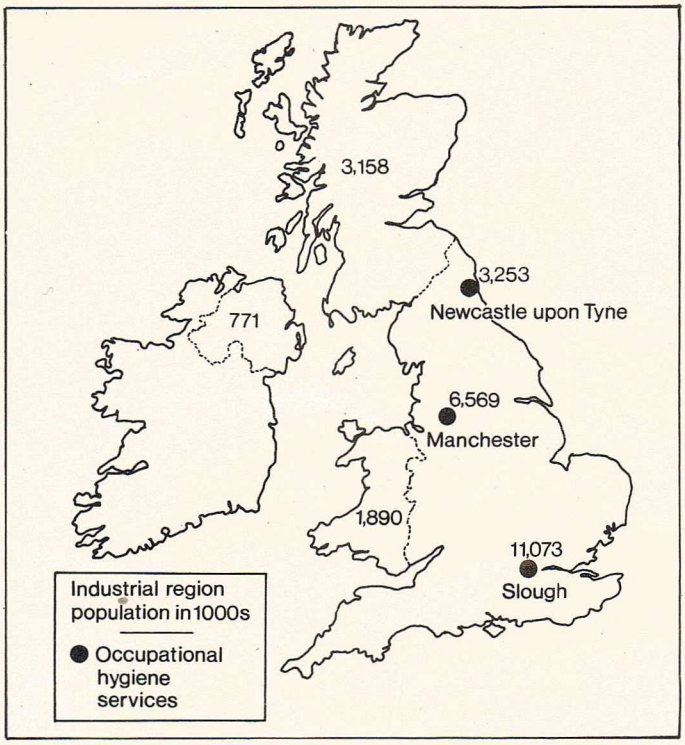

Figure 1. *The position of occupational hygiene services in the UK in relation to industrial populations.*

McCallum, R. I. and Steel, J., *Proc. XIV Int. Congr. of Occupational Health, Madrid, 1963,* Excerpta Medica Foundation, Amsterdam, 1964.

These analyses are additional to routine biochemical and special forensic measurements. The Newcastle group also has impressive facilities for carrying out lung function tests.

Three industrial or agricultural diseases deserve special note as they are not seen often in hospitals in Britain, and may therefore go undiagnosed.

Anthracosis is caused by an organism which lives in animal hair and hides, and therefore affects tanners and wool-sorters. It is characterised by painless local infections of the skin of the face, neck and arms, with so-called 'malignant pustules'; the local glands are swollen but do not suppurate. The lungs may be affected, when it is called 'wool-sorters' disease'. If it is diagnosed early, it can be cured with sulphonamide drugs, and antibiotics, but if septicaemia supervenes, the prognosis is poor.

Actinomycosis is a disease of cattle which probably enters the bloodstream through the gums, where it may be a parasite. It usually affects the jaw, where it causes painful indurations. Other sites are the intestines or liver, where multiple abscesses occur, or the lungs, where it demonstrates a clinical picture similar to tuberculosis. The small abscesses caused by *Actinomyces* are described as having a characteristic 'sulphur granule' appearance. Local drainage of abscesses, and treatment with tetracycline may be curative, but early diagnosis affects the prognosis greatly.

Weil's disease or spirochaetosis icterohaemorrhagica is a disease of miners, sewer-men, fish-cleaners, or any workers coming into contact with the urine of rats, which excrete the *Leptospira.* The patient has fever, hyperpyrexia—sometimes with rigor—labial herpes, and conjunctivitis. After about a week, he becomes jaundiced. There are many haemorrhagic manifestations, particularly in the gut. Mild cases of the disease are sometimes diagnosed as influenza. Diagnosis is made by injecting the patient's urine into a guinea-pig. Treatment is by high doses of antibiotics.

Other industrial conditions, whose recognition is easier, are chronic bronchitis, infections of the hand, pulmonary tuberculosis, 'beat-knee', and glanders, which is a rare infection carried by horses.

Accidents

It has been estimated that 2 per cent of all industrial accidents are unpreventable, 50 per cent are practically preventable, and 98 per cent are of 'preventable type'. In 88 per cent, the main cause is the machine being operated, and in about 15 per cent, the machine contributes to a large extent. For every single major injury, there are 29 minor ones, and 300 accidents without injury.

The Robens Report

The recent Robens Report estimated that in Britain 1,000 people a year are killed, 500,000 are injured, and 23,000,000 days are lost as a result of industrial accidents. This is an enormous expense to the country, both personal and economic. The report pointed out that there was an enor-

Table 3. Male death rates (per 100,000) and mortality ratios[1] from arteriosclerotic heart disease including coronary disease, by age and social class, England and Wales, 1949–1953.[2]

Class	Age Group 25–34		35–44		45–54		55–64	
	Rate	Ratio	Rate	Ratio	Rate	Ratio	Rate	Ratio
England and Wales								
I (highest)	32	81	30	108	203	144	671	154
II	—	86	—	104	—	110	—	111
III	—	97	—	100	—	102	—	108
IV	—	100	—	84	—	80	—	78
V (lowest)	5	128	30	108	130	93	376	86

[1]Ratio, within age groups, of rate in each social class to rate of total population in the age group taken as 100.

[2] Antonovsky, A., *J. chron. Dis,* 1968, **21,** 65.

Table 4. Common occupational diseases.

Organ mainly affected	Agent	Industrial process
Skin	Acid, alkali	Chemical and cement manufacture
	Detergents	Laundries; catering
	Arsenic	Insecticide manufacture
	Benzene	Solvent manufacture
	Carbon tetrachloride	Dry cleaning; refrigeration
	Chromium	Electroplating; preservatives
	Phenol	Manufacture of disinfectants
	Tar	Roofing; roadmaking
Lungs	Dust	Mining
	Silica	Quarrying
	Asbestos	Asbestos mining or manufacture
	Carbon monoxide	Garages; gas manufacture
	Formaldehyde	Plastic manufacture
	Hydrogen sulphide	Rayon industry; sewers; petrol refining
	Nickel carbonyl	Nickel manufacture, antiknock manufacture
Eyes	Hydrogen sulphide	Rayon industry; sewers; petrol refining
	Light	Glass manufacture; illumination
	Methanol	Antifreeze or varnish making; solvents
Nervous system	Lead	Paint production; battery production; lead mining
	Mercury	Thermometer manufacture; germicides
	Methanol	As above
	Zinc	Zinc smelting; brass foundries
Multiple organs	Anthrax	Handling of hides
	Glanders	Handling horses
	Leptospira	Coal mines; sewers; fish docks

mous mass of legislation. Many of the laws and regulations are out of date and complex, and many factory and agricultural workers cannot understand them, as they are couched in legalistic terms.

Robens has suggested that one department of Government be given responsibility for all factory safety, and that this department should have 1,000 inspectors and wide powers. A new code accompanied by simple but comprehensive legislation needs to be enacted. It is clear that should these proposals be carried out, general practitioners, casualty officers and orthopaedic surgeons, as well as industrial medical officers will have to acquaint themselves with the main regulations.

The financial loss to society through industrial accidents is enormous. It is estimated that each accident costs the country five times the cost to the men involved. To the cost of his absence to himself, one must add the cost of his treatment, his replacement, disruption of work schedules, interruption of his colleagues' work, insurance, convalescence, etc. Accidents at work are big business.

Machine Causes of Accidents

The main factory hazards are:

1. Inadequate or unused machine guards.
2. Sharp edges of tools.
3. Defective or slippery tools.
4. Unsafe arrangements for manipulation of large machines.
5. Inadequate lighting of work surfaces.
6. Inadequate ventilation for noxious fumes.
7. Unsafe clothes, for example, high heels, failure to use goggles, torn gloves, etc.
8. Unsafe electrical or mechanical industrial processes.

It can be seen that nearly all these hazards are avoidable, and the industrial medical officer shares with the trade union official the responsibility of seeing that they are avoided. Nevertheless, many accidents arise from failure of operatives to carry out prescribed safety precautions.

Axioms for Safety

Industrial safety officers have evolved several axioms. Nearly all accidents are complex, and result from unsafe acts of persons. The severity of accidents is often quite fortuitous. Methods of prevention come under four headings:

1. Rearrangement of the machinery or repair of a tool.
2. Persuasion of operatives to be aware of danger.
3. Personnel adjustment, i.e. the right person for the right job.
4. Discipline, whereby the infringement of safety regulations is seen to be taken seriously by the employers as well as employees.

The approach to accident prevention is similar to quality control. An industrial process has to be analysed step by step and the stages at which accidents occur must be identified and remedied.

The Role of the Doctor

The doctor who is not an industrial medical officer normally sees the patient after the accident has happened. His first task may be urgent treatment. However, he has other major responsibilities. He must examine and measure any lesion, as he will often subsequently be called upon as an expert witness. He must give necessary antisera and antibiotics. Often he must order X-rays to justify subsequently the adequacy of medical treatment, if necessary in a court of law.

In the clinical examination of an accident such as a cut finger or a fractured wrist, the doctor—while not a detective—must try to see if the lesion is compatible with the history, as lawyers often ask about this. Any piece of glass, metal, or separated tissue must be labelled and preserved.

At a later stage in the condition, the doctor may be asked to sign a certificate prolonging a man's absence from work, or sending him back. Here the interests of the patient must take priority over that of his employers, but a doctor is not expected to perjure himself. The general practitioner or casualty officer's final responsibility is to discuss accidents with the industrial medical officer, as well as with the patient, to prevent their recurrence.

Incidence of Accidents

A few generalisations have been deduced about the incidence of accidents. It is high in the young worker, and settles down to a fairly constant level after a few months, to rise again towards the age of retirement (see Figure 2). Loss of visual acuity, visual accommodation and hearing probably all contribute to this incidence. Accidents occur more often towards the end of the working week. In women accidents are much more common between the first four days and the 24th to 28th days of the menstrual cycle (see Figure 3). These generalisations are derived from statistical studies, and should serve as indicators for populations susceptible to accidents, though they do not help us necessarily in the treatment or prevention of individual accidents.

Ergonomics

In recent years, ergonomists have been turning their attention to making life at work more comfortable and agreeable. They have exploited a number of anthropometric techniques to fit the machine to the human being. Controls on instruments have been designed for comfort of use; signals on trains are now electrically operated; lorries have power assistance for steering. Much of the stimulus for this ergonomic work came from studies initiated during World War II to improve comfort and efficiency for pilots and tank crews.

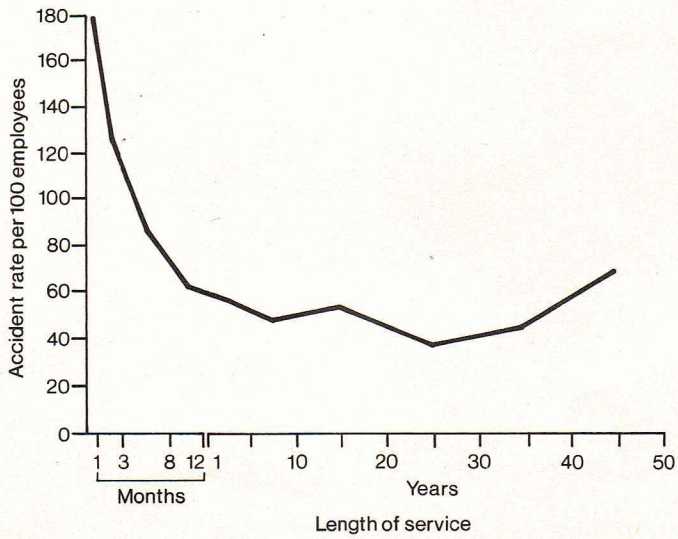

Figure 2. *Change of accident rate with age.*
Browne, 1959.

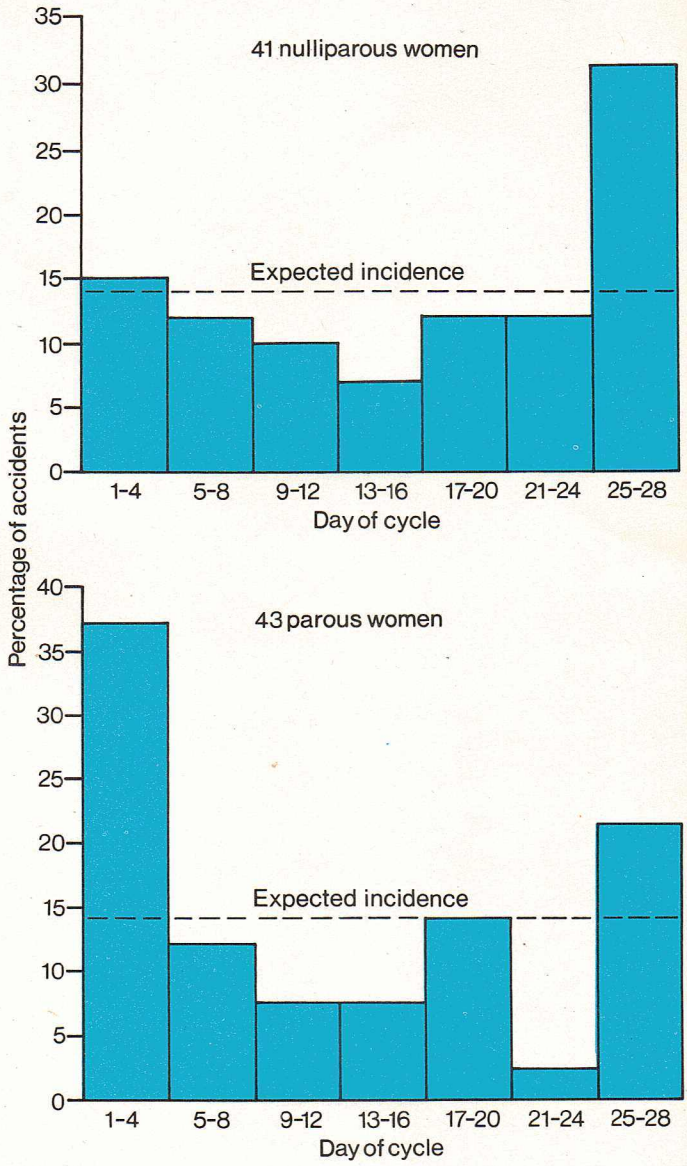

Figure 3. *Distribution of accidents in nulliparous and parous women.*
Datton (1964) in Haddon, W., Suchman, E. A. and Klein, D., *Accident Research*, Harper & Row, New York, 1964.

The Chair

Since most sedentary workers spend over a third of their time seated, the design of the chair has been given a great deal of attention. Careful anthropometric measurements were made of sitting height, knee to ischial tuberosity distance, knee to heel distance, etc; for example, the latter measurement in women is about 5 cm less than in men. The optimal angle of the back of the seat was assessed by electromyographic studies, in which it was assumed that the minimum muscle activity indicated the least tone in that muscle. Surveys were carried out with groups of people using chairs of different angle and seat and back measurements. Secretaries were observed secretly, and the incidence of their moving spontaneously used as an index of the discomfort of the particular chair. ▷

Too hard a chair compressed the ischial tuberosities and would cause ischial bursitis ('weaver's bottom'). The blood vessels over the ischium and the heel are radially arranged and do not easily collapse under pressure. Too soft a seat distributes the pressure too widely over the buttocks. A comfortable chair should permit access of air to the skin so that perspiration may evaporate. Thus woven materials are preferable to impermeable plastics. Such a tailor-made human chair has been tested on typists, and it was found that the number of times they wriggled was decreased, and their production increased, by the introduction of the new chairs. If it worked with typists, *a fortiori* it should work better with lorry drivers and crane operatives.

Fatigue

Fatigue is of several different kinds. The neuromuscular fatigue shown to generations of medical students since the time of Sherrington applies only to one reflex arc. Another arc acting on the same muscle may show undiminished activity. This fatigue is probably due to the accumulation of local metabolites, as recovery from it is delayed by closing off the blood vessels to the area. Neuromuscular fatigue may occur in violent physical exercise like football or tennis, especially the first time the games are played in a new season.

However, in many experiments, the loss of voluntary ability to contract muscles can be shown to be central, as electrical stimulus peripherally can still induce muscle contraction. Mental fatigue defined as 'a loss of ability to handle information' is a very complicated process indeed, which can be analysed into several components, and is different from adaptation, habitation, satiation, or inhibition. There is a sensory component, which can be shown as diminished visual and auditory acuity; there is a slowing of motor activity; fatigue is irregular; the ability to carry out a task becomes disorganised, and inappropriate manoeuvres are made; there are temporary phases of improvement; and the fatiguing of a particular modality tends to be specific to that modality.

Considerable efforts have been made to clarify psychologically how fatigue acts, just as they have to examine the deficit following sleep deprivation. Rather surprisingly, it has been found that the 'higher activities', like major political decisions or chess moves, are relatively little impaired. Fatigue is generally seen as an increased number of errors and inappropriate manoeuvres, often paralleling an increased incidence of accidents. However, subjects can counteract it by conscious effort, by physical exercise, by hearing loud noise, and by taking amphetamines. All doctors know of their ability to react to an emergency by carrying out very precise and careful operations at ungodly hours of the night.

Working Hours

During World War I, it was thought that the longer the hours people worked, the greater their production, but it was soon noticed that there was an optimum working week of 40–50 hours, after which productivity went down. The Health of Munition Workers Committee recommended that working hours should not be excessive, and experimental studies at the Max Planck Institute in Germany have shown the same result. Indeed, it has also been noticed that if people are deprived of short rest periods like tea or coffee breaks, their productivity goes down; they also resist being deprived of these breaks, by taking unofficial ones. Thus, the Englishman's tea break is ergonomically desirable as well as being socially irresistible.

A great many people do not like their work, and this results in absenteeism, prolonged absence following minor illness, low morale, many accidents and dissatisfaction with wages and working conditions.

Adjustment to Work

Failure to adjust to work has many causes, of which boredom is the one most commonly expressed. Poor physical conditions and pay are others. Other causes which have been identified include under-use of the man's talents, wrong training, poor opportunities, a fear of criticism or ridicule, and unrealistic fantasies about his own job potential. Causes not so often recognised are men's anxieties about their families, and women's about their marriage or their menopause. In one American study, 84 out of 91 employees who complained of overwork were found to have pre-existing tension and poor relationships with other employees; in only nine could the complaint of 'overwork' be attributed reasonably to the work itself. This is perhaps an example of the general phenomenon that people may often carry their family relationships to work, and that conflicts in the one situation are often reflected in the other. All sorts of transfer situations may occur.

Summary

In summary, we may say that a doctor should be expected to be able to identify that a disease is occupational. He should also be acutely aware of the interreactions between his patient's personality at home and at work. Despite the continuing fall in basic hours of work, most people spend about a third of their lives at work, a third sitting on a chair, and a third asleep—trying to forget about it all. □

References

McMahon, B. and Clark, D. W., Eds., *Epidemiological Methods in Preventive Medicine,* Little, Brown & Co., Boston, 1967.

University of Newcastle upon Tyne, some Newcastle Papers on industrial health and biostatistics, 1956–1961; some papers from the sections on industrial medicine, occupational hygiene, pulmonary physiology and medical statistics, 1968.

US Department of Health, Education and Welfare, *Mortality by Industry and Cause of Death Among Men 20–64 Years of Age in 1950,* Washington, 1963.

Further Reading

Edholm, O. G., *The Biology of Work,* Weidenfeld & Nicholson, London, 1967.

Ergonomics in Machine Design, Proceedings of a Symposium in Prague, 1967, ILO, Geneva, 1967.

Gartly-Jaco, E., Ed., *Patients, Physicians and Illness,* Free Press of Glencoe, 1963.

Heinreich, H. W., *Industrial Accident Prevention,* McGraw-Hill, New York, 4th edition, 1959.

Susser, M. W. and Watson, W., *Sociology in Medicine,* Oxford University Press, London, 2nd edition, 1971.

Walford, A. T., *Physiology of Human Survival,* Edholm, O. G. and Bacharach, A. L., Eds., Academic Press, London, 1965.