THE MEASUREMENT OF MORBIDITY

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INTRODUCTION

THIS paper stems from a suggestion that it would be worth while to bring to the notice of the profession the progress which has been made and the statistical problems that have arisen in the study of epidemiology in its wider sense, viz. the study, not merely of the spread of communicable disease as was formerly implied by this term, but of the natural history of disease; its prevalence, causation, symptomology and prognosis. It would, however, require a series of papers to cover so wide a field and would demand medical as well as statistical competence. It therefore seemed advisable to use the more restrictive title chosen in order to emphasize the fact that, in the main, consideration is devoted to statistical rather than to clinical aspects.

2. The actuarial profession as a whole has tended to avoid coming to terms with medicine, despite the fact that there have been, not only in recent times, substantial contributions by individual actuaries in the field of medical statistics. The first volume of the *Journal* quotes, from a paper read by Neison (1851) to the Statistical Section of the British Association, some statistics of proportionate mortality from different diseases in successive age groups. This volume contains a letter from a Dr Babington (1851) asking for support for the newly founded Epidemiological Society, and in the second volume Dr McWilliam (1852) published a note on the 'views and objects' of this Society and refers to 'an enlarged and proper view of the value of medical science as an element in the system of Life Assurance—a view that does not limit the usefulness of the medical officer to the mere selection of eligible lives but which also recognizes in well-directed sanitary legislation a means of mitigating, if not of obviating, those evils which are constantly operating to the destruction of human life'. This plea was often to be reiterated in subsequent issues of the *Journal* by actuaries themselves: 'we begin to wonder how we could be so long asleep to the consequences of this neglect, at whose door lies the guilt of all the deaths which might have been prevented. Society pays the penalty of its own indifference to the misery of the poor; and fearful diseases, overstepping the locality where they are born, every now and then compel attention to duties which luxury has forgotten or pride disdained' [Editorial note, 1852].

3. In 1857 the Institute reprinted Prof. Buchanan's address to the British Association on the 'physiological Law of Mortality, and on certain deviations from it observed about the Commencement of Adult Life' in which he developed the thesis that every child at birth contained within it the elements of its own decay on which was superimposed the destructive influences of external causes such as war and pestilence and even temperature, the increase of mortality in early adult life being ascribed to the anxiety, fatigues, dangers and privations afflicting young men on first establishing themselves in the world. [Perhaps foreshadowing Clarke's distinction between 'anticipated' and 'senescent' deaths of nearly a hundred years later (1949).] In the same volume

of the *Journal* Dr Reid rejected the idea of any physiological law which in the absence of 'conspiring' external forces would predetermine mortality at a specified age, but insisted on 'tracing all the causes of death to their *exciting* cause', thus unfolding 'the proof as to the one being the effect of the other, from physiological or organic action having been deranged'.

4. In 1860 the Institute reprinted notes for the guidance of medical referees prepared by Dr Ward: 'the habit of smoking tobacco, which has recently been the subject of so much illogical argument, deserves a passing notice. There is no evidence whatever to show that this practice, when had recourse to in moderation, and not complicated with spirit drinking, at all tends to shorten the duration of life. Addiction to it in great excess may doubtless induce dyspepsia, nervous affections, possibly paralysis, certainly *delirium tremens*.... The prominent position which consumption occupies in the mortality tables of this country is due far more to its undoubted and constant hereditary transmission than to any peculiarities of climate.'

5. Porter (1861) returned to the subject of preventive medicine; he concerned himself with excessive mortality from tuberculosis in printers and incriminated the lack of ventilation, the dust, and their drinking habits; and anticipated many of the findings relative to other industries later to be recorded with more substantial statistical evidence in the occupational mortality investigations of the Registrar General. Porter displayed considerable acquaintance with physiology and anatomy which clearly deepened his understanding of the occupational hazards of the time. He insisted, however, on the hereditary character of respiratory tuberculosis. [The bacillus was not identified by Koch until 20 years later when the Institute (Bristowe, 1887) immediately published a note on the changed medical view, i.e. that the disease was due to an exogenous infective agency; and that the disease itself was not hereditary. Later an important paper by Rusher and Kenchington (1914) on the mortality effects of family and personal histories with special reference to tuberculosis appeared to accept the substitution of inherited susceptibility to tuberculosis for the actual inheritance of the disease, and paid more attention than hitherto to infection but did not take much account of the inheritance of adverse social and economic conditions.] The essay ends with an impassioned plea for the greater exploitation of vital and health statistics. In 1877, Sprague (1878) examined the statistical evidence in favour of smallpox vaccination and found himself dissatisfied not with vaccination itself but with the statistics used by its proponents. The Institute returned to the subject twenty or so years later when in the middle of a smallpox epidemic Burridge (1902) produced more conclusive evidence of the protective value of vaccination.

6. Walford (1881) called for the establishment of a central register of declined lives, not, however, for medical statistical purposes but as a protection against fraud; he also called for the special training of medical examiners.

7. In 1890 the *Journal* reprinted a paper prepared by Sir Arthur Mitchell in 1877 on the statistics of insanity in Scotland in which he carried out a cohort analysis of the rates of discharge from or death in asylums and of readmission which compares favourably with recent statistical work on this subject. He found that the 'element of duration of the malady has a much more important bearing on the expectancy of life than the mere question of age'.

8. Whether the increase in death-rate from cancer was real or due to improved diagnosis was discussed by Teece (1902), and a discussion on the

causation of cancer ensued in which an eminent visiting surgeon, Sir Thomas Smith, accepted the assumption that the disease was parasitic (though he did not say as did Teece that this was synonymous with 'infectious'), but to do him justice declared 'The first thing to be said about cancer was that nothing at all was known about it.' That the Institute took this discussion very seriously is evidenced by its reproduction in the *Journal* of a joint paper to the Royal Society in 1893 on the subject by George King and Arthur Newsholme. Later (1904) there was reproduced a paper by Newsholme on the association between cancer and alcohol consumption.

9. In 1903 there had appeared the report of the *Specialised Mortality Investigation* of extra risks of the Actuarial Society of America, and in 1911 there began the series of important studies of the experience of impaired lives carried out jointly by the Society and the Association of Life Insurance Medical Directors, the latest of which has recently been reported (1954).

10. The co-operation of Thompson with Dr Bardswell in the preparation of the Medical Research Council's Report (1919) on sanatorium treatment for pulmonary tuberculosis (based on the experience of the King Edward VII Sanatorium) provided an early example of direct application of actuarial methods in the study of prognosis. In 1932 Stockman similarly co-operated with Dr Trail in the further analysis of the mortality experience of the same sanatorium. Later there was to appear the third of the periodical mortality investigations of the Brompton Hospital Sanatorium (Hartley, Wingfield and Burrows, 1935), in which Burrows co-operated as the actuarial member of the team and which was noteworthy for his insistence on what is now an accepted part of the clinical trial, viz. the provision of a valid control group for assessing the effect of special treatment. The author was privileged to follow in his footsteps as actuary to the fourth report which appeared a few years ago (Foster-Carter, Myers, Goddard, Young and Benjamin, 1952).

11. In a discussion on permanent sickness insurance in 1939 (Heath, 1940), the President posed the question 'Death was death, but what was sickness?' which no one answered. In a subsequent paper Rich (1940) made an analogy between degrees of health and degrees of temperature which came nearer to the contemporary view of biological normality as a dispersion of characteristics within broadly separated limits. But that, apart from some notable examinations of disease description in death causes (Daw, 1954; Barnett, 1955), is as close as the actuarial profession has felt it necessary to approach the discipline of medical science.

12. Yet while these rare interventions have demonstrated that the power of analytical thought which characterizes the profession might be of service to medicine, actuaries have tended to treat disease too much in terms of generalization; in the sharp division between the quick and the dead rather than in gradation of degrees of ill-health representing a chain of events leading to death; in the elaboration of mortality laws arising from the operation of abstract inimical forces rather than from the composite incidence of specific disease entities; in the treatment of impaired lives, not so much in terms of the behaviour of impairments as in terms of the mortality experience or risk underwriting results of the whole group; in the projection of rates of mortality specific for age, sex, year of birth, class of business, but not specific for disease; in the observation not of the pattern of sickness prevalence but of the cost of sickness claims. This at least has been the tendency. Actuaries have withal

been remarkably successful in protecting the interests of assured lives; it is impossible to prove that they would be more successful as a result of studying the natural history of disease. History has, however, justified the faith that deeper analysis provides a sounder basis for prognostication; not in the forecast itself where simplicity rather than refinement is still the ideal but in determining with greater certainty the minimum degree of refinement which must be accepted, and what can be ignored or merely broadly accounted for; and actuaries clearly have made and can make an effective contribution to the advance of medical science.

THE MEANING OF SICKNESS

13. Sickness and health are antitheses and are difficult to define except in terms of each other. A morbid condition is a departure from the normal healthy condition, and the prevalence of disease can only be assessed given adequate and practical criteria for defining departure from normality. Stocks (1949) has said 'the distinction between living and dead is clear cut, but no such frontier line between sickness and health can be said to exist except in the case of acute illness caused immediately and directly by an external agent. There is a zone between the two states in which the division whether the subject is sick or not depends on definitions or standards of good health, and also on who decides. It is often said that only a physician is competent to decide what a patient is suffering from; but the patient often has to decide whether or not he is ill at all. If he believes himself to be ill, then he is not in normal health; he is consciously suffering from something and therefore sick. On the other hand a person may think he is well, but on examination for some purpose such as life insurance or by mass radiography it is discovered that he has a disease which may at any time cause disability. From that moment he begins usually to suffer inconvenience, if not actual symptoms and then comes into the category of persons who are sick.' The aim of this paper is to review some of the problems and techniques that have arisen in the different modes of measurement of sickness applicable to different definitions of ill-health, and to different agencies identifying the ill-health. Apart from the varying standards of health and diagnosis involved there are a number of different unitary concepts involved. Illness is a condition which continues for a period of time. We may, therefore, consider how many sickness periods (illnesses) began in a specified interval or how many terminated during the interval or how many were current at any time during the interval. We have also to distinguish between persons and illnesses, remembering that a person can have more than one illness within an interval and even at the same point of time. An illness may be a new disease or a recurrence of a disease suffered on some previous occasion. An attempt will be made to define the units used on every occasion; in general, the term 'incidence' will relate to the emergence of new cases (a 'flow' concept) and 'prevalence' to the numbers existing at a point of time (a 'stock' concept).

NORMALITY

14. It is to a large extent the need for standards by which to assess health that has led to the development of social medicine as a distinct discipline. 'If we are to apply the adjective "normal" to the multitudinous structures and

functions of which—together with their coordinated activity—health is the composite picture, we must understand better what we mean by it and where possible establish standards and measurements of normality.... In man, as in other animals, variation is so constantly at work that no rigid pattern—whether anatomical, physiological, psychological or immunological—is possible.... There is...for each structure or function what may be called a normal range of variability' (Ryle, 1948).

15. Ryle refers to clinical errors which have arisen from failure to recognize the normal range of variability, and quotes Martin for two examples: (i) the palpability of epitrochlear glands which is present in 40% of adult males though once regarded as a symptom of disease, particularly of syphilis (1947), (ii) myotatic irritability of the pectoral muscles commonly present in healthy individuals (a form of the familiar stretch reflex) though often referred to as a suggestive sign of pulmonary tuberculosis or other debilitating disease (1946). There are many other examples. Von Graafe's sign (*lid lag*) was once thought to be peculiar to thyrotoxicosis, but it is now known to be present in other diseases, especially peptic ulcer, and it has no diagnostic value in relation to its hyperthyroid connexions (Jackson, 1949). A significant proportion of fit young men exhibit a degree of gastric acidity which at one time would have been regarded as pathological and suggestive of duodenal ulceration (Bennett and Ryle, 1921; Campbell and Conybeare, 1924). In 1946 there was published a survey of a group of young students at Harvard 'who had general all-round "normal" reactions'. The following are some of the medical data:

Measurement	No. of individuals	Mean	Range
Pulse: recumbent	259	66·1	40 – 96
Blood pressure, recumbent (mm. of Hg):			
Systolic	265	114·9	98 –146
Diastolic	265	71·7	40 – 92
Red blood cells (millions/cu.mm.)	254	5·04	4·25– 5·60
Haemoglobin (%)	255	97·4	85·4 –107·8
Blood sugar (mg. %)	147	100·0	84 –125
Respiratory ventilation (l./min.)	209	7·0	3·5 – 14·4

16. Though blood pressure tends to rise with advancing age it is difficult to say when this is pathological, even though safety margins may be reduced. Hobson and Pemberton (1955) found that in a random sample of old people living at home 43% had a resting diastolic blood pressure of 100 mm. of mercury or over and most of these were 'in good health'. Blood pressures fitted a Normal curve and the dispersion as indicated by the mean ± twice the standard deviation was (mm. of Hg):

	Males	Females
Systolic	107·3–236·9	117·4–250·6
Diastolic	55·4–127·4	66·2–131·8

'There was no significant correlation between height of the systolic or diastolic blood pressure and vertigo, tinnitus, angina of effort, clinically detectable arteriosclerosis, radiological size of heart, the subject's well being and activity

or albuminuria.' The following normal ranges of biochemical values were found in elderly males (similar variation was found in females):

	No. of subjects	Mean	Dispersion (± 2 s.d.)
Haemoglobin (g./100 ml.)	177	14·4	10·8– 17·9
Serum calcium (mg./100 ml.)	35	10·1	9·0– 11·2
Serum cholesterol (mg./100 ml.)	98	268	176 –409*
Serum alkaline phosphatase (K.A. units)	64	8·3	2·7– 25·5*
Blood urea (mg./100 ml.)	50	39·1	26·4– 57·8*

* Dispersion calculated on lognormal scale and converted into ordinary values.

17. The human eye provides an interesting example of successful correlation between elements which vary freely over quite a wide range; though the various components of the optic system (axial length, depth of anterior chamber, refractive power of lens, refractive power of cornea) are each distributed Normally in the population, the distribution of total optical refraction is not Normal but is very sharply peaked—the long eye tends to get a thin cornea and lens (Sorsby, Davey, Sheridan, Tanner and Benjamin, 1957).

ABNORMALITY

18. It is the successful adaptation of the complex human organism as a whole to the particular variates of composition and function with which it is endowed and to the external environment in which it has to survive that constitutes good health. Account must also be taken of the need to adapt to physical and emotional stresses, and to environmental changes. This adaptation is essential to stability and survival, but it is not satisfactory to measure sickness simply by failure to survive, though in the last resort, e.g. in under-developed countries where morbidity statistics are deficient, mortality may be used as an index of general health. Departure from the well-being that constitutes good adaptation is usually identified as 'the point at which either (*a*) the subject began to be conscious of symptoms or some disability or (*b*) someone else decided that disease was present of a nature which could not continue to be ignored without danger to the patient' (Stocks, *c.* 1949).

COMMUNICABLE DISEASE

19. It was in fact the danger to other persons as well as to the patient that stimulated the earliest form of morbidity reporting, *i.e.* statutory notification of infectious disease; and it was the spread of 'fearful diseases overstepping the locality where they are born' with which early epidemiologists were concerned.

20. The purposes of notification cover

(*a*) Planning of facilities for treatment, e.g. opening up of a pool of hospital beds when necessary.

(*b*) Local administrative action:

(i) isolation of infectious cases or sources of infection,
(ii) prophylaxis,
(iii) disinfection,
(iv) after-care.

(*c*) Medical intelligence:

(i) epidemic control,
(ii) morbidity indices.

(*d*) Epidemiological research.
(*e*) Diagnostic study.

Morbidity measurement is only one and not the most important of many objectives, most of which are concerned with action in the field of medical administration.

21. The following diseases are notifiable in England and Wales: anthrax, cholera, diphtheria, dysentery, encephalitis, erysipelas, food poisoning, leprosy, malaria, measles, meningococcal infection, plague, pneumonia, poliomyelitis, puerperal pyrexia, scabies, smallpox, tuberculosis, typhoid fever, typhus, whooping cough. Many of these diseases have been virtually banished from this country by modern hygiene—anthrax, cholera, leprosy, malaria, plague, smallpox, typhoid, typhus—and the incidence of diphtheria has been dramatically reduced by measures of immunization to an insignificant level. Antibiotics and sulpha drugs have so added to the efficacy of treatment that dysentery, erysipelas, measles, pneumonia, puerperal pyrexia and whooping cough have ceased to be regarded as dangerous in the absence of any specially complicating factors such as pre-existing disease or advanced age.

22. It would be impossible, even if the paper were wholly devoted to it (and the author were competent), to encompass all the achievements or outstanding problems of classical epidemiology. There is space only to mention a few aspects relating to the main theme of morbidity measurement.

23. Completeness of notification in London has been tested by Benjamin and Gore (1952) for measles, scarlet fever, and whooping cough, by comparing the incidence of these diseases as recorded by statutory notifications, by the infectious disease pre-admission histories of children admitted to hospital for diseases other than that under review, and by school absence records. The normal method of measurement is to express new cases notified within a specified interval as a rate per 1000 of the population at risk. Where infectious diseases are endemic it is merely a matter of time before the infection is encountered, and since the period of time is short the common fevers are characteristically diseases of childhood; for this reason the population at risk is sometimes restricted to those under age 15, though detailed treatment usually extends to the provision of rates for at least ages 0–4, 5–9, 10–14, 15–24, 25–44, 45 and over. A useful summary measurement is obtained by ignoring mortality and assessing the risk of contracting the disease before age y by the expression

$$\sum_{x=0}^{x=y-t} t.r_{x|x+t-1},$$

where $r_{x|x+t-1}$ is notification rate for the age group x to $x+t$ calculated over a period sufficiently long to embrace the normal proportion of epidemic and non-epidemic years. For measles which in most large towns is epidemic in alternate years a two-year period is sufficient; for whooping cough and scarlet fever there is no fixed epidemic rhythm, though there is considerable variation in incidence from year to year, and it is advisable to take a period of two or three years.

24. Benjamin and Gore also made estimates from the same hospital and school records of the incidence of certain common fevers which are not notifiable, *viz.* rubella, chickenpox and mumps.

25. The results were summarized as below:

Disease	Percentage of children attacked	
	By age 5	By age 15
Chickenpox	20	45
Rubella	7	15
Measles	35	65
Mumps	10	15–30
Whooping cough	25	35
Scarlet fever	4–5	10–12

26. As a result of therapeutic advances none of these diseases is now regarded as lethal, but in case it should be thought that they are all of no importance it may be mentioned that measles, through secondary ear infection, plays an important part in the aetiology of acquired, as distinct from congenital, deafness and whooping cough appears to provide a significant risk of subsequent bronchiectasis and, if coincident with primary tuberculous infection, of the infiltration of the latter. Infection with rubella during pregnancy carries a high risk of foetal abnormality.

27. Stocks (1949) has examined the degree of completeness of notification in England and Wales as a whole by comparison with Survey of Sickness statistics (see §45) and reached the conclusion that 'thinking of the rates of illness in terms of the typical manifestations of the disease and excluding subclinical varieties, doubtful cases and evidences of infection without definite clinical symptoms' the degrees of completeness were:

Acute poliomyelitis Cerebrospinal fever Diphtheria Scarlet fever	Notification is fairly complete
Respiratory tuberculosis	Probably nine-tenths notified
Typhoid and paratyphoid	Probably four-fifths notified
Measles	About two-thirds notified
Pneumonia	From a third to a quarter notified
Whooping cough	From a quarter to a fifth notified
Erysipelas Non-respiratory tuberculosis	Defective to an indeterminate degree
Dysentery	Notification only fractional

There is reason to believe that since 1949 there has been an improvement in the completeness of notification of tuberculosis, whooping cough, and especially of dysentery (for which numbers of notifications in England and Wales have risen from 4538 in 1949 to 31,858 in 1954).

28. For infectious disease to be notifiable it has to be *recognized*, which means, usually, that there have to be overt symptoms. An intriguing problem

of modern epidemiology is provided by the subclinical (symptomless) infection which appears to be a necessary postulate to explain the epidemic behaviour of at least two diseases, measles and poliomyelitis. There is space only for the mention of the case of poliomyelitis. As long ago as 1932 Stocks pointed out that it was rare for an epidemic to produce frank attacks in more than a small proportion of the population, and that there must be a high proportion of people who had acquired immunity by previous and silent infection. He found that in a local outbreak in Lancashire a second case in the same family occurred in only 1 in 162 of the houses affected. Taking the average size of household from census data as 4·5 and assuming from serological investigations in a similar community that 35% of the population were non-immune, he argued that $[(4{\cdot}5)({\cdot}35)-1]$ would be the number of non-immunes secondarily infected per family but only 1 in 162 of these would show symptoms, so that if s is the number of subclinical infections for each frank case

$$[(4{\cdot}5)({\cdot}35)-1]=s/162,$$

giving $s=93$. Using a method which avoided making an estimate of immunity but involved assumptions about the recognition of minor febrile reactions in the presence of a frank case, Daley and Benjamin (1948) obtained an estimate of 120 for s in the epidemic outbreak of 1947. The feature is of importance in supporting other sources of evidence that the virus is ubiquitous and that its spread is not susceptible to the type of epidemic control operated in smallpox outbreaks; and in enabling estimates to be made (on the basis of past notification rates) of the current level of immunity.

29. Mention ought to be made of the virtual banishment of diphtheria by immunization measures. Cases in England and Wales have fallen from 41,404 in 1942 when the campaign virtually began to 155 in 1955, and deaths from 1827 to 13. The type of measurement involved here is not an attack rate (which is trivial) but a local index of immunity. Assuming immunization takes place at 8 months of age and runs down in effectiveness over a period of 5 years, local returns of proportions of children of birth year $1956-x$ who (at 31 December 1956) have been immunized within the last five years are scrutinized to ensure that for $x=0$ the proportion is not seriously short of 33% (since this is the maximum proportion of infants that can be injected after 8 months of age and within the calendar year of birth), and for $x=1$ not below 100% by a margin greater than that which experience has shown to be safe; 75% might be regarded as acceptable (given the inevitability of a certain hard core of 'refusals'). For $x=5$ or more some credit can be given to injection of more than 5 years' duration by applying a less stringent yardstick of say 60%.

30. Epidemiological research has been much stimulated by the application of modern probability theory. The classical mathematical models have been deterministic (see, for example, Soper, 1929) in the sense that given rates of infection and accession and removal of susceptibles, the number of new cases arising in a particular interval of time is definite and determined by the proportion of the population which is still susceptible at that time. This leads to an epidemic curve of the type

$$x=m+\int_0^t (a-z)\,dt \quad \text{or} \quad \frac{dx}{dt}=a-z,$$

where z = cases per unit time, x = number of susceptibles, a = accessions of susceptibles per unit time, m = steady state, or level, number of susceptibles, when one infects one.

31. Bartlett (1949) and Bailey (1950) have stressed that a more complete stochastic model should be used to take account of the fact that the single point on the deterministic curve ought to be regarded as the mean of a probability distribution. The smoothness of observed epidemics which has seemed to support deterministic theory arises from the fact that the statistics observed represent combinations of several restricted epidemics occurring at the same time with attack rates further smoothed by being averaged over finite intervals. Nevertheless, while the deterministic curves indicate the growth of an epidemic when numbers are large, they are not adequate when numbers are small or in the important early stages of an epidemic. The mathematics of the stochastic approach are formidable and lead to equations which are far from simple, but they appear to offer a sounder basis for prediction. One practical advantage may be mentioned. The deterministic theory involved a degree of damping in successive epidemic waves which is not observed in large communities. The stochastic theory does not result in damping terms in the equations and permits recapitulation of epidemic waves more in accord with experience.

TUBERCULOSIS

32. Tuberculosis has been so grave a problem in itself that it has always been considered apart from other infectious diseases. First of all there is a contrast between infection and disease; a large proportion of the population are infected before or during adolescence (perhaps two-thirds by age 20 (Medical Research Council, 1952)), and there are comparatively few adults who have not had a history of infection, whereas the proportion of the population on the registers of tuberculous patients supervised by chest clinics is only ·76% (Ministry of Health, 1956). Thus only a small proportion of those infected ever show significant signs of disease—the majority of primary infections heal uneventfully without active treatment. Secondly, the disease is characterized by a long period of chronic invalidity; even before chemotherapeutic agents were used the average period between notification and death for respiratory tuberculosis was 2·2 years (Stocks and Faning, 1944), and the deaths were fairly widely dispersed in time. Since the introduction of streptomycin and other antibiotic and chemotherapeutic agents and the bolder lung surgery which the powerful antibiotic 'covers' have permitted, mortality from tuberculosis has plunged downward. For example, for males aged 25–34 the mortality rate for respiratory tuberculosis which had fallen from 961 per million in 1931–35 to 674 in 1941–45 has dropped to 93 in 1955, i.e. less than one-tenth of the level of 20 years ago. Much longer periods of survival are now involved. In a recent study of a normal cross-section of chest clinic cases notified in 1949 and treated by chemotherapy or surgery, the proportion surviving 5 years was 83·4% (Caplin, Griffiths and Silver, 1956). As to the period of incapacitation, National Insurance records (unpublished data) indicate that the median length of spells of sickness claim due to respiratory tuberculosis terminating in 1953–54 was for males 352 days and for females 455 days. For those who are required to undergo institutional treatment the average duration of such treatment is 6 months (General Register Office, 1954).

Even though results of treatment are infinitely better now than formerly it is clear that the disease prevents the sufferer from carrying on a normal life for a period of a year or so in most cases, and in some cases for years. It is still a fact that every year in Great Britain 26 million person-days are lost to industry as a result of tuberculosis in respect of those covered by insurance, apart from the loss for non-insured persons.

33. Since the disease spread throughout the community each succeeding generation has fared better in combating the ravages of the 'white scourge'. This feature has been extensively analysed on a cohort mortality basis by Frost (1939), Springett (1950), Daw (1950) and Spicer (1954). Generally the results may be summarized by saying that though for men the secular trend is that the peak of mortality in middle adult life has moved steadily to later ages and become diminished, this is mainly due to succeeding generations having lower mortality, so that the residual (at late ages) of the high mortality of an early cohort is greater than the early adult peak of the present generation; for women in whom the disease has always been more fulminating and less chronic the peak has remained in early adult life but has become greatly diminished. This has led to the suggestions that more developed communities have been 'breeding out' the disease (i.e. producing, by natural selection, genetic strains of lessened susceptibility), or alternatively, that the bacillus itself has become less virulent. There is little evidence to support either suggestion. A much simpler explanation is possible. The problem of tuberculosis is a volumetric problem of a reservoir of infection, i.e. of the quantity of bacilli freely circulating. Reducing the spread of the disease both by isolating diagnosed infectors or reducing their infectiousness by treatment and also by providing fewer opportunities for unknown infectors to infect others in crowded and ill-ventilated workshops, and increasing general resistance to disease by improved social conditions, has resulted in succeeding generations having a reduced risk of meeting heavy doses of bacilli. Since the war this process has been tremendously accelerated by the great rapidity with which modern chemotherapy sterilizes the lesion and renders the patient non-infectious, and by improved case-finding which has enabled more infectors to be detected and rendered non-infectious. It should be borne in mind that it is indeed a question of how much disease is contracted in early adult life, as most of the morbidity of later adult life is due to breakdown of old lesions (Springett, 1951). Indeed, this underlies not only the constancy of the cohort pattern but explains some of the deviation from a simple picture to which Spicer (1954) draws attention. The following notification rates for respiratory tuberculosis per 100,000 in England and Wales for (pre-chemotherapy) 1946 and 1955 complete the picture:

	0–	5–	15–	25–	35–	45–	65+
Males: 1946	32	46	179	174	125	138	54
1955	36	34	125	110	96	121	81
Females: 1946	28	49	213	141	65	35	16
1955	35	38	156	112	59	30	17

The risk of contracting disease in adolescence is clearly diminishing. (There has been some concentration on the detection of the often symptom-free elderly sputum-positive male and this explains the higher rate at 65+.)

Definitions	Rate	Crude	Adjusted
Period = either from date of commencement of treatment or from first diagnosis but must be stated A = alive at end of period A_0 = no evidence of disease A_c = cancer present A_x = presence of cancer uncertain D = known to be dead (similar suffixes apply to conditions at death as for A) L = untraced at end of period p = survival rate (comparable for age, etc.) in general population excluding cancer	*Survival rate*: number of persons alive at end of period of observation as proportion of those alive at beginning *Apparent recovery rate*: number alive with no evidence of disease as a proportion of those alive at beginning of period of observation	$SR_{cru} = \frac{A}{A+D+L}$ $RR_{cru} = \frac{A_0}{A+D+L}$	$SR_{cor} = \frac{SR_{cru}}{p}$ to allow for natural mortality $RR_{adj} = \frac{A_0\left[1+\frac{A_x}{A_0+A_c}\right]+\frac{1}{2}D_0\left[1+\frac{D_x+L}{D_0+D_c}\right]}{A+D+L}$ to allow for period of freedom of disease of deaths and untraced. Other possibilities are to equate D_x to zero and to omit L altogether

CANCER REGISTRATION

34. Another way in which sickness may be identified is in the form of a system of total registration of cases of malignant disease. Where disease runs a long chronic course, something more than mere notification is required. Treatment is protracted; in some cases radical and in others palliative. There exists, at any one time, a large population of patients in various stages of the disease. In the absence of a specific cure of unquestioned efficacy there is at any one time not only a large volume of treatment in process but also a large programme of research into new forms of therapy. There is a great need for information of aetiological significance, of response to treatment and of ultimate survival, for different sites and stages of disease, for different methods of treatment and for different sections of the population; and this information must be on a comparable, i.e. uniform, basis. A system of registration existed in this country before World War II for cases treated by radiotherapy as part of the control over radium, an expensive commodity; this was reorganized by the Radium Commission in 1945 in accordance with Ministry of Health and General Register Office proposals, and in 1947 the General Register Office took responsibility for the operation of the system. When the National Health Service Act came into effect in 1948 the continuation and extension of the plan for cancer records became the responsibility of the integrated hospital service. Though registration is not compulsory there is a gradual approach to completeness; in some areas this has almost been reached, though over the country as a whole it is doubtful whether more than two-thirds of all malignant cases are registered. Periodical follow-up analyses are published as a supplement to the Registrar General's *Statistical Review*; the latest appeared in 1955, and covered the 5-year survival of 1945–46 registrations to 1950–51.

35. Common measures are the survival and recovery rates as defined in the table opposite. The correction of the survival rate for 'normal' survival introduces the need for considering life tables omitting the operation of a particular cause—in this case cancer.

36. Something must be said about cancer of the lung, the increase in the mortality from which in older men has, with arterio-sclerotic heart disease, overshadowed improvements in mortality from other causes such as tuberculosis.

England and Wales—Males aged 55–74. Death-rates per million

Cause	1944	1954	Change
Cancer of lung and bronchus	993	2,659	+1,666
Other cancer	5,707	5,116	− 591
Arterio-sclerotic (including coronary) heart disease	3,241	7,147	+3,906
Other heart disease	6,066	3,425	−2,641
Pneumonia, bronchitis	3,832	3,792	− 40
Tuberculosis	1,077	727	− 350
Other causes	12,678	11,476	−1,202
All causes	33,594	34,342	+ 748

37. Atmospheric pollution is suspected, but investigations are not far advanced. A statistical association between smoking (especially cigarette smoking) and lung cancer mortality has been found. There have been a

number of statistical studies of which the most noteworthy in this country is that of Doll and Hill (1954, 1956) based on a prospective inquiry into the deaths of medical men with known smoking habits. In such vitally important aetiological studies the 'longitudinal' study, *viz.* following up well-defined groups forward in time, is clearly to be preferred to retrospective methods.

PRIVATE INSURANCE RECORDS

38. Coronary heart disease has been mentioned, and this provides an example of another method of sickness identification, the use of private sickness insurance records. The now classic study of coronary heart disease in male medical practitioners of Morris, Heady and Barley (1952) was based on the sickness and death records of 6,000 members of an assurance society, aged 35–64, who held non-cancellable sickness insurance, providing benefit, on receipt of a medical certificate, for periods of incapacity to work which lasted 7 days or more. The following statistics were derived:

(1) The annual incidence (by age) of first clinical attacks of coronary heart disease (coronary thrombosis, acute myocardial infarction and angina pectoris) during 1947–50.

(2) The annual death-rate in the period from this cause, subdivided not only by age but according to whether death occurred in the first 6 days of the first clinical attack, in the remainder of the first month, or later.

(3) The prevalence of coronary heart disease in 1950, i.e. the total proportion disabled from work during the year for as much as a week, or dying. It was also possible to give a measure of those attacked in 1949–50 who were not disabled in 1950.

(4) The prognosis for life, i.e. chance of survival for specified periods of time up to 7 years from first attack.

(5) The prognosis for further sickness absence, i.e. proportion absent again within a specified period of time and total working time lost.

(6) Comparisons were made of the separate experiences of general practitioners, general practitioner-specialists, full-time consultants and medical administrators, and comparisons were made with a large miscellaneous group of men in the civil services, in the professions and industry.

39. This study is of especial interest in that life-table techniques were extensively used both in the derivation of the desired rates (it was, for example, necessary to consider separately the decrements of deaths from coronary heart disease and deaths from all other causes) and in presentation of the results. The following example taken from the paper illustrates the clarity of such presentation:

Chance of getting coronary heart disease. Male medical practitioners

Age x (years)	Of 1000 men aged x, the number indicated below would get clinical coronary heart disease before age					
	40	45	50	55	60	65
35	3	10	27	67	130	200
40	—	7	24	65	129	200
45	—	—	18	59	124	196
50	—	—	—	43	110	184
55	—	—	—	—	72	152
60	—	—	—	—	—	90

SOCIAL INSURANCE AND SICKNESS ABSENCE RECORDS

40. While private insurance records alone lend themselves to detailed analysis there is a great deal of information about morbidity from National Insurance records. At first sight absence from work or (if not employed) inability to participate in the daily activities normally undertaken, appeals as a clear and unequivocal indication of sickness and on the whole this is true but there are two important reservations:

(1) Sickness absence for employed persons is often associated not only with the payment of National Insurance benefit but with benefits from private insurance with a Friendly Society and in many cases with maintenance of part or full wages by the employer. The point of time at which an employed person 'goes sick' may depend not only on the absolute fact of feeling unwell but on whether there is any loss of income involved and, if so, upon the degree of incapacity at which any financial pressure to remain at work ceases to operate. The same factors operate to determine the point of time at which he returns to work. Sickness absence becomes therefore a relative measure and may mean different degrees of illness for different groups of workers. Even for non-employed persons a similar difficulty arises; a housewife with a large family and unable to afford assistance may struggle to carry on longer than those with less responsibility and more domestic help.

(2) Not all sickness absence is medically certified, and even where it is so certified the administrative arrangements for the disbursement of sick pay may mean that the medical certificates cannot be made directly available to those who are concerned with statistical analysis, and the quality of the data may suffer in this respect if recording has to be left to works officials whose interests are naturally more in factory administration than in medical statistics and who do not appreciate the problem of classifying diagnoses. Furthermore, the need to submit the medical certificate to an employer may tend to make the medical practitioner circumspect in his description of the condition causing incapacity, if only that in the interests of the patient he may have to give a provisional diagnosis before he is certain (which means that subsequent certificates for the same absence may bear different diagnoses as he becomes more certain) or he may consider it expedient so to word his certificate as to be least likely to jeopardize the continued employment of the patient. Persons not gainfully employed, e.g. housewives, are less likely to consult doctors for minor degrees of incapacity, and even where the conditions are serious it is unlikely that they would voluntarily produce medical certificates to satisfy the needs of any survey of incapacity; such surveys therefore are only likely to elicit information about the conditions they 'complain' of rather than precise diagnoses. (This is not to say that statistics of 'complaints' are without value.) Generally, therefore, practical conditions militate to weaken the validity of the diagnostic classification of sickness absence records.

41. Watson emphasized (1930) that sickness benefit as provided by Friendly Societies and by the original compulsory system of National Health Insurance of 1911 was strictly associated with suspension of earning capacity attributable to disability, and was not primarily concerned with the underlying cause of the disability itself. In such circumstances the establishment of medical diagnosis is less important than the practical difficulty of establishing loss of earning capacity, with the immediate problem of deciding whether inability to work

is to be assessed in relation to usual occupation, any alternative employment which might normally be available, or on more absolute standards. The danger of confusing this concept with true morbidity can be emphasized by the fact that even in times of improving hygiene and falling mortality, sickness claims were often found to increase substantially if economic incentive to claim were provided by unemployment or by any relaxation of the rules of the Friendly Societies. From the earliest times therefore the actuary concerned with sickness insurance has been accustomed to measure sickness in terms of the 'average number of weeks of sickness (claim) experienced by each individual between ages x and $x+1$'.

42. We are not directly concerned here with the financial aspects of such sickness rates but with information that may be yielded on medical causes of disability. A detailed breakdown of National Insurance statistics is given in the *Digest of Statistics Analysing Certificates of Incapacity* which is produced regularly by the Ministry of Pensions and National Insurance. This Digest is a collection of basic facts and the calculation of rates is left to those who refer to it, the numbers at risk being provided. Over and above the range of statistics of claims familiar to most actuaries and reviewed in a recent Government Actuary's Report (1956) the main interest in the Digest lies in the extensive analysis of spells of sickness by certified medical diagnosis and by duration.

43. From these tables it is possible, for example, to see that of the 187·76 million days of incapacity in 1953–54 for males, 20·32 million or 10·8% were attributable to bronchitis. No other cause contributed so large a proportion. Spells commencing in the year to 5 June 1954 per 1000 at risk rose from 15·6 at ages 15–19, to 27·6 at 40–44 and 88·6 at 60–64. At 5 June 1954 1·8 per 1000 of males aged 40–44 and 16·5 per 1000 of those aged 60–64 were incapacitated from this cause. Of the 52·8 thousand incapacitated by bronchitis at 5 June 1954, 26% had been incapacitated up to 1 month and 17% had been incapacitated for 3 years or more. Similar information can be derived for a large selection of other diagnoses. With all reservations this is an important source of information on morbidity.

44. In keeping with this type of information are the sickness absence records maintained by certain of the larger industrial concerns in this country. A detailed report of the system instituted at the London Transport Executive has already been given (Lloyd and Spratling, 1951), and it is not proposed to repeat the details here, except to draw attention to the problem of recording and classifying diagnoses in sickness absence in industry. The type of detailed analysis that would be appropriate to clinical records in hospital or in cause of death classification would not be supported either by the quality of the data or by the use to which the tabulations are put. Broader categories have to be devised, and this cannot be done unless there is some understanding of what a diagnosis means. An important collection of tables has recently been published (London Transport Executive, 1956), and these represent a good illustration of the wider view of epidemiology, *viz.* the comparison of the disease pattern at different ages, in different occupations within well-defined limits of measurement and with intimate knowledge of working environment, and selective forces. Some mention should also be made of an important work of a similar character on absence records in the Post Office (Roberts and Reid, 1954).

SOCIAL SURVEY

45. From 1944 to 1952 the Social Survey interviewed at the beginning of each month samples of the civilian population of ages 16 and over and recorded the illnesses and injuries said to have been experienced during each of the two calendar months preceding. The size of each monthly sample throughout England and Wales was about 3000; it was drawn from local card indexes of the National Register and was representative of all areas, urban and rural (Slater, 1946; Box and Thomas, 1944). An account of some of the results of this survey has been given by Stocks (1949), and routine tables were published in the Quarterly Returns of the Registrar General from 1947 up to the end of the survey. Stocks (1949) tested the adequacy of the sample and found it sufficiently representative and large to support the calculation of incapacity rates by diagnostic group and by age and sex and for quarter to quarter comparisons of sickness incidence. He also examined the 'memory factor', i.e. the tendency for people to post-date the inception of an illness to a date nearer the date of interview or to forget the more remote illnesses. For 'new and recurrent illness starting' the rate (all ages combined) in the more recent month of the interview period was 109% of that for the two months combined for males, and 107% for females; hence the decision to base rates on the two months combined. Several different rates were calculated for routine publication, e.g.

Prevalence rate, i.e. number of illnesses present in the population at any time during the period, regardless of when they began, per stated number of population.

Sickness rate, i.e. number of persons who were ill at any time during the period, regardless of when they began to be ill, per stated number of population.

Inception rate, i.e. number of illnesses which began during the period, per stated number of population.

Incapacity rate, i.e. total days of incapacity (away from work, or for those not working prevented by illness from going out of doors) per stated number of the population during the period.

Rates were calculated in denary age groups for each sex for different medical cause groups, and for all causes combined for different industrial groups and for different income groups (i.e. income of the principal wage earner in the family). Frequency rates of medical consultation were also recorded. The survey of sickness provided a general indication of the level of morbidity in the population at a time when other sources of information were not developed. A possible criticism of the survey is that general statements of symptoms by the public themselves were forced into a detailed diagnostic classification, whereas the sickness presented here was essentially a record of how people 'felt'. Indeed, a survey of 'complaints' related strictly to what the people interviewed actually said would provide a valuable supplement to analyses of medically certified sickness; it might help to provide a bridge between vague symptomology (backache, depression, etc.) and identifiable anatomical or physiological abnormality.

46. The survey method has also been used to great advantage in special occupational studies. For example, an epidemiological study of the incidence

of colds in office workers was carried out by obtaining detailed histories of 'cold' experiences each week during a period of several months (Reid, Williams and Hirch, 1953).

HOSPITAL RECORDS

47. A possible method of identifying sickness (of a severer character) is by reference to hospital admission. The advantage is that in most cases a firm diagnosis can be made, supported by every available objective clinical and laboratory test, and a clear description given of treatment. There are, however, serious disadvantages. Morbidity implies a risk or rate, and there is no population at risk to which tabulations of hospital clinical records can be related until 'catchment areas' can be more precisely defined. Furthermore, inquiries based on in-patient records are directed, not to all sickness, nor to all sickness serious enough to be treated in hospital, but only to those illnesses which in the circumstances of the moment (waiting lists, medical priorities, etc.) are actually accepted for hospital treatment. Unless patients can be compelled to utilize a particular hospital rather than one of choice, and unless hospitals are equally compelled to accept a rigidly defined spread of diseases and degrees of severity, these disadvantages appear likely to continue.

48. This is not to say that hospital records are not a valuable source of information about the actual utilization of hospitals, and forms and results of treatment. The principal value of hospital in-patient analyses lies in the picture they present of the contemporary clinical work undertaken by the individual hospital. Changes in this picture over a period of time provide information which is essential to the proper allocation of beds, surgical facilities, ancillary diagnostic services and staff; to the arrangement of teaching programmes; to the design of selective admission policy. Statistics of outcome of treatment (recovery rates, incidence of complications, length of stay) for specific diagnostic entities can provide an index of the efficacy of hospital care. All this is essential but it is not morbidity measurement.

49. There are exceptions to all sweeping assertions. A number of acute forms of disease are invariably admitted to hospital, e.g. some acute fevers (tuberculous meningitis, poliomyelitis, typhoid, diphtheria, meningococcal infection, etc.), acute psychosis, abdominal emergencies (acute appendicitis, perforated peptic ulcer, obstructed hernia), renal or urinary calculus, osteomyelitis, major injuries, burns and poisonings. For such conditions as these it would be true to say that national hospital admission rates could be calculated and an assessment made of age, sex and occupational differentials.

GENERAL PRACTITIONER RECORDS

50. Most medical care services have their focus in the family doctor, and it is natural to look to general practitioner records for comprehensive statistics of morbidity. Ideally the general practitioner would be making regular observation of families within his care and noting the incipience of the earliest symptoms of even minor degrees of disease. This ideal is some distance away. Owing to freedom of choice the general practitioner does not see all members of the family except in a proportion of cases as low as 60% for the typical family of a married couple with children (Backett, Shaw and Evans, 1953), and since practices are large he does not see them regularly but only when they are sufficiently unwell to demand his attention.

51. A further difficulty is that general practitioner records by their very nature do not lend themselves easily to statistical analysis. When a patient enters the surgery of a general practitioner it is by no means usual for an immediate diagnosis to be made; if it were so it might simplify statistical analysis but it would probably *not* be good medicine. Very often the record card of a patient will show a series of visits with notes of various symptoms and reaction to prescribed treatment, and the patient may then be referred to hospital without a formal diagnosis necessarily being recorded (though most hospitals now endeavour to keep general practitioners fully informed about the progress of patients referred to consultants), or alleviation of symptoms may cut short attendances and the record may not be completed unless the doctor has the opportunity to review his records for that purpose. Patients sometimes attend for minor degrees of discomfort or for advice, for example, about fitness for jobs or about marriage, and in such cases there may be a great deal observed but little to record.

52. Despite these difficulties a number of important studies of illness in general practice have been made (Pemberton, 1949; McGregor, 1950; Fry, 1952; Backett, Shaw and Evans, 1953; Backett, Heady and Evans, 1954; Logan, 1953). The last-named reference is to a pilot scheme developed by the General Register Office early in 1951 and operated in eight practices. In co-operation with the newly formed College of General Practitioners this scheme has since been extended to more than a hundred practices covering nearly half a million patients.

53. The main morbidity measures emerging from general practitioner records are: (1) the rate of new cases of particular disease groups per 1000 persons registered within a specified interval, by sex and age; (2) the proportion of persons in a particular sex and age group who consult their doctor t times within a specified interval ($t=0, 1, 2, \ldots$); (3) frequency distributions of duration of treatment.

54. A difficulty which has not been entirely solved and which affects the accuracy of populations at risk used as the denominators of rates, is the inflation of doctors' lists arising from the lag in, or omission of, notification of removal. Arrangements exist for the notification of removal on death even where the general practitioner is not in attendance, but in cases of change of practitioner the old list will not normally be corrected until the removing patients register with new doctors, and they may not sign the necessary cards until some ailment brings them to the new doctor's surgery. In the meantime the doctor to whom they transfer has patients actually at risk for whom he has no records, and this helps to offset the inflation due to unnotified removals, but on balance it is found that lists are subject to inflation to an extent which varies according to whether or not a practice is growing.

55. In the study of Backett *et al.* (1953) the size of the practice was checked by writing to every name on the register and by home visits in some cases. The following figures were recorded:

	Number	Excess (%)
Individuals registered and found to be present	3037	—
Individuals registered according to local Executive Council	3483	15
Individuals registered according to the medical record envelope held by doctor	3611	19

Of the 574 (i.e. 3611 – 3037) 'missing' persons, 59 were found to have died, 178 had transferred to another doctor, 284 had no local record and could not be traced, and 53 were accounted for by duplicate cards.

56. Mention must be made of *ad hoc* surveys conducted under the auspices of the College of General Practitioners, e.g. a study of acute chest infection as seen in general practice based on a 'clinical reconnaissance' by 55 general practitioners (1956) has provided valuable information of the various syndromes seen and of their meaning. It is likely that there will be considerable developments in the future.

MENTAL DISORDER

57. Limitations of space prevent justice being done to the problem of measuring the total volume of mental disease in the community. This problem itself epitomizes all that has been said about the dispersive character of normality. In the General Register Office survey of general practitioner records referred to above, it was found that the number of patients consulting their doctors for psychoses, anxiety reaction, asthenic reaction, other psychoneuroses, alcoholism, mental deficiency and other disorders of character were (annual rates per 1000 of the practice populations):

Period	Males					Females				
	0–	15–	45–	65+	All ages	0–	15–	45–	65+	All ages
1951–52	15	41	37	34	33	19	77	100	63	68
1952–54	19	40	43	39	34	18	84	98	66	71

These figures are not necessarily representative of the country as a whole, but the rates are impressively large, especially for adult females. Of 4732 patients consulting for psychoneuroses only 473 or 10% were referred to hospital for in-patient or out-patient treatment. Hospital statistics therefore only touch upon the hard core of a very large problem.

58. It is only in respect of hospital treatment that comprehensive statistics exist. The General Register Office, on behalf of the Ministry of Health and the Board of Control, compiles statistics based on admission and discharge records of all the National Health Service mental hospitals and mental deficiency hospitals in England and Wales. The statistics cover age, sex, marital status, occupation, diagnosis, length of stay, cause of death if dying in hospital, and distinguish first admissions from readmission; the relevant tabulations are published in supplements to the Registrar General's *Annual Statistical Review*. The broad picture is of a standing mental hospital population fed by admissions tending to be concentrated both in early adult life and at advanced ages, a large proportion of which is subject to rapid turnover with a duration of stay of only a few months and with a hard core remainder who stay for very long periods, in many cases until death. In so far as contemporary changes in admission rates may affect the hospital population structure for many years to come, the statistics lend themselves to actuarial calculations of an 'emerging cost' type.

CONCLUSION

59. This necessarily condensed review of current morbidity measures illustrates the gap which still exists between the concept of disease as a wide dispersion of conditions, ranging from some unknown limit of 'health' to a very definite limit of death, and the available indicators of disease incidence and prevalence. Where in the corresponding time scale between incipience of abnormality and death, do the indicators have their reference point? What is the relative sensitivity of the indicators to changes in the well-being of the population? What correlation is there between them? There is still a wide field for research and experimentation, in which a primary part will be played by the 'longitudinal' study, i.e. the carefully controlled follow-up of a group of 'healthy' persons of well-defined social characteristics in whom the emergence of disease may be closely observed and recorded in its detailed presentation and in proper relation to biological and external environmental factors which may be involved in causation, in the rate of development, or in the possibility of reversion.

60. If such an approach were also to be made to the study of mortality experience, life assurance underwriting would have a stronger scientific foundation, since there would be a more rational basis for the classification of impairments resulting from the deeper understanding of the significance of various degrees of abnormality. The latest Impairment Study of the Society of Actuaries (1954) stated: 'The data in many impairment classifications are particularly heterogeneous. Some classifications are heterogeneous simply because they cover a variety of conditions. Others are heterogeneous because, for practical reasons, risks have been grouped together without regard to the varying accuracy or credibility of the information concerning the impairment. A further degree of heterogeneity has been introduced into the combined inter-company experience by differences between companies in their underwriting and classification practices... In interpreting the mortality findings for various physical impairments, it should be kept in mind that most medical examinations for life insurance are not as intensive as the usual diagnostic examinations in medical practice. Moreover, applications sometimes fail to report complete details concerning the adverse aspects of their medical histories... Many of the impairment classifications, especially those relating to conditions found upon examination, do not represent specific clinical diagnoses, but rather reports of physical or laboratory findings. Such data and particularly the laboratory findings may not in some cases reflect any disease or its causal pathology yet may in other cases be symptomatic of any one of a number of diseases.' These reservations do not mean that the results of the study are not of value—they represent a considerable advance on previous knowledge—but they do indicate scope for further advance.

61. There is a field for research in the development of concepts and definitions for disease measurement. The Statistics Sub-Committee of the Registrar General's Advisory Committee on Medical Nomenclature and Statistics has examined the problem of defining morbidity measures (1954) in two stages: (i) the choice of descriptive words, e.g. the substitution, for the general term 'sickness', of words more specifically describing the character of the condition measured, such as 'sickness absence', 'in-patient care', 'general practitioner consultation'; the substitution of 'inception' (to indicate 'beginning') for

'incidence' which is too broad in current usage; (ii) classification and definition of rates, i.e. distinction between rates relating to inception, prevalence, duration and fatality respectively. In each case the rate is given a full definition and a short title. For actuaries the most challenging of the recommendations is that relating to the measure which the actuary has always called a 'sickness rate'. This is called 'the average duration of sickness per person' (short title—'average duration per person') and is defined as 'The total duration within a defined period of all spells of sickness that occurred wholly or partly within that period divided by the average number of persons exposed to risk during the period'. In this paper reference has been made to new cases of disease occurring in a period (inception), to cases of disease existing at a point of time (prevalence), to sickness absence (duration), to frequency rates of consultation. It is important that all such measures should be subjected to close scrutiny in order to ascertain whether their meaning is sufficiently explicit and is capable of precise definition, whether they are the most convenient to calculate, and whether they are most adapted to the purposes for which they were devised. The language of disease measurement is still evolving and there is considerable scope for improvement in precision. A challenge is here offered to a profession which has a traditional interest in precise measurement.

62. It is essential that any advance in morbidity measurement should be related to utility. The development of soundly based theoretical concepts is vital to the production of meaningful indices of morbidity. But these indices, and the means whereby the data for their production is derived, must be adapted to such administrative and clinical needs as they are ultimately required to satisfy. These needs include the administration and planning of medical services of all kinds, including the assessment of the efficacy of such services and preventive as well as curative medicine. They include the administration of social security services, welfare services in industry, and the needs of private insurance institutions. There must be a proper balance between the content of the morbidity measure, the labour in its construction, its use value and not least the time factor in its release.

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ABSTRACT OF THE DISCUSSION

Mr B. Benjamin, in introducing the paper, said that the proper relationship between the denominator and numerator of any rate was a very important part of an actuary's training, and the technique in relation to sickness was set out fully in *Mortality and Other Investigations*, vol. 1, by Haycocks and Perks (1955), who had gone to the heart of the conceptual problem in saying 'There are degrees of sickness, although there is not, of course, any obvious scale of measurement', and 'It is clear that the idea of sickness (or 'morbidity' as it is sometimes called) as a general sociological phenomenon is very vague indeed.' He hoped that closer examination of that problem might yield positive advantages.

The first advantage would lie in the better understanding of the variables involved in sickness insurance even if that should amount to no more than a clearer recognition of the imponderables. Secondly, there might be a more scientific approach to underwriting and to the study of the special mortality risks of impaired lives, because defining an impaired life was essentially the same problem as defining sickness. The pertinent question was whether there was such a thing as an unimpaired life. As Perks (1952) had remarked in his paper *The Treatment of Sub-standard Lives in Practice* (*J.I.A.* **78**, 205) '...the first-class standard is a matter of deliberate policy rather than an objective criterion'.

Thirdly, and most important of all, the study of sickness might have a profound effect on their general approach to mortality measurement. It was quite true that many 'laws' of mortality had been proposed in which the gradual deterioration of vitality had been implicit. But finding a rational basis for a relationship between μ_x and $\mu_{x+\delta}$ still left a life table simply divided between the quick and the dead and in which the l_x column was accorded a quality of homogeneity which it did not possess. It might well be that the life table of the future would be more complicated.

Because there had been more recent work to report he had omitted reference to a great number of earlier investigations—for example, the industrial sickness studies pioneered by Bradford Hill (1927, 1929, 1930). Again, only since drafting the paper had he discovered the early papers by Elderton and Perry (1910) on sanatorium treatment for tuberculosis, already then calling for the conditions of randomization which in more recent times had been accepted as essential to the clinical trial. In 1913 Elderton gave a lecture, on the same subject, at University College which unfortunately had never been published. In it he had detected from the statistics that in determining subsequent mortality the stage of disease at diagnosis was more important than the treatment then available, a fact which had not been generally recognized until much later. Elderton had concluded: 'the rates of death and sickness in the community are the primary study of the actuary; and I would suggest to those of you, if there are any, who think that the subject I have discussed is merely one of medical interest, that the subject is thoroughly actuarial'.

In addition, he had not developed the mortality implications of sickness analysis and therefore had made no reference to related mortality studies in recent years, for example, papers by Barley (1948), Beard (1948), Ogborn (1953), and Phillips (1954). In the sickness field, he had omitted an American paper by Marks and Spiegelman (1946), developing a life table method for deriving age rates of occurrence of new cases of chronic disease from prevalence rates

by age—that was to say, proportions of the population known to be suffering from the disease at a point of time. The difference in a life table population of 'sufferers' between l'_{x+1} and l'_x less one year's special mortality, must be the new cases less one half year's special mortality, the special l'_x being derived from a standard l_x by applying prevalence rates observed in a field study. The implications for an extended life table to which he had already referred were obvious.

[A supplementary list of these further references has been added at the end of the paper.—Eds. *J.I.A.*]

Mr C. J. Cornwall, in opening the discussion, said the paper, together with the list of references, represented useful material for workers in the field of morbidity data. The author, however, awarded only semi-precious status to one type of stone which might in the long run prove to be as valuable as any, namely, records of absence from work, of which increasing use was being made. That reflected parallel trends in medical research on environmental factors and in the progress of preventive medicine.

During the nineteenth century preventive medicine was concentrated on the 'well-directed sanitary legislation' referred to in §2. That work was largely complete. The initiative was passing to industry. The Industrial Medical Officer, given the support of management, had the opportunity to make the next 50 years a period of spectacular progress, but, like the pioneers of public health before him, he would require statistics to build up his case for remedial action. In particular, employers' records of sickness absence, which permitted comparison between different occupations, might be of great value both for aetiology and for the development of preventive medicine.

Certain reservations to the value of sickness absence records were set out in §40, but those reservations should themselves be accepted with reservation. The level of sickness absence might be affected by variations in the degree to which loss of income was involved, but that need not invalidate a comparison of the experience of groups with the same employer but in different occupations, because it was likely that the two groups would have similar entitlement to sick pay and probably the same proportion of Friendly Society membership. Nor did differences in entitlement to sick pay invalidate comparisons of the distribution by diagnosis of the sickness absence records of two different employers.

The difficulties associated with certification and recording could be exaggerated. Usually, the uncertificated spells of absence were those of short duration and, although such spells might be of importance to the employer for administrative reasons, they were of minor interest to the medical research worker. For certificated absences there were, he thought, good prospects of classifying the certified diagnoses correctly, provided it had first been decided to use the records for research. Until that decision was taken, records which were collected and maintained for other purposes would probably not be suitable. The possibility remained that the diagnosis on the certificate did not reflect the true opinion of the general practitioner. That problem was probably not serious. London Transport had found that the proportion of diagnoses on certificates of absence which could not be ascribed, because of imprecision, to a specific 3-figure code under the International Statistical Classification was less than 2%. Even where a precise diagnosis was misleading, the difficulty could be reduced where staff were customarily seen by the firm's doctor on return to work, because he could amend the recorded diagnosis when he thought it expedient to do so.

Records maintained by individual employers had, perhaps, four potential advantages over statistics prepared from National Insurance data. First, they could be explicitly designed to yield the maximum of useful information for medical research. Secondly, the employer could know with complete accuracy the occupation of a particular member of his staff and often, also, his previous occupations in the same firm. National Insurance officials had not that advantage and there arose in practice all those difficulties of imprecise statement of occupational status which were so well known to students of the occupational mortality indices prepared by the Registrar General. The National Coal Board, for instance, were convinced that their staff did not suffer so high an incidence of sickness absence as the National Insurance figures would suggest. Presumably it was fashionable in some areas to claim a mining occupation when filling in National Insurance forms. Thirdly, the employer could readily produce controls to match, in respect of occupation, age, length of service or other factors, individual cases of a particular medical condition. Finally, and most important of all, the employer was likely to be in a position to produce satisfactory figures, by occupation, of exposure to risk.

There were some difficulties in the interpretation of sickness absence statistics which were not mentioned by the author. For example, the experience of different occupational groups was affected by the selection applied to members of the groups. That included both self-selection and the employer's selective processes. It applied on admission to an occupation and continuously while the occupation was followed. In addition, the extent to which a given clinical condition gave rise to sickness absence depended partly on the nature of the occupation. A group of retail shop assistants might experience a high rate of sickness absence from colds only because they were discouraged from coming to work with a cold; there might or might not be a high rate of incidence of the clinical condition described as 'a cold'. Thus, it was not always easy to say whether an observed difference in the sickness absence experience of two occupational groups was the result of occupational effects on health.

Records maintained by employers had provided material for research on many of the subjects covered by the paper. For example, reference was made in §37 to the suspected association between cancer of the lung and atmospheric pollution. London Transport data for maintenance workers in bus garages and trolleybus depots, respectively, revealed no significant difference in the incidence of lung cancer among the two groups. The workers in bus garages were exposed to heavy concentrations of diesel exhaust fumes; presumably the trolleybus workers were not. The similarity of their experience, therefore, suggested that there was no association between lung cancer and atmospheric pollution from diesel exhaust fumes. Stocks ((1952) *Brit. J. Cancer*, **6**, 99) had shown a significant correlation between the incidence of cancer of the lung and density of population per acre. He had suggested that lung cancer might be associated with atmospheric pollution from domestic coal fires, because the intensity of that type of pollution in a given area would vary with density of population.

It was noted in §43 that the largest single group of days of incapacity was that attributed to bronchitis. That disease represented a major problem and it was likely that an increasing volume of research would be devoted to it. London Transport data for bronchitis among maintenance workers in bus garages suggested that, allowing for the age distribution in different areas, the incidence of spells of sickness absence due to bronchitis was highest in the north-east of

London and lowest in the south-west. The north-east also had the greatest density of population, and that called to mind Stocks's work on lung cancer referred to earlier. The north-east might also have the highest level of atmospheric pollution from industrial sources, because the prevailing wind in the London area tended to blow smoke and fog to the north-east. Reid (*Proc. R. Soc. Med.* **49**, No. 10) had found similar evidence of an association between atmospheric pollution and bronchitis in relation to geographical area in the experience of Post Office staff in different areas of London.

Coronary heart disease was discussed in §§ 38 and 39 with reference to a survey of private sickness insurance records. Sickness absence records had also been used for research in that field. For example, Morris, Heady, Raffle, Roberts and Parks ((1953) *Lancet*, **2**, 1053 and 1111) had examined the sickness absence experience of London Transport drivers and conductors and of certain groups of Post Office workers. Bus conductors on double-deck vehicles were found to have less coronary heart disease than bus drivers, and postmen less than telephonists, executive officers and clerks. That suggested the hypothesis that men in physically active jobs had a lower incidence of coronary heart disease in middle age than men in physically inactive jobs. Comparison with the Registrar General's occupational mortality data appeared to give support to that hypothesis.

Heady, Morris, Lloyd and Raffle ((1954) *Brit. J. Ind. Med.* **11**, 20) had subsequently examined the previous sickness experience of London Transport drivers and conductors suffering from a first clinical episode of coronary heart disease and had compared it with the experience of a control group. They had found no evidence of a difference in the health history of the cases and the controls. The result supported the idea that coronary heart disease struck suddenly and without warning, but not that coronary heart disease selected particularly healthy men. Among the coronary cases, no absences attributed to related conditions such as hypertension or diabetes were recorded before the first attack of coronary heart disease.

More recently, Morris, Heady and Raffle ((1956) *Lancet* **2**, 569) had reported that they had begun to examine, with reference to London Transport drivers and conductors, the relationship between coronary heart disease and somatotype, or bodily configuration. Somatotype was indicated broadly by measurements of uniform, and the distribution of the exposed-to-risk by size of uniform had been obtained. Preliminary results indicated the existence of consistent differences between the two groups. At all ages drivers showed larger chest and waist measurements than conductors, even at ages below 30, when the difference must surely be the result of selective processes, including self-selection, rather than occupational factors.

It was encouraging to reflect that, for a particular group of persons, a sufficient volume of morbidity data for analysis was usually accumulated more rapidly than the necessary volume of mortality or other decremental data. Work in that field was hampered, however, because there was no convenient test of significance which could be applied to comparisons either of attack rates, that was to say inception rates or spells, or of sickness rates, that was to say average annual durations per person.

Coward's paper *The Distribution of Sickness* (*J.I.A.* **75**, 12) provided a theoretical formula for the standard deviation of the distribution of a group of persons by duration of sickness. Haycocks and Perks (*Mortality and Other Investigations*, vol. 1) discussed methods of obtaining, or estimating, the standard deviation in practice.

Two difficulties arose in the application of significance tests. First, it was necessary to calculate second moments of the distribution of persons by duration of sickness. That might not be easy if the records were kept in such a way that it was first necessary to bring together separate spells of sickness experienced by the same person. Secondly, the distribution of persons by duration of sickness was quite different from the 'Normal', so that any significance test rested on the fact that the mean of a sample from any type of distribution tended to be distributed normally if the sample was large. If the group under examination was not large, the position was obscure.

It had been suggested that the distribution of persons by duration of sickness was exponential in form. If that was so, it would be simple to apply an F test to comparisons of average annual duration to determine the significance of the results. A similar method had been adopted by Maguire, Pearson and Wynn (*Biometrika*, **39**, 168) in analysing coal-mining accidents. In his own experience, however, an exponential curve did not seem to fit that type of distribution. Nevertheless, it might be possible to fit sickness data with some type of distribution having a simple relationship between first and second moments.

He made a plea that the problem of applying significance tests to morbidity data should be studied. Practical solutions would be of value in the analysis of morbidity, and hence in medical research. He thought it would be fitting if the actuarial profession were to provide them.

Mr R. G. Barley said that, broadly speaking, the wide variety of problems discussed in the paper were of two kinds. There were the purely medical problems which fell outside the experience of most actuaries and there were the investigations to which they were accustomed in their traditional field. One characteristic of the purely medical investigations was that the available data were frequently much less precise than those in their more usual investigations, about which he wished principally to speak.

Traditionally, the investigations concerned the operation of some kind of insurance fund, using that term in the widest sense. The time was coming when more attention would be paid to disability benefits of one kind or another. It seemed to him inconceivable that the tremendous growth of retirement benefit schemes would not bring in its train a growth in the importance of incapacity benefits through a demand for schemes to add to the State benefits for incapacity, temporary or permanent, or to supplement relatively small ill-health retirement benefits. Where disability pensions were concerned, morbidity was defined by the terms of a contract and that led to a special type of definition capable of considerable variation from one kind of contract to another. Usually the data could be as precise in many respects as they cared to make them. They knew the exact dates of birth, exposure to risk and claims for benefit, for example.

Nevertheless, those of them who were concerned with disability benefits had not been active in investigating and publishing sickness experiences, and that was doubtless partly due to the late Sir Alfred Watson's having produced such a useful set of tables from the Manchester Unity experience. Those tables had come more properly to be regarded as hypothetical tables, and for many purposes it was, in fact, frequently possible to determine by quite simple means what adjustments were needed in them for a particular purpose, and often an elaborate investigation was unnecessary. Nevertheless, full-scale investigation of a body of disability insurance data of sufficient size, undertaken with imagination and aided by modern facilities for computation, would undoubtedly

produce most interesting and useful results. Much information, of particular help in underwriting, could be obtained by examining the experience with reference to the cause of incapacity. For example, a small unpublished investigation of peptic ulcer claims indicated a fairly constant rate of recurrence over a period of 20 years from the date of onset, associated with a higher than average experience of other illnesses. A great deal had happened during the 20 years since that investigation had been started. Nevertheless, there was nothing to encourage the relaxation of the practice of excluding benefit in respect of peptic ulcer when accepting new proposals where a past history of peptic ulcer was disclosed, although the average length of claim suggested greater leniency to those applying for benefit deferred 6 months or more. On the other hand, an investigation in relation to acute rheumatism allowed considerable relaxation of a practice of excluding acute rheumatism or its effects whenever a proposer had suffered from rheumatic fever in childhood.

Those two investigations had been undertaken primarily from the point of view of administering the insurance business concerned, but such investigations were not without interest in other connexions, as the author had indicated by mentioning the coronary thrombosis investigation described in §38. The same investigation had been continued and some further results, which gave information about mortality after coronary thrombosis, had recently been published in the *British Heart Journal*. That investigation was a small part of a wide statistical investigation of coronary heart disease which was being undertaken by Dr Morris and his colleagues. Moreover, that was by no means the only investigation going on. In his association with Dr Morris he had discovered many interesting things, amongst them the fact that it was practically impossible to investigate morbidity without also investigating mortality.

On the subject of mortality, he wished to mention two major problems: coronary heart disease, on which teams of research workers were doing statistical investigations, and cancer, on which Professor Bradford Hill had been engaged. Round the corner, waiting to be discovered, there might be some fundamental facts about the cardio-vascular system or about the growth of body cells. He suggested that the work going on would ensure that if such facts existed they would be found; and when they were found they might well completely upset their forecasts of mortality. Whether or not they were personally interested in morbidity or in statistical investigations in a theoretical sense, he thought they should all pay a great deal of attention to what was going on in the investigations into those two subjects.

Mr H. W. Haycocks said that in a paper delivered to the Faculty (*T.F.A.* 19, 317) a medical man had ended with the following statement:

> The actuary has been said by the irreverent to be a cross between a bookmaker and an undertaker. When he is joined by his Chief Medical Officer the combination is without a name. But this combination over the past century has evolved a system which, however imperfect, has the merit of having kept the balance between the acceptance of all lives, good and bad, on the one hand, and on the other the rating up of every proposal so heavily that no business results. The imperfections of the system are mainly medical. The actuary's profession is an exact science, the doctor's is largely empirical.

That was an astonishing statement containing a good deal of confusion. He had heard the actuary described as some kind of a medicine man, but never as nicely as that and by another kind of medicine man. It might be correct to call

the actuary's profession an exact one—not an exact science—much in the same sense as the bookmaker's profession was an exact one; they both ran a successful business without invoking the aid of any exact science.

As actuaries they made very little use of elaborate scientific hypotheses. Insurance had been practised successfully before science, as we knew it, existed. Like the author, he wished to quote from Perks's practical paper *The Treatment of Sub-Standard Lives in Practice* (*J.I.A.* **78**, 205): '...an office can be as lenient as it likes [in accepting lives] provided that it does not thereby attract an undue proportion of sub-standard lives or encourage its agents to seek out sub-standard lives.' Surely it was generally realized that under certain conditions the whole population could be insured. Mortality rates for any reasonable method of underwriting were sufficiently stable for an office to make a safe allowance for mortality in calculating premiums. Offices also used the bookmaker's device of laying-off bets. The whole procedure was very empirical.

In Perks's paper were implicit, not explicit, the principles of actuarial science, if science it was. Perhaps the time had come for a paper making those principles explicit. Perks, whilst deprecating an investigation by cause of rating as a futile procedure so far as life assurance underwriting was concerned, went on to say that there was a vast store of information in the papers of life offices which might well provide valuable information from a medical or sociological point of view. The Institute could and should encourage disinterested research of that kind. An admirable example of what could be done was the *Monthly Statistical Bulletin* published by the Metropolitan Life Insurance Company of New York, which contained interesting short articles on various aspects of vital statistics based on national data and on the special data of the company. There had been articles in the *Bulletin* on many of the topics mentioned during the discussion, and although it was an American publication he had at times been forced to refer British research workers to it because there were no similar data in the United Kingdom.

Few people outside the actuarial profession appreciated the problem of exposed-to-risk. The subject could be generalized. In the restricted field of mortality and sickness attention was directed to age or duration rates. More generally, however, rates were concerned with the mathematical treatment of aggregates. That was clear from the table mentioned in §35. A rate was a measure of some change in an aggregate over some defined interval. It need not be a uniform time interval. That was the author's 'flow' concept. There was also his 'stock' concept, for which there was no term in general use; possibly the term 'proportion' was the best and it denoted some measure of the aggregate at some given point in the interval. It might be a point in time but it need not be.

All that could be developed formally in a way quite strange to the actuarial student. He (the speaker) would like to see the work in their textbooks because he thought that the actuarial techniques based on rates could be extended to many problems in industry outside insurance and in other sciences. Having quoted Perks favourably he could also say that on the question of generalizing the concept of rate, Perks had not had a very good influence on him. No doubt they had to remember the purpose for which the textbook *Mortality and Other Investigations* was written. Students found the subject difficult and some actuaries might think that generalization would make it even more difficult. In practice that depended on the type of student.

In medicine, however, there was an additional problem in that the elements of the aggregate were complicated organisms—humans—and those organisms

themselves developed in time. They therefore needed another set of measurements, in addition to measurements on the aggregate as a whole. They needed sets of measurements in time on the members of the aggregate. Moreover, disease was frequently a reaction between human beings, other organisms and the environment. If they set up a mathematical model based on such a large number of variables the whole matter became very complex from the point of view of mathematical representation.

Dealing with measurements on an organism over time involved the mathematics of stochastic processes. Unfortunately, just what measurements should be made was not yet known with any precision. The author and many doctors had pointed out that there was no clear-cut line of division between normal and abnormal. The distributions of, say, blood temperature of the normal and the sick overlapped. Suppose a record were kept of certain measurements on a group of supposedly healthy individuals over a long period. In the current state of knowledge it would never be clear when one of those measures was becoming abnormal and thus indicating that something was going wrong. Yet it was certain that medical scientists would have to find sets of measures which they could apply to the whole population with a reasonable prospect that that would lead to the early diagnosis of disease, if medicine were to develop as a successful science. Too much attention was inevitably still being paid to diseased organisms, and relatively little to the history of supposedly healthy organisms.

In that connexion he quoted from an article 'What is disease?' by Dr Lester King, an American, published (1954) in the *Journal of Philosophy of Science*, 21, 194:

> As illustrating the confusion surrounding the notion of disease, I recall a very precise young physician who asked me what our laboratory considered the normal hemoglobin level of the blood (with the particular technique we used). When I answered 12–16 grams, more or less, he was very puzzled. Most laboratories, he pointed out, called 15 grams normal, or perhaps 14·5. He wanted to know how, if my norm was so broad and vague, he could possibly tell whether a patient suffered from anaemia, or how much anaemia. I agreed that he had quite a problem on his hands, and that it is a very difficult thing to tell. So difficult, in fact, that trying to be too precise is actually misleading, inaccurate, stultifying to thought, and philosophically very unsound.
>
> He wanted to know why I did not take one hundred or so normal individuals, determine their hemoglobin by our method, and use the resulting figure as the normal value for our method. This, I agreed, was a splendid idea. But how were we to pick out the normals? The obvious answer is, just take one or two hundred healthy people, free of disease . . . .But that is exactly the difficulty. We think of health as freedom from disease and disease as an aberration from health. This is travelling in circles, getting us nowhere.

Turning to the need for actuaries to develop the application of statistical methods to medicine, he said that that was a very difficult problem and he was sceptical whether much could be done. In that connexion he thought the history of Professor Hogben's interests during the last few years was revealing. Some years earlier Professor Hogben had embraced statistics with enthusiasm, had become the first editor of the *Journal of Preventive and Social Medicine*, and had written two long books on statistics. Shortly a book would be published by him in which he described his disillusion.

He thought that Professor Hogben was not worrying about simple statistical tests which merely indicated that there was probably some significance in an observed difference, but that his quarrel was with the testing of alternative

hypotheses, with the statistician's claim to be able to make a precise probability statement about his findings, and with the setting up of models, such as epidemic models. It seemed that the latter were open to the same objections as applied to econometric models. When reading articles—for example, those by Kendall and Bartlett—it was easy to see the similarity. It was not clear what medical theories were behind the system of equations. The parameters and the system of errors were not stable in time and the whole thing became rather useless from the point of view of prediction. That meant that those models were seldom more than suggestive summaries of past data. He had nothing against expressing those statements in mathematics. The statisticians were doing valuable work because mathematics was a precise language which showed up clearly the poverty of arguments and theories.

A problem which caused great difficulties in economics was expectations. He was sure that a similar problem would arise in medicine—the expectations of the patient. A doctor could not afford to ignore them. As actuaries they knew from the mortality of annuitants that health expectations were real things, but how they could be measured medically he did not know.

Mr F. H. Spratling supported the opener's plea for the development of statistical tests of significance which could be applied to sickness absence statistics, and commended it to the mathematically minded; he was sure that something of the kind was badly needed.

In an appendix to the paper which Lloyd and he had submitted in 1951 (*J.I.A.* 77, 196) they had given a provisional list of twenty-one broad diagnostic groups based on the 3-figure International Statistical Classification which they had thought could reasonably be applied to analyses of sickness absence statistics. That problem of grouping had been kept under review by reference to both statistical and pathological considerations as more data had been accumulated and in the light of experience certain minor modifications had been made to the provisional groups. In particular, it had been found possible to reduce the number of groups from twenty-one to twenty, and the revised system of grouping had been used for the tables, based on the experience of certain occupational groups in London Transport, and published under the title *Health in Industry*.*

He thought that some of the London Transport sickness absence rates might be suitable as a basis for financial calculations, including valuations and contribution rates. They were based on more recent observations than were the Manchester Unity sickness rates and it might well be that they would require less modification for such purposes than the Manchester Unity rates. There was scope for research and he hoped it might be undertaken.

The author had referred to the question of terminology in relation to morbidity statistics. The old terms, such as sickness rate and attack rate, had served actuaries well but they no longer held the field. In London Transport they had felt constrained to follow the modern idiom. The sickness absence rate had become the average annual duration per person, measured in days, the attack rate had become the annual inception rate (spells) and the average length of absence had become the average length of spell. He thought it was essential for actuaries to use the new terms if they wished to continue to be understood outside their own profession.

* Mr Spratling has provided a statement of the revised grouping system, which is reproduced on page 267.—Eds. *J.I.A.*

Dr L. G. Norman (a visitor) thought that they were discussing two entirely different things. One was the measurement of absence due to sickness and the other was morbidity in general. Absence from employment could be measured precisely. Morbidity itself was less capable of measurement. He welcomed the combined operations of actuaries and medical men to which the opener had referred, because he thought that together they could accomplish a great deal. Indeed, as the author had shown, much had already been done in that research field.

There were many fields of medical science in which precise measurements were already undertaken, such as applied psychology, radiotherapy and genetics. All sickness fell into three broad groups—infections, new growths and degenerations. The epidemiology of infections had been adequately studied and those diseases, with some exceptions, had largely been overcome. The study of the epidemiology of degenerations and of new growths was only just beginning. Many questions had not been answered; perhaps they had not even been asked. Was it true that senior executives and businessmen suffered more from certain illnesses than their colleagues of a like age who did not occupy senior positions? Did a history of a certain type of infection, for example whooping-cough in early life, predispose an individual to bronchitis? Presumably such questions could be answered, but the answers had not yet been found. It needed not medical but statistical research to find out the answer to such questions. There was a great field there in which their joint enterprises could produce valuable results.

There were two other important questions on which he doubted whether very much was being done: which diseases occurred in the same individual and which diseases did not occur in the same individual? Good records, properly interpreted, would build up a body of knowledge on those points.

In §13 the author said 'the prevalence of disease can only be assessed given adequate and practical criteria for defining departure from normality'. The point was touched on again in §59 with the reference to conditions 'ranging from some unknown limit of "health"'. Absence could be measured precisely, but whether health itself could be measured was doubtful. It seemed to be chasing the rainbow's end. The World Health Organization had defined health, and definition was a step towards measurement but the definition was not very satisfactory. It was 'a state of full mental, physical and social well-being, and not merely the absence of disease'. Well-being was, however, itself health and the definition was therefore circular. The reason was, he thought, that health was not a quality which had any real existence. It was not a real thing like the rostrum or an abstract thing like the multiplication table. It was a *balance* in biological systems and as such had no real existence and could not be directly measured. The term 'positive health' which had been coined just after the war had been tacitly dropped. There was no such thing.

Nor was it easy to measure ill health. It looked simple to take a readily diagnosable condition such as diabetes and measure its prevalence, but already it was necessary to allow for at least three different types of diabetes—type 1, type 2 and type J—before a separate analysis could be made. As knowledge of the origin of the condition increased, he wondered whether there would be more types to consider. It might even be that medical diagnosis would be of a different kind in future—that the basic diagnosis would become 'frustration' or something of that sort, the development of a high blood sugar or high blood pressure being regarded as a secondary condition.

The opener's approach to the study of absence was most valuable and was likely to produce useful advances in medical knowledge.

Mr L. V. Martin had particularly noted §43, where it was stated that in 1953–54 men had experienced 187 million days of sickness incapacity. If to that were added the sickness of women and uncertificated sickness, no less than 300 million days were lost every year through sickness. He did not think nearly enough attention was paid to that loss, which was three or four times the amount lost through unemployment and 100 times the amount lost in strikes in the same period. He was sure that everyone present would support the author's plea that they should try to learn more and more about the nature of sickness absences. Though many possible investigations which had been mentioned remained to be carried out, a considerable body of statistics was already available and he felt that there were many questions posed by the existing data which they should be asking. For example, the author had mentioned that of the male sickness absences 20 million days were due to bronchitis, and from the same source it appeared that 15 million days were lost through tuberculosis and 14 million days through rheumatism and arthritis; such figures indicated the need for research into those diseases.

Considering sickness absences from all causes, the average loss for men was 13 days a head. Why should it vary from 10 days in London and the south-east to 21 in Wales? The figure for London might be affected by the presence of so many office workers but in the Midlands, largely an industrial area, the figure was only 12 days—much less than the 21 days in Wales. For bronchitis, the most important cause of all, the number of spells commenced in the year among a thousand men varied from 22 in the southern region to 67 in Wales. Surely those variations should be investigated.

As there was much more sickness from bronchitis in Wales and in the northern region than in London and the south-east and in the eastern region, it was to be expected that there would be much the same pattern for tuberculosis which was another respiratory disease; and indeed the tuberculosis death rate was much higher in the north and the west than in the south and the east. The figures of sickness absence due to tuberculosis did not, however, follow that pattern; there appeared to be little more sickness from that cause in the north and west than in the east and south, though there was appreciably more in Wales. Thus on 5 June 1954, 2 in every 1000 men were sick with bronchitis in the east and south of England, the figure rising to 5 in the north; and yet the number in every 1000 who were sick with tuberculosis on that date was 3 in both areas. Those figures seemed well worth further study.

If it were possible to reduce the amount of bronchitis in the north and west to the level experienced in the east and south there would be a vast saving to the country's economy and, what was perhaps more important, a great deal of suffering would be avoided. It was appalling to think what 300 million days of sickness meant in terms of suffering, poverty and loss to the community, and he would strongly support the pleas which had been made for more and more studies in morbidity.

Sir William Elderton said Dr Norman had spoken about chasing a rainbow, and he had a feeling that to a large extent that was forced on them when dealing with sickness or with causes of death. The difficulty was that they were not dealing with real causes but with what medical men put down as causes from

such evidence as they could collect from the patients and from their own observations, disguised sometimes by a little difficulty in analysing exactly what had been collected. Consequently, they were dealing not with statistics of causes of sickness but with statistics of causes estimated, which might be widely different. The whole question of precision was raised, and precision was bound to be absent to a very large extent. If they took blood pressures in 1957 and compared them with figures taken in 1930 or 1940, were they sure that they were dealing with like things? Did all doctors take blood pressures with exactly the same sort of instruments and same technique as were used 30 years previously? He did not suppose so.

For another example of the difficulty about precision, reference could be made to the table in §36, from which it appeared that deaths from cancer of the lung and bronchus rose from 993 to 2659, taking the units as given in the table, and that deaths from other cancer went down from 5707 to 5116. That could be taken as one group. In the next group, the coronary group, the figures were 3241 and 7147, and for other heart diseases the figures were 6066 and 3425. He had a feeling that that was evidence not necessarily of a change in disease but of a change in the fashion of recording it.

The question of lack of precision led him to a point which other speakers had shown that they had in mind. Like him, they wanted to use statistics of mortality and morbidity connected with specific diseases; but they had to face the difficulty of doing so from statistics which were not precise. He suggested that the young actuary or statistician who enjoyed applying modern mathematical stastistical methods should be warned not to do so until he had first spent many tedious hours satisfying himself that the statistics were above suspicion. Poor or inaccurate or faulty statistics could not be made better by mathematics.

Mr R. D. Clarke supported the author's hope that the medical and actuarial professions might co-operate in furthering research, and he thought it might be interesting if he described a project which had been seriously considered but had been dropped. It was concerned with tuberculosis, and with mortality rather than morbidity, but the lessons to be learned from the endeavour were instructive.

A life assurance proposal which revealed a history of tuberculosis received very careful attention and might be declined or might be accepted with a fairly heavy loading, frequently in the form of a decreasing debt. A society which supported the interests of tuberculosis sufferers made representations that there was considerable hardship to men who had previously suffered from tuberculosis because they could not get life cover when they needed it—particularly those who were buying houses and needed mortgage protection. It was argued that there had been a great decline in the over-all death rate from tuberculosis during the twentieth century, and also that there were new treatments which had come into force in recent years and which greatly improved the chances of recovery, that was to say, of arrest of the disease. Of course, he had first to point out that they were concerned not with the incidence in the country as a whole and not with the rate of recovery among those who were suffering from active disease, but with the subsequent mortality experience after an arrest had been noted and the patient had resumed his normal life. Following on that was the familiar argument that improved treatments might increase the subsequent mortality experience by allowing more of the unfit to survive.

In considering how to pursue the matter, it had been apparent that life office

records were not suitable because those concerned wanted to study the people who had been declined. At one stage of the inquiry he received some useful advice from Dr J. N. Morris, and between them they worked out a scheme by which it was hoped to make use of local authority records. There was, however, the question of cost. An investigation of that kind had to be conducted over a long period and follow-up registers had to be kept in force. That cost a lot of money. Would the money be well spent in that way or would it be better spent in other forms of research of perhaps more direct benefit to those suffering from the disease?

A further important point was that it would be a long time before the results of the investigation would become useful. It was no use making the inquiry retrospective; they wanted to know what the mortality experience would be of the people who had been treated by the most modern methods. The investigation had to go forward in time and it might be 5 or 10 years before anything of use was available.

Furthermore, the investigation could have gone the wrong way and shown that the relative mortality of those who had formerly suffered from tuberculosis was more than had been suspected. The society concerned, having put up a certain amount of money to pay for the research, might have got an unfavourable result and have harmed its members rather than helped them. Ultimately, when all those arguments had been taken into consideration, it was decided to abandon the project.

He thought it was the right decision, but he had a little regret because it might have provided some useful knowledge, particularly in regard to the causes of death among those people who in the past had been treated for tuberculosis. At the same time a solution to the immediate problem might be sought at an administrative level by persuading life offices to impose extra premiums rather than debts, so that full life cover was immediately available, and to charge sufficiently high extra premiums to enable them to decline fewer proposals and to accept more.

Mr H. A. R. Barnett said that morbidity statistics would not be complete unless there was also a build up of statistics dealing with cause of death. While Sir William Elderton's warning about the possible weakness of those statistics should be remembered, he felt that an attempt should be made to see what the statistics revealed if an investigation were made into the whole or part of the C.M.I. data, analysing by cause of death.

He suggested that if certain offices were invited to submit photostatic copies of all the death certificates submitted to them, it would be found that the work would not be as arduous as it might sound either for the offices concerned or for those undertaking the investigation.

Dr A. Bradford Hill, in closing the discussion, said that the author had referred to the report of the Statistics Sub-Committee of the Registrar General's Advisory Committee on Medical Nomenclature and Statistics, and to its recommendation that the measure which had been called a 'sickness rate' should be called 'the average duration of sickness per person'. He had to confess that he (the speaker) was the Chairman of that Committee! He could, however, assure them that he was not a person lightly to break with tradition and he could recall being introduced to the mysteries of the sickness rate at least 30 years earlier by Sir Percy Harvey and Mr Menzler. But, apart from the mellowing effect of

time, he suggested that it *was* a little difficult to use the word 'rate' to describe the mean of a frequency distribution. Further, the Committee of which he was Chairman had been charged with the task of endeavouring to bring some precision into definition and terminology, not only for national use but, if they could do so, for international use. They had to cater for many people with no knowledge of, nor interest in, actuarial usage. After much consideration they had concluded that the 'sickness rate' ought to give way.

The opener had rightly pointed out that research into environmental factors had partially passed from the general field of the environment in relation to infectious diseases to the more specific environment of industry and occupation. Dr Norman had likewise referred to the passing of the problem of the infectious diseases. While in broad agreement he wondered whether infectious diseases were entirely such a problem of the past as was so comfortably thought. For example, scarlet fever might revert to its virulent form, and influenza to the 1918 vintage, or to some vintage of which they had no knowledge.

In relation to the environmental factors in industry speakers had stressed the enormous total of sickness absences in Britain and the wide field for exploration. In making comparisons between sickness absences in different occupations he was not, however, sure whether enough stress had been laid upon one factor—the relationship between the nature of the work and the nature of the disability. He supposed that even the most enthusiastic road drill worker would have to cease drilling during an attack of lumbago, whereas an actuary could stand, if not sit, at his desk; a London bus driver, Dr Norman would agree, would certainly be off the road with a fractured radius whereas one of the speaker's professorial colleagues had been teaching and carrying on research in the past fortnight with exactly the same condition. Perhaps those were extreme cases, but that factor must to some unknown extent affect the sickness absence rate of occupations nearer in kind. On the other hand, if they could bring the inquiry down to the employer level rather than that of broad national statistics, they might be able to see more easily what was going on and make more appropriate comparisons. Possibly speakers were a little optimistic, however, in supposing that industry, which was largely composed of relatively small units, would accurately know its exposed-to-risk. In his experience they might have but little knowledge of the age distribution of the factory workers; they were not all like London Transport.

He would put rather less weight on the problem of the diagnosis of short illnesses than the author. Mr Spratling had pointed out that a relatively few broad groups had sufficed for the London Transport data and the speaker thought that lack of medical diagnosis with the quite short illnesses would not appreciably detract from such data. In many such instances the doctor could only put a label upon the symptoms, and the label might easily be in error since the doctor had not enough to go on. Much of what was currently called influenza had never seen an influenza virus—a point which Sir William Elderton had made in relation to causes of sickness as well as causes of death. With illnesses of a few days' duration the patient's own label might not be so amiss.

Many speakers had stressed the almost impossible problem of defining health and defining the Normal, and the author had discussed the wide range of variability in physical constants that appeared to be compatible with good health. To what extent, he wondered, were the ranges quoted derived from single observations made on a large number of people? If they were so derived, then it might be, for instance, that a single observation at one time of a haemoglobin

value of 85 or a serum cholesterol of 400 was of no import. But did the individual invariably show such a value and, if he did, would that be compatible with good health? He remembered an inquiry during the war into the dietetic habits of the population in which it was found that x% of work people had gone to work on the previous day without any breakfast. To avoid lapses of memory or distortions the question had been asked in that form. It could be argued, he suggested, that that was a bad habit only if the *same* x% daily went without breakfast. But, if x% were, say 5%, then the breakfast-missers on any previous day might be a different group every day for 3 weeks, and it was unlikely that would matter at all. He suspected the same might be true of some of those so-called normal ranges found in persons in good health and thought it would be of interest to know their scatter if based upon, say, a dozen observations on each person.

A second point was that those observations were compatible with *current* good health. It did not follow that they were compatible with continuing good health over a length of time. In some recently published work—which seemed to link with Mr Haycocks's question of earlier diagnosis—Dr Acheson had described how he had selected the fittest men he could find in the Royal Air Force and after making them run up and down an inordinate number of stairs had taken an electrocardiogram of each. Some 7% of those 500 men had revealed changes identical in pattern with that found in patients suffering from myocardial ischaemia. While those changes were clearly compatible with current good health it was perhaps disconcerting to note that coronary occlusion, angina pectoris and sudden death had been commoner in the blood relations of those men than in those of their colleagues with normal tracings. What the future might tell was the crucial point. It might be so with other so-called normal values. That opened a fascinating field for research. He wondered whether it could be tilled in life offices together with the problems touched upon by Mr Barley and Dr Norman of the subsequent histories of patients who had suffered in earlier life from such diseases as rheumatic fever and peptic ulcer.

One difficulty in those inquiries was the long duration of time over which they had to extend. For example, the author had made a passing reference to the association between smoking and cancer of the lung, and with regard to methodology 'in such vitally important aetiological studies', was firmly of opinion that the prospective method was clearly to be preferred to the retrospective. While broadly agreeing, he suggested that the advantage of the prospective inquiry was not always so great as was sometimes maintained. Indeed, in some circumstances, it had none. Suppose they had some rare condition occurring only once in 1000 persons; it clearly would not be practicable to follow a sufficiently large population to see how such cases might arise in relation to environmental factors. Inevitably the known cases would have to be taken and their antecedents sought out to ascertain whether they differed from the general run of mankind.

Moreover, even if the prospective method was feasible, it was usually long and costly. In the problem of smoking and cancer of the lung, unless Doll and he had *already* made the investigation retrospectively and found strong evidence of an association between cigarette smoking and cancer of the lung, he would not have felt justified in spending 5 years and several thousand pounds on a prospective inquiry. There often had to be retrospective evidence to justify the prospective approach.

Dr Norman had raised very much the same question and had aimed at a

kind of combined retrospective-prospective inquiry which, no doubt, was the ideal if it could be done. They could take records established many years back, e.g. of children who had had whooping cough in early life, and then see what had happened in the ensuing 40 or 50 years. But it was not often that that would be feasible. The fact that there was an association between rubella in the mother during pregnancy and congenital defects in the child was observed retrospectively by an astute Australian physician. Whether in fact there was a 'high risk of foetal abnormality' could be solved only by a prospective inquiry. It had not been solved because very few pregnant women got German measles.

Nearly 20 years ago, said the author, one of the Institute's Presidents had posed the question 'Death is death, but what is sickness?'. It seemed to him that the author and other speakers had shown how difficult it still was to answer that question and how, indeed, it would be answered very differently in different circumstances.

The President (Mr C. F. Wood) said that those members of the Institute whose daily work was concerned with life assurance were always grateful when someone who had practical experience of another field of actuarial activity submitted a paper to the Institute. Their gratitude was intensified when there was a paper of high standard from a member who was obviously so interested in his subject and spoke with an intimate practical knowledge.

The paper stimulated the imagination and gave glimpses of wide and varied fields of medical research which were waiting investigation. It indicated the sources of data which could be investigated and by implication invited younger members of the profession to come forward to utilize their statistical training to assist in work which could be of great value to the medical profession, to social workers and to the community. Younger members of the profession and recently qualified Fellows might like to be reminded that there was a Research Committee of the Council, the members of which were only too anxious to give advice and practical assistance to anyone who had an inclination to research.

The reference in the paper to the study of private sickness insurance data posed the question why there should be so little demand for that most valuable form of insurance in the country. From the point of view of the individual head of a family the three major causes of cessation of earned income were sickness, old age and death. National Insurance provided income to the insured on sickness or incapacity, income to the insured on retirement and income to his dependants on his death, but the amount of the benefit in each case was limited to a weekly sum which barely supported a minimum subsistence level. Personal insurances and pension schemes were extensively used to supplement the income from the State benefits. Family income policies provided income to dependants on death, pension policies and schemes provided income on retirement. But rarely did the individual contract or the pension scheme provide income in the event of temporary or permanent incapacity. Actuaries of earlier generations had had experience of sickness insurance through the administration of Friendly Societies. The current generation would be aware of the remarkable growth of sickness insurance in various forms in the U.S.A. and Canada despite the unfavourable experience of the 1930's. If there were a need in Britain, life offices and private schemes could be expected to meet that need, and when that time came there would be many interesting actuarial problems for the members to solve in the inauguration and the administration of the arrangements.

Ella Wheeler Wilcox wrote:

> Talk health. The dreary never ending tale
> Of mortal maladies is more than stale.
> You cannot charm or interest or please
> By harping on that minor chord, disease.

The never ending tale of mortal maladies which they had heard from Mr Benjamin was far from stale. It had been presented with a fresh outlook which had charmed and interested and pleased.

They had had an interesting and informative paper on a subject which was not within the normal purview of the Institute. He asked the meeting to accord to Mr Benjamin a very warm vote of thanks.

Mr Benjamin, in reply, said he agreed with most of what the opener had said and wished to pay a tribute to the high standard of recording at London Transport and the great contribution they had made to research. The difference between them was mainly in emphasis. He was glad that the opener had referred to the problem of selection, because that was a factor in relation not only to sickness absence, but also to labour turnover, which could not be over-emphasized. He hoped that work on distribution of the duration of sickness would be developed.

Mr Barley had illustrated the practical importance of sickness studies as a guide to mortality risks and he was not alone in his declaration of faith. Mr Haycocks's remarks were timely both in relation to actuarial practice and in relation to the need for more generalization in the treatment of exposed-to-risk.

Mr Spratling had given further interesting information on the experience of London Transport. He was glad that Dr Norman and his colleagues were at the meeting because they had done much to contribute to the general advance of industrial medicine. Dr Norman's distinction between sickness absence and morbidity would satisfy those members of the profession who regarded the term 'sickness' as all-sufficient. The detailed health records which would be essential to determine the number of different diseases the same person might have were much more of a practical possibility than might be generally thought.

Mr Martin had underlined the great problem of sickness absences and had asked a number of pertinent questions which it was to be hoped industrial medicine would seek to answer. Sir William Elderton had frankly faced the problems of 'chasing the rainbow', and he hoped that his advice would be taken.

Mr Benjamin subsequently wrote:

I agree with Mr Cornwall that the initiative in preventive medicine is passing to the industrial medical officer. I am glad that this is so for there are urgent problems to be solved, in particular the resistance to improvement in the mortality of middle-aged and older men, some part of which may arise from industrial stresses and strains. I look forward, however, to the day when the initiative will finally pass to the family doctor with a small practice and 'time to stare'. For environmental factors are very largely inseparable, and to deal with industrial stresses alone will not be sufficient.

Mr Barley's remarks as extended by Mr Barnett express exactly, and more clearly than I could, the objectives of my plan for a 'morbid', i.e. a diagnostic, interest in incapacity and mortality. These objectives would have embraced the interesting project which Mr Clarke had described; I have been campaigning

among Chest Physicians for just such a project for a long time with very little success though the necessary records have been in existence since 1912.

I am in entire agreement with the emphasis Professor Bradford Hill has placed on a number of important points in relation to sickness absence—the enormous field of exploration, the value of working at employer level, the influence of type of work in determining whether a particular disease is incapacitating, and the diagnostic problems of absences of short duration. I accept his support for the retrospective method in rare conditions and as a means of providing 'first evidence'. Above all I personally concede his case that the 'sickness rate' ought to give way. I hope the rest of the profession will do so too.

In the following table three examples are given of the relationship between prevalence rates and mortality rates for specific disease groups. The relationships are very crude since the prevalence rates are derived from the Ministry of Pensions and National Insurance Digest and relate to insured males as at 5 June 1954, whereas the mortality rates relate to the whole male population during 1954. The ratio of (ii) to (i) is an index of the fatality of the disease, which is closely related to treatment, while (i) is less related to treatment than to environmental conditions and preventive measures. The prospects for treatment improvement and for advances in prevention are two different aspects about which, separately, we often know a good deal. Might we not therefore be in a better position to attribute the correct shape to the curve of age mortality rates by approaching it through these two components? Especially if we require a generation table? Might it not also be found that the variation with age of disease prevalence and of case-fatality are separately more simple than in combination? Thus, the life table of the future may be a multiple decrement table in which the survivors are transferred to and from certain classes of chronic disease sufferers according to known rates of incidence and recovery, these classes being subject to rates of mortality applicable to the diseases. At least there is some scope for experiment. Mr Barnett has indicated one pre-requisite, viz. analysis of deaths by cause. The more difficult problem, the provision of incidence rates, had prompted the paper.

England and Wales. Males. Rates of (i) prevalence and (ii) mortality from certain diseases, per 1000

Age	Respiratory tuberculosis			Arterio-sclerotic and degenerative heart disease			Influenza, pneumonia and bronchitis		
	(i)	(ii)	(ii) ÷ (i)	(i)	(ii)	(ii) ÷ (i)	(i)	(ii)	(ii) ÷ (i)
15–19	2·0	·013	·007	—	·007	—	1·2	·040	·033
20–24	3·4	·055	·016	·08	·010	·13	1·4	·030	·021
25–29	3·6	·108	·030	·13	·030	·23	1·7	·030	·018
30–34	3·3	·150	·045	·12	·084	·70	1·9	·051	·027
35–39	3·1	·177	·057	·13	·221	1·70	2·1	·101	·048
40–44	2·9	·204	·070	·53	·523	·99	2·7	·191	·071
45–49	3·0	·295	·098	1·05	1·18	1·12	4·0	·392	·098
50–54	3·3	·454	·138	2·68	2·46	·92	6·9	·905	·13
55–59	4·0	·541	·135	6·20	4·27	·69	12·4	1·79	·14
60–64	3·3	·766	·232	10·8	7·30	·68	17·9	3·20	·18

List of broad diagnostic groups for analysis of sickness absence
(referred to in Mr Spratling's remarks)

No. of group	Short description	International statistical classification (3-figure code number)	Changes compared with provisional list, *J.I.A.* 77, 225
1	Tuberculosis	001–019	
2	Infective and parasitic diseases	020–138	Addition of venereal diseases (020–035) from group 20
3	Neoplasms	140–239	
4	Functional nervous disorders	300–318	790 transferred to group 20
5	Organic nervous disorders	330–369, 780, 781	Addition of symptoms referable to nervous system (781) from group 20
6	Diseases of the eye	370–389	
7	Diseases of the ear	390–398	
8	Diseases of the circulatory system	400–468, 782	
9	Colds and influenza	470, 480–483	472, 473, 510 transferred to group 11
10	Bronchitis	500–502	
11	Other respiratory diseases	490–493, 763, 783 471–475, 510–527	Addition of acute pharyngitis (472), acute tonsilitis (473), and hypertrophy of tonsils and adenoids (510) from group 9
12	Diseases of the stomach and duodenum	540–545, 784	
13	Hernia of abdominal cavity	560, 561	
14	Other diseases of the digestive system	550–553, 530–539, 570–587, 764, 785	
15	Diseases of women	620–689	
16	Diseases of the skin	690–698, 700–716	699 omitted—unallocated code
17	Diseases of bones and organs of movement	720–749, 787	
18	Accidents on duty	(N) 800–999	
19	Accidents off duty	(N) 800–999	
20	Miscellaneous	000, 240–299, 320–326, 590–617, 750–762, 765–776, 786, 788, 789, 790–795	Addition of nervousness and debility (790) from group 4, and no certificate (000) and ill-defined causes (795) from group 21 020–035 transferred to group 2; 781 transferred to group 5