

SOME OBSERVATIONS ON MORTALITY STUDIES

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I PROPOSE to discuss certain aspects of mortality investigations which relate to the future and the character of these studies as seen in the United States of America. My remarks are intended to call attention to the sharply rising costs of more searching inquiries into death rates and to the advisability of broader approaches to mortality. Such approaches may depart from the main stream of actuarial endeavours in this field and raise new questions both of substance and methodology.

There is no research so intensive that it cannot be deployed more widely or deeply with additional effort. Actuaries are faced with difficult decisions in judging under what circumstances to stop the process of inquiry and when to continue probing in order to gain greater understanding of the biology of death. The issues involved—what information is sufficient for practical purposes and what advantages accrue from a more comprehensive view of the subject—must be dealt with on an *ad hoc* basis. It is nevertheless significant that most actuarial investigations of mortality have been restricted to data needed to answer practical questions and it is only rarely that actuaries (such as Beard and Redington) have pursued their inquiries beyond immediate objectives. Whereas at one time actuaries were considered to have the last word on many problems relating to mortality, in more recent years the more sophisticated analyses of death rates have come from demographers, epidemiologists and medical scientists.

In my judgement actuaries ought to extend their purview to new knowledge about death rates and new methods of statistical analyse. Both are needed to perceive the underlying biological phenomena more clearly; such interpretations can help us to visualize the possible future courses of mortality in different circumstances. Actuaries already have an advantage here since they pioneered the investigation of mortality among persons with physical impairments and diseases.

In the United States these studies go back to the 1890s when vigorous efforts were made to improve the underwriting of life insurance risks. After the business depression of the 1870s and 1880s death rates among insured lives increased and rates of rejection for life insurance climbed to as high as 15%. To reduce these high rates of rejection, studies were launched to determine the mortality among impaired lives. These culminated in the Specialized Mortality Investigation of 1901 which covered the experience of 34 companies over the previous three decades; this was probably the first large-scale attempt by actuaries and

doctors to collect mortality data on various types of substandard risks over a prolonged period of time.

Follow-up studies conducted by the medical profession came somewhat later. Osler was one of the prime movers in this field. Surgeons were especially interested in finding out how effective their skills were, but the follow-ups infrequently took age into account and were rarely carried beyond five years. The results of treatment for tuberculosis necessitated longer follow-up studies. These and related developments led to the discipline of biometry, whose forerunners were Pearson and Galton in England. The foremost exponent of biometry in the United States was Raymond Pearl at Johns Hopkins University.

The perspectives in biometry have changed radically over the past half century because of the emergence of the chronic diseases as the leading causes of death. When pneumonia and the infectious diseases figured prominently in the overall death toll, the emphasis was on relatively short-range observations. As heart disease and cancer gradually began to dominate the mortality spectrum, the increasing interest in the natural history of the degenerative diseases required a much longer period of observation. It was not until the close of the Second World War, however, that medical scientists took up seriously the task of investigating the long-range effects of the early symptoms of these diseases.

In the meantime some actuaries, working jointly with medical men in the life insurance business, conducted a series of large-scale mortality studies involving follow-ups extending over periods from ten to over twenty years. The Medico-Actuarial Investigation completed in 1918 laid down the pattern for subsequent studies in the United States. These included the Impairment Study 1929 and its 1931 supplement, the Blood Pressure Studies of 1925 and 1938, the Impairment Studies of 1936, 1938 and 1951 and finally the largest of them all—the Build and Blood Pressure Study of 1959. These investigations all aimed to isolate and measure the effect on mortality of specific risk factors (such as particular occupations, medical conditions, habits) as well as certain combinations of these factors. The underlying hypothesis was that each of the factors under consideration could be regarded as an independent variable. This concept was at the bottom of the numerical underwriting method which treated the total mortality risk as a linear compound of a number of independent risk factors exemplified by build, occupation, medical impairments, habits etc. Even though such a formulation was recognized to be something of an over-simplification, it worked well in the practical solution of the problem of classifying life insurance risks. The medical profession also indulged in lesser over-simplifications, perhaps because Pasteur had shown that specific organisms were the causative agents of most infectious diseases. There was a tendency to look upon most diseases as distinct entities, traceable to specific factors. It took many years before the accumulated evidence began to suggest that most chronic diseases were complicated processes of multifactoral origin and that many chronic diseases might sometimes be closely interrelated.

In the Build and Blood Pressure Study currently under way, as a sequel to

the Build and Blood Pressure Study of 1959, we have adopted a more flexible conception of medical impairments and of disease processes. We do not visualize departures from normal build and blood pressure as independent conditions but rather as symptoms associated with a more deep-seated pathological disturbance in body metabolism. We intend, of course, to tabulate the mortality experience according to variations in build and blood pressure as a guide for the underwriting of life insurance risks, but we will in addition try to obtain some better notions of the interplay between departures from normal build and blood pressure with other abnormalities, particularly the constellations of symptoms indicative of pathological processes. Our main concern in the blood pressure portion of the investigation is to find out whether or not the methods of treating hypertension used in recent decades have been effective in the long run. This question requires us to consider the significance of overweight and of hypertension in the development of many chronic diseases and also as part of the ageing process.

It is doubtful whether we will be able to answer this question from the current study or for that matter from future mortality investigations of insured lives. We are concerned because the cost of preparing medico-actuarial records on insured lives has been increasing sharply and it is therefore likely that these records will either be greatly curtailed or discontinued in the years ahead. Some economies in the conduct of mortality investigations are in prospect, but the chances are that they cannot check the rapid rise in the cost of studies made from medico-actuarial records. One of the developments in the offing is to operate through a central agency such as the Medical Information Bureau, which has for many years functioned as a general registry into which a very large number of life insurance companies have funnelled information about impairments found on proposals for insurance. Such information has usually not been detailed enough to serve as a basis for mortality studies, because it was intended primarily to supply danger signals indicating that a particular applicant ought to be more thoroughly investigated. However, it would be feasible to assemble much more detail of the medical impairments reported on proposals, provided that the Medical Information Bureau did not divulge this information on individuals, but used it only for scientific studies.

We need to look to new sources of knowledge about the mortality associated with medical impairments and diseases. The Society of Actuaries and the Association of Life Insurance Medical Directors recently published a volume entitled *Medical Risks: Patterns of Mortality and Survival** which digested and converted a variety of clinical and other mortality studies into a uniform life table pattern of mortality rates, survival rates and mortality ratios. A large amount of qualitative information was transformed into figures of interest to underwriters, actuaries and medical scientists. This approach holds out the promise of more informative mortality studies for the future.

The range of such studies could be greatly expanded if the life insurance

* Reviewed on p. 257.

business established a registry of deaths among insured lives, perhaps administered by the Medical Information Bureau. This could be done if a sizeable number of life insurance companies were to report each year the key facts relating to each death on an insured life and if such data on deaths among insured lives were kept for a prolonged period of time. With a registry of deaths among insured lives, it would be possible for physicians, hospitals and medical research centres as well as actuaries and life insurance medical directors to follow any group of insured persons with selected impairments or diseases. The registry of deaths could be consulted periodically to determine whether any death benefits had been paid on the insured lives comprising the group under study. The only information which the registry would supply would be whether a specific individual—name, date of birth, date and place of death, residence at time of death—could be identified as having had a death benefit paid. It would be up to those in charge of the mortality study to obtain the corresponding death certificate. By so limiting its function, the registry of deaths among insured lives could be operated under the same guidelines and safeguards relating to confidentiality as are prescribed for other vital statistics and health records used for research purposes.

The problem of preparing costly records for mortality investigations of persons with medical impairments or diseases can readily be solved by relying on the records which are normally prepared by physicians, hospitals and medical research centres for their own use. However, the problem of following such persons for long periods of time is not only exceedingly costly but also extremely difficult unless the individuals under study carry ordinary insurance or have served in the armed forces of the United States. The Veterans' Administration maintains a reasonably complete registry of veteran deaths.

Some organizations have succeeded by dint of great effort in following relatively small numbers of persons for long periods of time. The most notable of these have been the Framingham Study and a few similar studies such as the Albany, Los Angeles, Western Electric and Tecumseh investigations.

The most comprehensive and ambitious of these epidemiological investigations, which have relied on their own resources for the follow-up, is the Cancer Prevention Study, initiated in October 1959 by Dr E. Cuyler Hammond for the American Cancer Society. The follow-up in this study was made possible largely by the efforts of some 70,000 volunteers who normally collect funds for the American Cancer Society. The study covers about a million persons who have been traced for over 12 years.

I have had the privilege of having been associated with a number of projects relating to this study. Among the more recent of these was a mortality investigation whose objective centred on finding out whether low-tar, low-nicotine cigarettes were less hazardous to health than the cigarettes smoked ten or fifteen years ago. The death rates experienced among smokers of the low-tar, low-nicotine cigarettes were appreciably smaller, suggesting that such cigarettes are in fact less hazardous; animal experiments appear to confirm such a conclusion.

The Cancer Prevention Study illustrates a number of the important principles which need to be observed in carrying out follow-up studies. For one, it has emphasized accuracy and completeness of the data from which mortality rates are derived. Actuaries need to be reminded that mortality rates compiled from the records of insured lives may contain built-in inaccuracies. For instance, the differences in death rates between premium-paying and paid-up policies at the older ages indicate in part the incomplete reporting of deaths on paid-up contracts.

Another basic issue which has coloured much of the thinking in the Cancer Prevention Study is that some chronic diseases and reported causes of death cannot be considered as distinct biological entities. The multifactorial origins of cancer and coronary disease have been accepted as working hypothesis, but specific causes of death as given on death certificates have been used in a rather unquestioning manner. It is becoming clear that single specific causes of death are rarely tenable in old age and that they may often represent only provisional judgments at the younger ages.

An even more subtle issue on which we should perhaps focus attention is the representativeness of a particular mortality experience and the appropriateness of the control groups used to determine departures from normality. While the latter problem is not important for insurance and pension studies, where our standards of expected mortality are usually fixed, they are of critical importance in the interpretation of mortality experience for scientific purposes and in gauging the likelihood that future experience will conform to past patterns.

The fundamental point, as I see it, is to interpret mortality statistics not merely in descriptive statistical terms but rather in terms of their biological significance.