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THE IMPACT OF MEDICAL ADVANCES AND LIFESTYLE ON MORTALITY

A Discussion Meeting

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Introductory Paper

By T. Chatterjee, A. S. Macdonald, C. Macdonald, E. Roche and H. R. Waters

1. Introduction

Studying trends in mortality and morbidity has been at the core of traditional actuarial science since its beginnings. In recent times, the United Kingdom Profession has contributed to such studies in a number of different ways:

(1) through the work of the Government Actuary's Department on the analysis of national data;
(2) through the work of the Continuous Mortality Investigation Bureau on the analysis and graduation of insured lives data;
(3) through the work of various committees established by the Profession, e.g. the Critical Illness Trends Working Party; and
(4) through the work of individual members, or small groups of members, e.g. Richards *et al.* (2005).

This paper summarises the research resulting from two initiatives by the Profession designed to help actuaries and others to gain a better understanding of trends in morbidity and mortality: the Actuaries Panel on Medical Advances (APMA); and the Mortality Scoping Project.

2. The Actuaries Panel on Medical Advances

2.1 *Background*

The role of the APMA, a sub-committee of the Social Policy Board, is to investigate the impact on morbidity and mortality of medical advances. The APMA has been involved in two research projects:

(a) the development of a model for ischaemic heart disease and stroke, incorporating the major risk factors for these conditions; and
(b) a study of the effects of treatment with Herceptin for HER2-positive breast cancer.

2.2 *Heart Disease and Stroke*

Funding from the Engineering and Physical Sciences Research Council was used to employ a full-time researcher, Tushar Chatterjee, for three years at Heriot-Watt University, working under the supervision of Professors Angus Macdonald and Howard Waters. The U.K. Actuarial Profession supported the project by providing administrative support and arranging regular meetings of the APMA. Feedback from the members of the APMA, actuaries and doctors, was extremely valuable.

The objective of the project was to develop a stochastic model of an individual's lifetime, incorporating diagnosis, with ischaemic heart disease (IHD) and stroke and the development of the major risk factors for these diseases: hypertension, diabetes, obesity and hypercholesterolaemia. Smoking, another major risk factor, is included in the model. The model was parameterised using data from the Framingham Heart Study in the United States of America, with the parameters adjusted so that the model is appropriate for the U.K. in the early 21st century.

Such a model has many applications. Those covered in the research project were quantifying the effects on:

(a) expected future lifetime;
(b) expected future 'event-free' lifetime (time free of IHD and stroke); and
(c) the prevalence of diabetes, hypertension, IHD and stroke;

of the following:

(1) treatment with statins — cholesterol lowering drugs available since the late 1980s and widely prescribed since the mid-1990s;
(2) smoking, particularly the effects of giving up smoking at any future age; and
(3) the increasing prevalence of obesity in the U.K.

Three papers have been written on the basis of this research, Chatterjee *et al.* (2008a, b & c). The major conclusions from the research are:

(1) Statins increase the expected future lifetime from age 20 by approximately one year. The effect is greater for those at higher risk of IHD and stroke: males, smokers, diabetics, those with high blood pressure and/or high cholesterol. The increase in expected future 'event-free' lifetime is approximately 1.5 years.
(2) Smoking is a direct risk factor for IHD, stroke and mortality. Smoking reduces the expected future lifetime from age 20 by approximately 7.0 years (males) and 6.3 years (females). The expected future lifetime of a smoker aged 20 increases if they give up smoking at some time in the future. For example, a 20 year old male smoker who gives up smoking at age 70 (if he survives to that age) has, from age 20, an expected future lifetime greater by about one year than a 20 year old male smoker who never gives up.

(3) Obesity is a direct risk factor for diabetes, hypertension and mortality, but not for IHD or stroke. Obesity is an indirect risk factor for IHD and stroke through diabetes, a direct risk factor for IHD, and hypertension, a direct risk factor for both IHD and stroke.
(4) The body mass index (BMI) has a monotonic increasing effect on the prevalence of diabetes, hypertension, IHD and stroke. A higher BMI implies a greater risk of diabetes and hypertension, which, in turn, give a higher risk of IHD, stroke and death.
(5) The BMI has a U-shaped direct effect on mortality, with the highest and lowest categories, 'underweight' and 'morbidly obese', having the highest relative risks of mortality and 'overweight' having the lowest.
(6) Points 4 and 5 indicate that the overall effect on mortality of increasing the BMI is complex. Our models for changes in an individual's BMI all indicate an increasing prevalence of obesity. However, even the most extreme of these models leads to a decrease in expected future lifetime from age 20 of no more than one year.

2.3 *Herceptin*

Herceptin is the brand name of Trastuzumab, a drug designed to treat certain types of breast cancer (BC). These types of BC are known as HER2-positive, and they account for about 25% of all BC cases in the U.K. Herceptin was initially licensed to treat advanced cases of HER2-positive BC, but, following a high profile campaign, it was licensed in 2006 for treatment of early stage HER2-positive BC.

The project to investigate the effects of Herceptin was carried out by Edward Roche, as part of his MSc in Actuarial Science degree at Heriot-Watt University, under the supervision of Professor Angus Macdonald. This research was supported by a small grant from the Joint Research Board of the U.K. Actuarial Profession.

Details of this research can be found in Macdonald & Roche (2008).

2.4 *General Comments*

Studies of the type summarised above give valuable insight into future trends in morbidity and mortality. However, some general points should be noted:

(a) Detailed modelling requires a considerable input in terms of time. This, in turn, makes it expensive, often beyond the limits of research funds available from the Profession. The Herceptin project could be completed relatively quickly with relatively modest funding only because it relied heavily on earlier research going back to 1998, funded by grants from various insurance companies. See Lu (2007) for the most recent contribution to this stream of research.
(b) No model can be expected to include every possible factor. For example, the model for IHD and stroke does not include some lifestyle factors, such as exercise, diet and social class.

(c) Models require data for the estimation of parameters. This poses particular problems when attempting to model the future (long-term) effects of new drugs. By virtue of their being new, data on the long-term effects do not yet exist.

3. Mortality Scoping Project

A recurring theme of the Profession's recent research into mortality and morbidity, particularly in the work of the APMA and the CMI Projections Working Party, has been a growing awareness of the many other interested parties who are actively researching these topics.

Indeed, given the resources available for medical and sociological research, the Profession's own contribution is relatively small. Each discipline brings its own background and toolkit to the task, very often shaped by their own views of what the 'big questions' and 'outstanding problems' are.

The Profession's Mortality Scoping Project was set up, with a grant from the Faculty and Institute research funds, as a first step towards bringing these broad and overlapping research programs to the attention of actuaries, and promoting joint work wherever possible. Dr Catriona Macdonald undertook the project, which proceeded by contacting leading experts in many relevant disciplines, to ascertain their views of the important problems, methodologies and, in particular, leading-edge literature. The draft report, Macdonald *et al.* (2008), to be presented to a Faculty Sessional Meeting, describes and analyses the views so ascertained. The Scoping Project is not the end of the task, but very much a beginning, so suggestions for next steps will be most welcome.

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