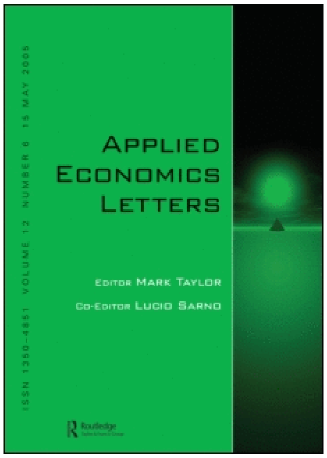

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Estimating the long-term costs of diabetic kidney disease: an economic approach

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Estimating the long-term costs of diabetic kidney disease: an economic approach

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Healthcare spending in Australia has increased rapidly in recent decades, partly due to the prevalence of lifestyle related illness, as physical inactivity and ageing have become common. Diabetes is a chronic and costly illness resulting from poor lifestyle choice and ageing. In this study, we estimate the long-run cumulative costs of a complication of diabetes, diabetic kidney disease, using well-known techniques from health economics. We find that spending on treatment for diabetic kidney disease will amount to $9.2 billion over the next 30 years. Most of the cost from this complication comes from the clinical stage of diabetic kidney disease.

I. Introduction

Diabetes is a disease whose primary risk factors are obesity, ageing and poor dietary habits. It is a costly disease, because it is chronic and leads to complications that require medical and hospital treatment. People who develop diabetes may live with the disease for decades. With the rise in inactivity, obesity and ageing there will be an increase in the incidence of the disease, leading to higher healthcare costs.

Type II diabetes is a condition of elevated blood-sugar levels. The body's organs, the eyes, heart, kidneys, liver and the brain, need precise levels of blood-sugar to work efficiently. A blood-sugar level that is either too high or too low will lead to the failure of one or more of the body's organs. A consistently high blood-sugar level can lead to hypertension, stroke or kidney problems.

Recently, the Australian Commonwealth Government Institute of Health and Welfare named diabetes one of Australia's top disease priorities.[1] The prevalence of the disease (diagnosed and undiagnosed) is currently 6.2% of the population or 850 000 individuals. This is projected to increase to 7.7% of the adult population by 2025.[2] In Australia it is estimated that 2.3% of all deaths can be attributed to diabetes related complications.[3] In 2001, the DiabCost study estimated the cost of diabetes to be A$2.1b a year, 3.6% of Australia's national health care expenditure.[4]

To determine the future economic impact of the disease, we estimate the long-term cost of diabetic kidney disease for the current diagnosed Australian diabetic population based on data obtained from a longitudinal study of diabetes patients in Australia. We simulate the progression of the disease in the Australian population using a Markov model, giving a broad example of how costs of treating diabetes will be incurred in the coming decades. We also look at the effects of adopting an active lifestyle on

[1] See Commonwealth of Australia Department of Health and Ageing (1998).
[2] See International Diabetes Federation (2003b).
[3] National Centre for Monitoring Diabetes (2002).
[4] See Davis (2004).

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healthcare spending related to diabetes, whether or not physically active patients with diabetes incur the same costs as physically inactive patients.

II. The Model

Markov modelling is used in health economics to simulate the progression of a disease in a population. A Markov model is defined by four variables: the states of health in which a set of patients reside, the length of time between transitions between states of health, the probability of moving from one state to a new state and the cost of being in each state. In our model for diabetic kidney disease there are three health states in order of degree: no kidney disease, preliminary, clinical, end stage diabetic kidney disease and mortality. Every year patients progress through these states based on actual progression rates observed from data in the fremantle diabetes study (FDS). The probability of progression from various states of health is shown in Table 1.

The cost of being in a state of health is simply the cost of treating that state. For example, preliminary diabetic kidney disease requires medical treatment. Clinical diabetic kidney disease requires more vigorous treatment than the preliminary stage and end stage kidney disease requires, at the very least, dialysis. Because, we assume that a patient is in a disease state for at least a year, costs are annualized. The costs of treating each state, based on the treatments for each state of health, are presented in Table 2. These are based on published information in the Australian medical and pharmaceutical benefits scheme.

Taken together, the above variables, set in a Markov framework, will provide an estimate of the development of diabetic kidney disease in a population with diabetes, from which its cumulative costs can be estimated. The model runs until at least 95% of the sample cohort enters the mortality state. At the start of the Markov simulation, we assume that 32% of the total sample had preliminary diabetic kidney disease and 9% had clinical diabetic kidney disease, based on the prevalence of diabetic kidney disease seen in the first review of the FDS.

In addition, the FDS recorded such characteristics as whether or not patients were physically active or inactive at the first review. Many studies have shown that exercise reduces the risk of developing diabetic kidney disease, and indeed,

Table 1. Annual transition probability matrix

	*S*0	*S*1	*S*2	*S*3	*M*
S0	0.8878	0.0976	0	0	0.0146
S1	0	0.9372	0.0402	0	0.0225
S2	0	0	0.8996	0.0092	0.0912
S3	0	0	0	0.7500	0.2500
M	0	0	0	0	1

Notes: *S*0: No diabetic kidney disease.
*S*1: Preliminary. *S*2: Clinical.
*S*3: End-stage.
M: Mortality.

Table 2. Costs of treating diabetic kidney disease $A2001

	Weekly	Annual
Preliminary	11	540
Clinical	203	10 535
End Stage	1195	62 132

Source: MBS; PBS.

diabetes in general. In addition to an overall estimate of the costs of diabetic kidney disease, we also compare the long-term implications of a physically active set of diabetes patients against a physically inactive set of diabetes patients. Transition probability matrices like Table 1 were constructed for the two sub-samples, one for physically active and one for physical inactive patients. Predictably, the active cohort has lower transition probabilities to mortality and to subsequent stages of diabetic kidney disease.

III. Results

The total cost and cost of each state of health on a per patient basis is presented in Table 3. *Total Cost*, suggests that a patient who has diabetes now is projected to cost the Australian healthcare system A$17 185. Around $2900 of this will come from treating preliminary diabetic kidney disease, $13 000 will come from treating the clinical stage and $1200 will come from treating the end stage of the complication.

We can extrapolate the results of the total FDS sample for the estimated current size of the diagnosed diabetic population in Australia (520 000 individuals based Australian diabetes estimates).[5] The results are presented in Table 4. We project that Australia will spend A$9.2b on medical and hospital treatment for

[5] We used the diagnosed population as this is the number of patients who will receive medical treatment. We assume the undiagnosed population will not receive direct medical treatment for their diabetes.

Table 3. Projected cost of diabetic kidney disease A$ 2001, per patient

	Total cost (95% CI)	Preliminary	Clinical	End stage
Total sample	17 185 (15 932 – 18 649)	2907	13 042	1237
Active	17 273 (15 695 – 19 282)	2979	12 905	1390
Inactive	16 054 (14 280 – 18 373)	2802	12 451	801

Table 4. Projected cost of diabetic kidney disease A$m 2001, Australian population

	Total cost	Preliminary	Clinical	End stage
Total sample	9264	1512	6782	643

diabetic kidney disease over the next 30 years. A$1.5b will be spent on treating the preliminary stage; A$6.7b will be spent on treating the clinical stage and A$643m will be spent on treating the end stage of the complication.

show that most of the cost comes from treating the clinical stage of the disease. Given that this stage of the disease requires greater treatment than the preliminary stage, this comes as no surprise. However, the clinical stage costs more than the end stage, despite the fact that when looking at the treatments required for each stage, the end stage (requiring dialysis) is far more expensive than the clinical stage. This is explained by the fact that few patients in our model were observed to develop end stage kidney disease.

Surprisingly, there was very little difference in total costs between the physically active and inactive sub-samples. The difference that was found suggests that the active sample was more costly than the inactive sample. Figure 1 shows the accumulation of total costs over time, on a per patient basis. Figure 2 is the survival curve simulated by the Markov model.

A survival curve shows the proportion of patients that remain in the Markov model after a number of years. Figure 2 shows that patients in the inactive sample exited the system at a faster rate than patients in the active sample, and indeed, than patients in the entire sample. The inactive sample, which was found to be slightly less healthy than the active cohort, exits the healthcare system at a greater rate because of higher mortality, and therefore over a long horizon, uses up fewer hospital resources than the active sample. This explains the result in Table 3 and Fig. 1, which show the overall costs in the active sample are greater than the inactive sample.

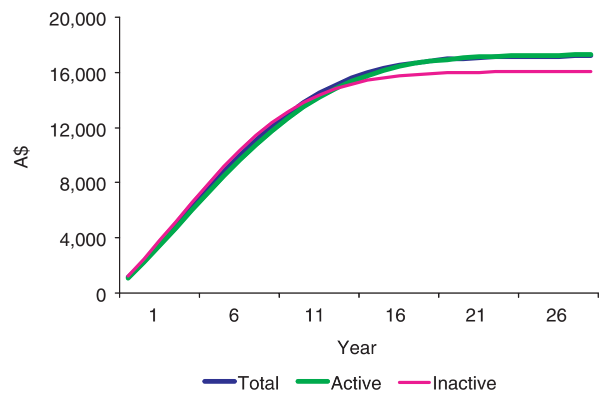

Fig. 1. Accumulation of costs per patient

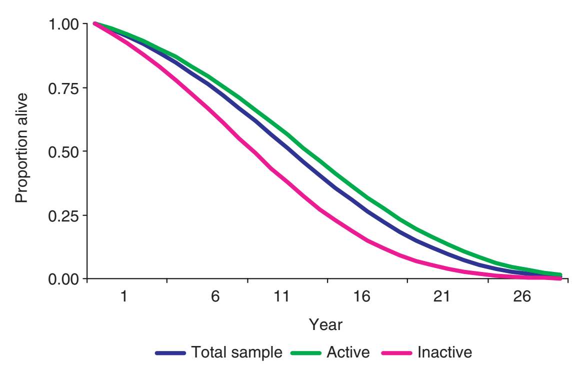

Fig. 2. Markov model survival curves

IV. Summary

We have shown that the future costs of diabetic kidney disease arising from the current diagnosed diabetic population will be significant. The model projects that the most significant cost will come from the clinical stage of diabetic kidney disease. Although, we found that the healthcare costs of physically active diabetes patients was in fact larger than inactive diabetes patients, this result was not significant. Moreover, the higher cost from the active sample is a result of increased mortality rate in the inactive sample.

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