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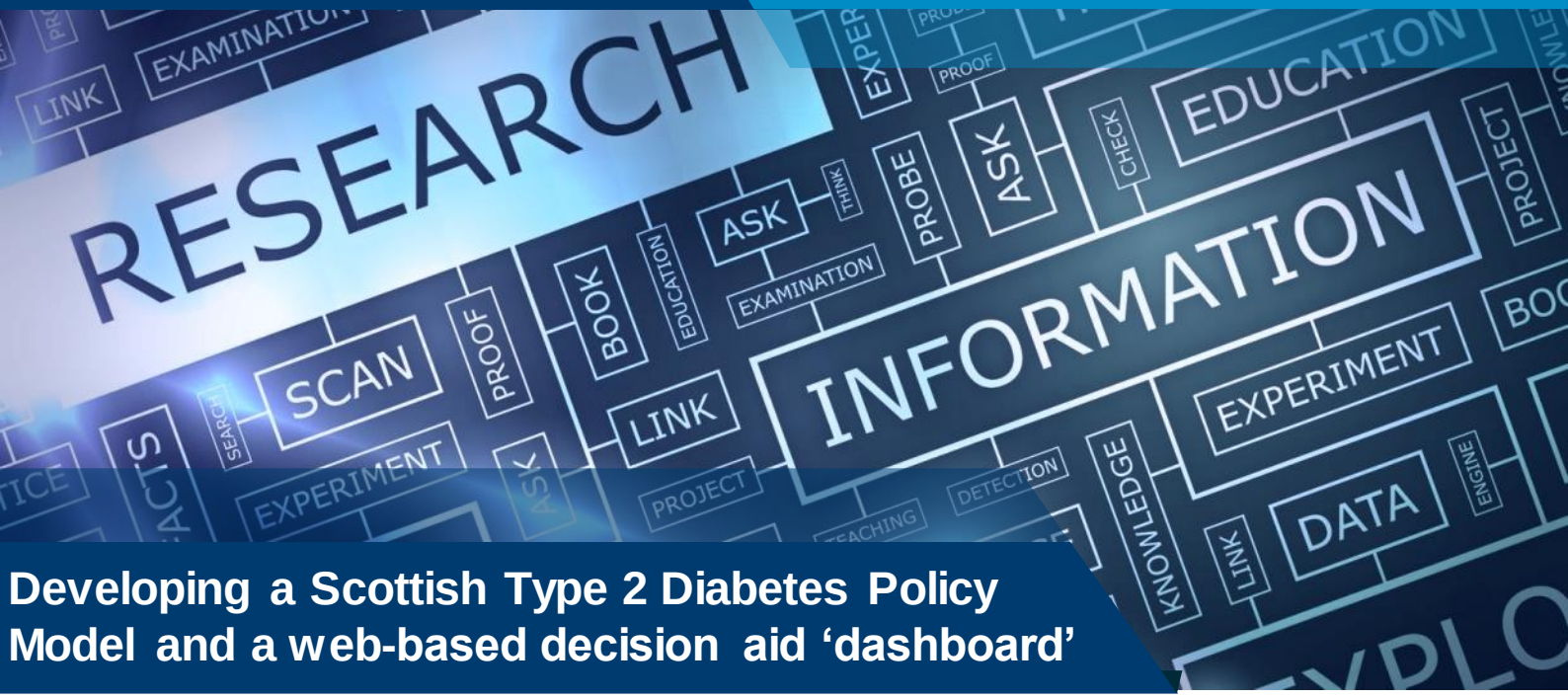
RESEARCH PROJECT BRIEFING



Developing a Scottish Type 2 Diabetes Policy Model and a web-based decision aid 'dashboard'

AIMS

Scotland has high quality, comprehensive clinical information on people with diabetes. Tools allowing visualisation of how changes in clinical risk factors (average blood glucose (sugar) levels (known as HbA1c), systolic blood pressure (SBP)) affect patient outcomes could be a highly informative aid to decision making. In this study, we introduce a Type 2 diabetes (T2DM) policy model which can be used to model remaining life expectancy using age, sex, socio-economic deprivation, HbA1c, SBP, smoking status, previous coronary heart disease (CHD) and previous cerebrovascular disease (CBVD) as independent risk factors. A policy model is a model that can evaluate the effectiveness and cost-effectiveness of interventions and inform policy decisions. This project aimed to develop, validate and assess the performance of a T2DM policy model, and develop a web-based decision aid for real-time modelling by policymakers, clinicians and people with diabetes.

KEY FINDINGS

- We generated a web-based tool using computer software to present model outputs in the form of a 'dashboard' with interactive features to illustrate how changing risk factors influences remaining life expectancy, Quality Adjusted Life Years (QALYs – these account for both quality and duration of life), risk of T2DM complications and healthcare costs.
- A 1% decrease in HbA1c is associated with a five months increase in life expectancy, an increase in QALYs by 0.1 and a decrease in costs of £535 (decrease in costs occur because improvement in health from HbA1c reduction leads to less healthcare visits).
- A 2% decrease in HbA1c is associated with a one year increase in life expectancy, an increase in QALYs by 0.15 and a reduction in costs of around £1,011.
- Implementing a hypothetical intervention that aimed to reduce HbA1c level by a minimum clinically important amount (1%) would be cost-effective with an incremental cost of £3,122 per QALY gained.

WHAT DID THE STUDY INVOLVE?

- A state transition cohort model was developed. In such a model, a cohort of patients move between health states over time. In particular, individuals with newly diagnosed T2DM since 2004 start in an initial state and transit to a death state.
- We used SCI-DC (Scottish Care Information – Diabetes Collaboration), a national register of people with diabetes, linked at the individual person level to hospitalisation, prescription and death records.
- We employed a logistic regression for the first year of T2DM diagnosis to predict the probability of surviving within the first year of T2DM diagnosis. Then, a two-state (alive-dead) parametric survival model was developed using age, sex, socio-economic deprivation (SIMD), HbA1c, HbA1c plus one-year, systolic blood pressure (SBP), SBP plus one-year, smoking status, previous CHD and CBVD as covariates.
- We modelled common T2DM complications of CHD, heart failure (HF), CBVD, foot ulcer amputation (FUA), referable blindness (RB) and renal failure (RF) to quality adjust life year estimates and also modelled total lifetime costs for individuals newly diagnosed with T2DM.
- At each stage of the modelling, we thoroughly checked assumptions and conducted sensitivity analysis where appropriate. Given QALYs and costs, our model can be used for economic evaluation to estimate the cost-effectiveness of new treatments for T2DM.

WHAT WERE THE RESULTS AND WHAT DO THEY MEAN?

In total, 224,994 people diagnosed with T2DM were followed for a maximum of 14 years to the beginning of 2019. In Table 1 we compare predicted life expectancies from our model with national life expectancies in Scotland. For our model we used the following profile: no history of CHD and CBVD, non-smoker, SIMD score of 5, SBP of 140 mm Hg, HbA1c of 60 mmol/mol, SBP one year after date of diabetes diagnosis of 140 mm Hg, HbA1c one year after date of diabetes diagnosis of 60 mmol/mol.

Table 1: Comparison of model predicted remaining life expectancy and Scottish national life tables (in years)

Age at diabetes diagnosis	Scottish National remaining life expectancy (2008-2010)		Predicted remaining life expectancy using T2DM policy model	
	Male	Female	Male	Female
40	37.75	41.41	33.35	34.62
50	28.75	32.07	26.41	27.48
60	20.42	23.26	19.75	20.78
70	13.2	15.33	13.64	14.57
80	7.48	8.77	8.43	9.20

Table 2 illustrates the life expectancy, QALYs and lifetime costs (undiscounted and discounted values) for diabetic individual profiles: 40-, 60- and 80-year-old woman, no history of CHD and CBVD, non-smoker, SIMD score of 5, SBP of 140 mm Hg, HbA1c of 60 mmol/mol, SBP one year after date of diagnosis of 140 mm Hg, HbA1c one year after date of diagnosis of 60 mmol/mol. Such results can be compared to those with, say, reduced values of HbA1c due to intervention effects, to carry out economic evaluation. Note: in health economics, discounting adjusts future outcomes and costs to represent "present values".

Table 2: Life expectancy, quality adjusted life years (QALYs) and lifetime costs (undiscounted and discounted values) for patients at age 40, 60 and 80 years old

Age at diagnosis	Life expectancy (years)	QALYs	Lifetime costs (pounds)
40	74.62 (59.38)	66.87 (55.01)	11336.02 (3795.48)
50	77.48 (66.89)	71.30 (63.07)	39318.97 (21626.8)
60	80.78 (74.02)	76.08 (70.83)	56397.36 (36688.4)
70	84.57 (80.76)	81.26 (78.30)	58676.64 (42737.03)
80	89.20 (87.40)	87.10 (85.70)	49889.3 (39920.65)

The primary outcome of the project is a web-based tool front end for our model. The T2DM dashboard presents model outputs in the form as shown in Figure 1 below with interactive figures and tables to illustrate how changing risk factors alters remaining life expectancy, QALYs, risk of T2DM complications and healthcare costs. To get access to T2DM dashboard you can click on the link: https://sephir.shinyapps.io/T2DM/.

Figure 1: Screenshot of T2DM dashboard

Notes for use: if you change any T2DM risk factors you will immediately see the corresponding outputs such as survival probabilities over time, remaining life expectancy, remaining QALYs, expected percentage of future T2DM complications and expected lifetime costs.

WHAT IMPACT COULD THE FINDINGS HAVE?

- Our T2DM dashboard can be used by people with diabetes in their own care planning and goal setting and to enhance their consultations with clinicians. They can alter their modifiable risk factor levels to answer questions such as "what is my current risk of a diabetes related complication, and how does the risk reduce if I can lower my HbA1c level?"; “if I start taking this new drug, how does that increase my life expectancy?”.
- From a clinician’s perspective, the model allows patient demographics and assessment of current risk to provide informative decision-making support. This could lead to prescribing of cost-effective second line therapy at a stratified/personalised level.
- The T2DM dashboard enables policymakers to interact with the model easily and in a timely manner to help their decision-making.
- The inclusion of socio-economic deprivation in our modelling allows explicit assessment of whether new T2DM interventions have the potential to reduce health inequalities.

HOW WILL THE OUTCOMES BE DISSEMINATED?

The study had a strong team that covered the fields/methods of clinical medicine, statistics, epidemiology, econometrics and health economics. The study also engaged with key stakeholders. The plan is to hold a stakeholder meeting in March 2021 and disseminate the results of the project followed by publications in peer-reviewed scientific journals and further presentations at academic conferences.

CONCLUSION

Our policy model can be used to estimate the impact of interventions on key outcomes for an individual newly diagnosed with T2DM. It can conduct economic evaluation and decision analysis to inform treatment strategies and allocation, including individually targeted and population interventions, and to assess impacts on health inequalities.

RESEARCH TEAM & CONTACT

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Additional Information
This project was completed on 31st January 2021 and received funding of £236,563 from the Chief Scientist Office (CSO).