Medical decision making: Microsimulation versus cohort modelling for assessing type 2 diabetes treatments

Juntao Lyu, Hansoo Kim

Centre for Applied Health Economics, Griffith University, Australia
Email: hansoo.kim@griffith.edu.au

Abstract: Type 2 Diabetes Mellitus (T2DM) is associated with high rates of mortality and complications, making it challenging to evaluate new treatments. Health economic models, such as cohort models and microsimulations, are currently available to evaluate new medications. However, it remains unclear which type of modelling is more suitable for evaluating T2DM treatments. Tirzepatide is a new treatment that has demonstrated promising results for glycaemic control in diabetic patients requiring insulin. The aim of this study is to compare the differences between microsimulation and cohort modelling when assessing tirzepatide for treating type-2 diabetes.

This study compared the outcomes from a microsimulation and a cohort model using the same baseline patient characteristics. The microsimulation used heterogeneous individual baseline data of 10,000 patients, while the cohort model only considered the average baseline values of the entire cohort. Both the cohort and microsimulation were based on published risk equations from the United Kingdom Prospective Diabetes Study (UKPDS OM2) (Hayes, Leal et al. 2013). These parametric proportional hazards equations predict each annual cycle's events of mortality and diabetes-related complications based on patients' characteristics. The microsimulation was implemented in R, and each patient's clinical data, including glucose control and BMI values and event histories are updated and carried forward to the next annual cycle. The cohort model was implemented in Excel using time-varying annual transition probabilities which are calculated from the characteristics of the cohort. Clinical data from a recent trial comparing tirzepatide (5mg, once per week) versus insulin glargine was used to inform the glucose control and BMI changes of diabetic patients (Del Prato, Kahn et al. 2021). Results over 10-year time horizons were assessed.

For the 10-year time horizon, compared to the cohort model, the microsimulation model resulted in statistically significant higher cumulative mortality rates (51.1% vs 28.9%, $p<0.001$) and higher cumulative rates of renal failure (14.3% vs 2.1%, $p<0.001$), heart failure (10% vs 3.7%, $p<0.001$), blindness (0.7% vs 0.02%, $p < 0.001$), and myocardial infarction (20.3% vs 15.3%, $p < 0.001$). However, the cohort model predicted a higher rate of ischemic heart disease (4.8% vs 8.3%, $p<0.001$) and amputation (4.2% vs 9.6%, $p < 0.001$). No difference in stroke incidence (6.8% vs 6.8%, $p=0.978$) was observed. Since the 1-year clinical trial outcomes only indicated the 5% mortality rate and the 6% cardiovascular events, this comparison between microsimulation and cohort simulation cannot conclude the exact accuracy but only the differences between the two model options.

Overall, the microsimulation of health outcomes for tirzepatide resulted in significantly higher rates of mortality and most of the complications associated with type-2 diabetes when compared to the cohort model. The cohort model only predicted higher rates of ischemic heart disease and amputation. There are significant differences in estimated outcomes when comparing microsimulation and cohort modelling for the treatment of tirzapatide in T2DM. This research suggests researcher to be aware of these significant differences and the contexts of using different models, further validations with more longitudinal clinical outcomes for T2DM models are required for future research.

REFERENCES

Del Prato, S., et al., 2021, Tirzepatide versus insulin glargine in type 2 diabetes and increased cardiovascular risk (SURPASS-4): a randomised, open-label, parallel-group, multicentre, phase 3 trial. The Lancet 398(10313): 1811-1824.

Hayes, A. J., et al., 2013, UKPDS outcomes model 2: a new version of a model to simulate lifetime health outcomes of patients with type 2 diabetes mellitus using data from the 30 year United Kingdom Prospective Diabetes Study: UKPDS 82. Diabetologia 56(9): 1925-1933.

Keywords: *Type 2 diabetes, prediction, microsimulation, cohort model*