



Implementation of guideline-recommended strategies for stroke prevention in U.S. adults with type 2 diabetes

A cost-effectiveness analysis

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ABSTRACT

OBJECTIVES

Substantial opportunity exists to enhance primary prevention of stroke in type 2 diabetes (T2D) patients. We aimed to evaluate the cost-effectiveness of improved implementation of seven current guideline-recommended strategies for primary stroke prevention in U.S. adults with T2D.

METHODS

Based on National Health and Nutrition Examination Survey (NHANES) data from 2015-2018, we identified individuals with T2D aged ≥ 45 years without stroke history. We simulated stroke events, stroke-related quality-adjusted life years (QALYs), and healthcare costs for this population over a 10-year horizon using a microsimulation model, the Michigan Model for Diabetes, comparing seven scenarios each with full implementation of one of the seven primary prevention strategies versus a status-quo scenario. The status-quo scenario assumed that the level of implementation of each of the seven prevention strategies was the average national implementation level in 2015-2018. The enhanced scenarios assumed all individuals implemented particular strategy as soon as they became eligible. Analyses were performed from a health system/payer perspective.

RESULTS

Full implementation of the well-controlled blood pressure (BP) strategy would result in approximately 65,419 fewer stroke events, 29,000 fewer stroke-related deaths, a gain of 0.02 QALYs, and savings of \$16.3 billion (2022 US dollar) nationally. In contrast, fully-enhanced implementation of the well-control HbA1c level strategy cost \$351 billion more nationally at a slight loss of 0.009 QALYs. Full implementation of guidelines related to statins, aspirin, warfarin treatment for atrial fibrillation, or smoking cessation would be cost-effective or cost-saving. The strategy of losing 5% weight for all overweight or obese individuals would not be cost-effective.

CONCLUSION

Enhancing implementation of guideline-recommended strategies for BP control, statins, aspirin, warfarin treatment, and smoking cessation for the U.S. adult T2D population without stroke history could potentially avert ~320,000 fewer stroke events, 62,000 fewer stroke-related deaths, and result in a gain of 0.09 QALYs, and savings of \$32.5 billion (2022 US dollar) nationally.

INTRODUCTION

Stroke is one of the atherosclerotic cardiovascular diseases (ASCVDs) that are the leading cause of morbidity and mortality for people with T2D and are the largest contributor to the direct and indirect costs of T2D. Numerous effective interventions to address risk factors for ASCVD are recommended by the American Diabetes Association (ADA), American Heart Association (AHA), and American Stroke Association (ASA) for primary prevention of stroke in people with diabetes. Most of these interventions are cost-effective. However, the level of the ASCVD risk-factor control for preventing primary stroke in adults with diagnosed diabetes is still suboptimal.

Table 1. Recommendations for preventing stroke in type 2 diabetes patients

Well-controlled HbA1c	Target of <7% (for patients aged 45-64 years) or <7.5% (for patients aged ≥ 65 years)
Well-controlled BP	Target of <140/90 mm Hg and treatment with an ACE inhibitor or angiotensin receptor blocker as the first-line medication
Statin treatment	For primary prevention, moderate-dose statin therapy is recommended for those 40 years and older. In patients with diabetes who are at higher risk, especially those with multiple ASCVD risk factors, or with ASCVD risk > 20%, or aged 50–70 years, it is reasonable to prescribe high-intensity statin therapy. Moderate-intensity statin therapy is recommended in patients with diabetes who are 75 years or older.
Treatment with Aspirin/clopidogrel	Recommendations for using aspirin as primary prevention include both men and women aged ≥ 50 years with diabetes and at least one additional major risk factor (family history of premature ASCVD, hypertension, dyslipidemia, smoking, or chronic kidney disease/albuminuria) who are not at increased risk of bleeding.
Non-smoking	A diabetes patient should quit smoking
Well-controlled BMI	Among overweight (BMI=25-29 kg/m ²) and obese (BMI >30 kg/m ²) individuals, weight reduction is recommended for reducing the risk of stroke
Warfarin treatment	Treatment with warfarin for patients with atrial fibrillation (AFib) at high risk for stroke (defined as a CHA ₂ DS ₂ -VASc score ≥ 2)

METHODS

The Michigan Model for Diabetes (MMD) 3.0 is a validated microsimulation model for T2D. Disease progression in MMD is based on six discrete-time discrete-event sub-models that simulate diabetes-related complications (retinopathy, nephropathy, neuropathy), major comorbidities (coronary heart disease [CHD] and cerebrovascular disease), and death due to non-diabetes-related causes. MMD explicitly models diabetes management strategies and stroke prevention strategies recommended by ADA/AHA/ASA through a treatment module.

A RShiny web app for MMD 3.0 is available at the **MICHIGN DIABETS MODELING GROUP's** website: <https://michigandiabetesmodelinggroup.github.io/>

Figure 2. Overall Structure of MMD

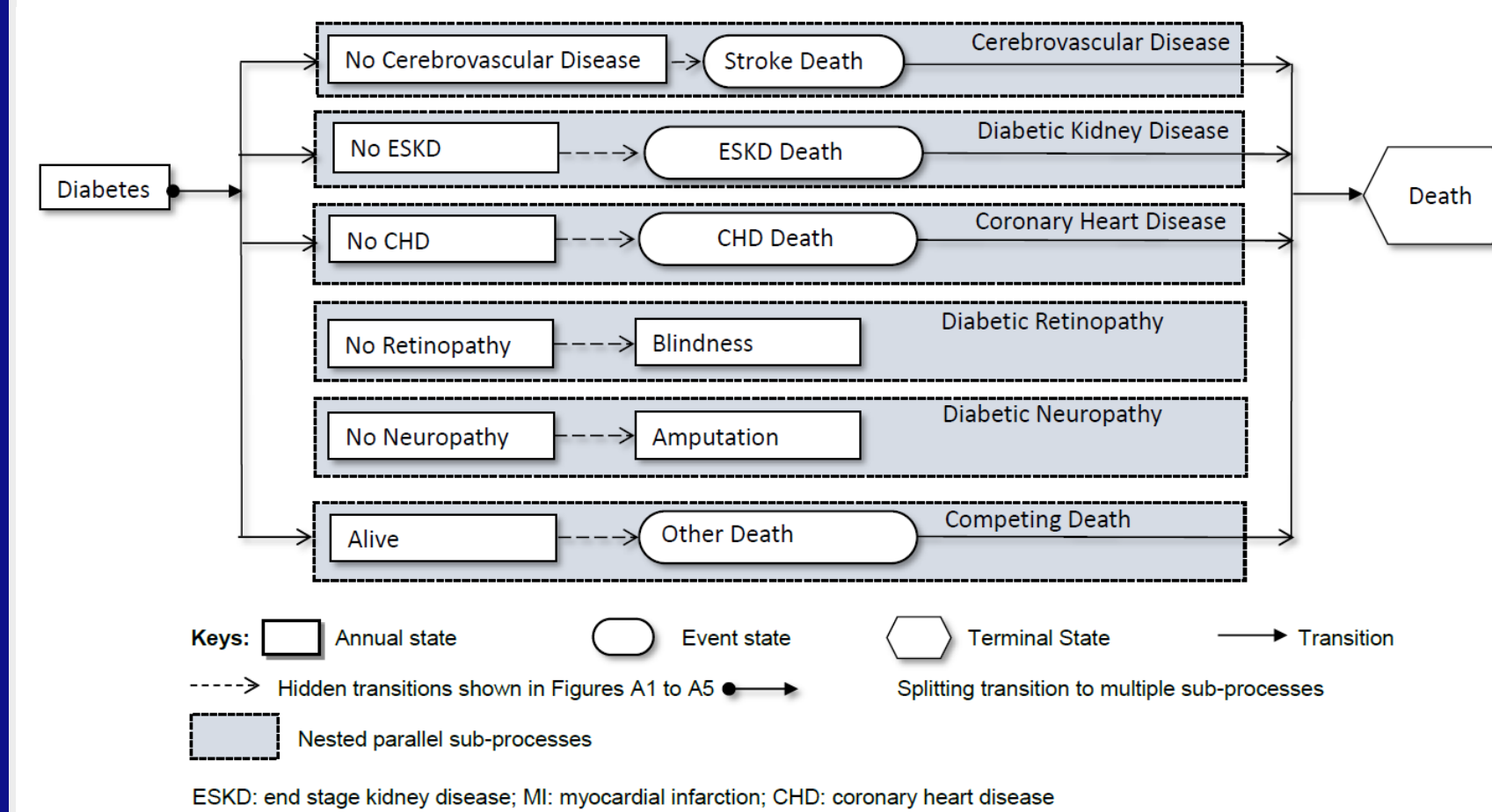
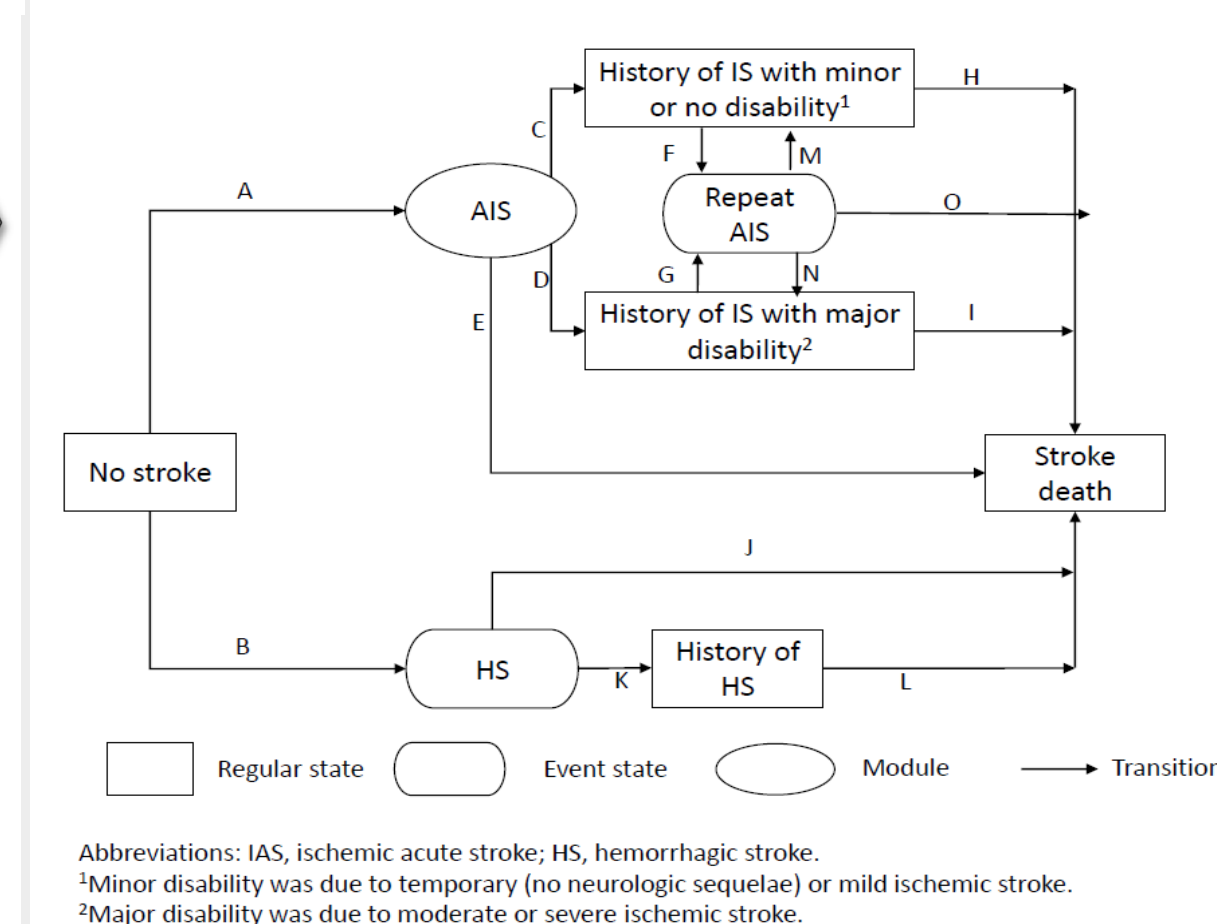


Figure 3. Stroke Sub-model Structure



We ran simulations on a NHANES 2015-2018 population aged ≥ 45 years with T2D and no history of stroke over a 10-year horizon, comparing seven enhanced scenarios vs. a status-scenario.

Status-quo assumes that the level of implementation of each of the seven prevention strategies was the average national implementation level in 2015-2018.

Enhanced scenarios (non-BMI): All individuals implemented particular strategy as soon as they became eligible.

Enhanced BMI control: All patients with BMI > 25 kg/m² participate in weight loss program to lose 5% of their body weight at the beginning of the simulation.

Enhanced multiple preventions: a combination of prevention strategies that are shown to be cost-effective or cost saving when tested alone.

All analyses were approached from a payer's perspective. All future costs and QALYs were discounted annually by 3% of the values for the previous year, according to standard practice. We run 100,000 runs to decrease Monte Carlo uncertainty of the means of outcomes. When summarizing simulation results (e.g., total cost, mean cost, mean QALYs, number of stroke events), survey sampling weights were used to derive results that can be generalized to the national population.

CONCLUSION

Enhancing implementation of guideline-recommended strategies for BP control, statins, aspirin, warfarin treatment, and smoking cessation for the U.S. adult T2D population without stroke history could potentially avert a large number of stroke events and stroke-related deaths, improve quality-of-life, and be cost-saving.

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Results (All results are reported in 2022 US dollar; over a 10-year horizon)

