Cardiovascular Disease Policy Model for Scotland

The CVD Policy Model is an established model employing a risk score developed for the Scottish population, supplemented with Scottish data on costs and health outcomes, to examine long term health outcomes. It uses data from the Scottish Heart Health Extended Cohort (SHHEC).[1 2] SHHEC is made up of individuals from the Scottish Heart Health Study which recruited random samples of the Scottish population between 1984 and 1987, and measured ASSIGN risk factors (including age, gender, family history of coronary heart disease (CHD) and stroke, socioeconomic status (linked to the Scottish Index of Multiple Deprivation (SIMD)[3]), diabetes, systolic blood pressure, number of cigarettes smoked per day, and total and HDL cholesterol) linked through Scottish Morbidity Records (SMR) and the General Register Office for Scotland (GROS)[4] to identify all hospital events and death records. This data linkage allowed the cohort to be followed up for a long time via routine NHS datasets: median survival time to first event (i.e., non-fatal CHD, non-fatal cerebrovascular disease (CBVD), fatal CVD or fatal non-CVD)) was almost 21 years. The CVD Policy Model uses ASSIGN risk factors[4] to predict both cardiovascular disease (CVD) events, and death from all non-CVD causes, including for example, cancers and respiratory diseases. The model therefore provides a prediction of life years gained, QALYs and lifetime costs based on individuals' ASSIGN risk scores.

Life expectancy: As Figure 1 shows, individuals are assumed to be free from CVD at the point that they enter the CVD Policy Model. Each individual is allocated a risk score based on their ASSIGN risk variables, which determines the risk of experiencing an initial event (non-fatal coronary heart disease (CHD), non-fatal cerebrovascular disease (CBVD), fatal CVD and fatal non-CVD) (see Figure 1, Equation 1). Individuals subsequently transit into one of four "competing" event states: non-fatal CHD hospitalisation; non-fatal CBVD hospitalisation; death from CVD; or death from non-CVD causes. Survival analysis was used to model the cause-specific hazards of these competing first events. As not all SHHEC participants had experienced a first event by the end of follow up, the model used a parametric approach to extrapolate and provide estimates of the total remaining life expectancy. The predicted cumulative incidence of events was calculated from the cause-specific hazards and the probability of surviving from any of the competing events at a given time. Those individuals for whom the initial event is non-fatal will experience a fatal event at some point in the future, the risk of which is a determined by a combination of their age at initial event, family history of CHD/stroke and SIMD (see Figure 1, Equation 2)[5 6]. Each individual's life expectancy is determined as the sum of the time to the initial event plus the time to the fatal event (for those whose initial event is not fatal).

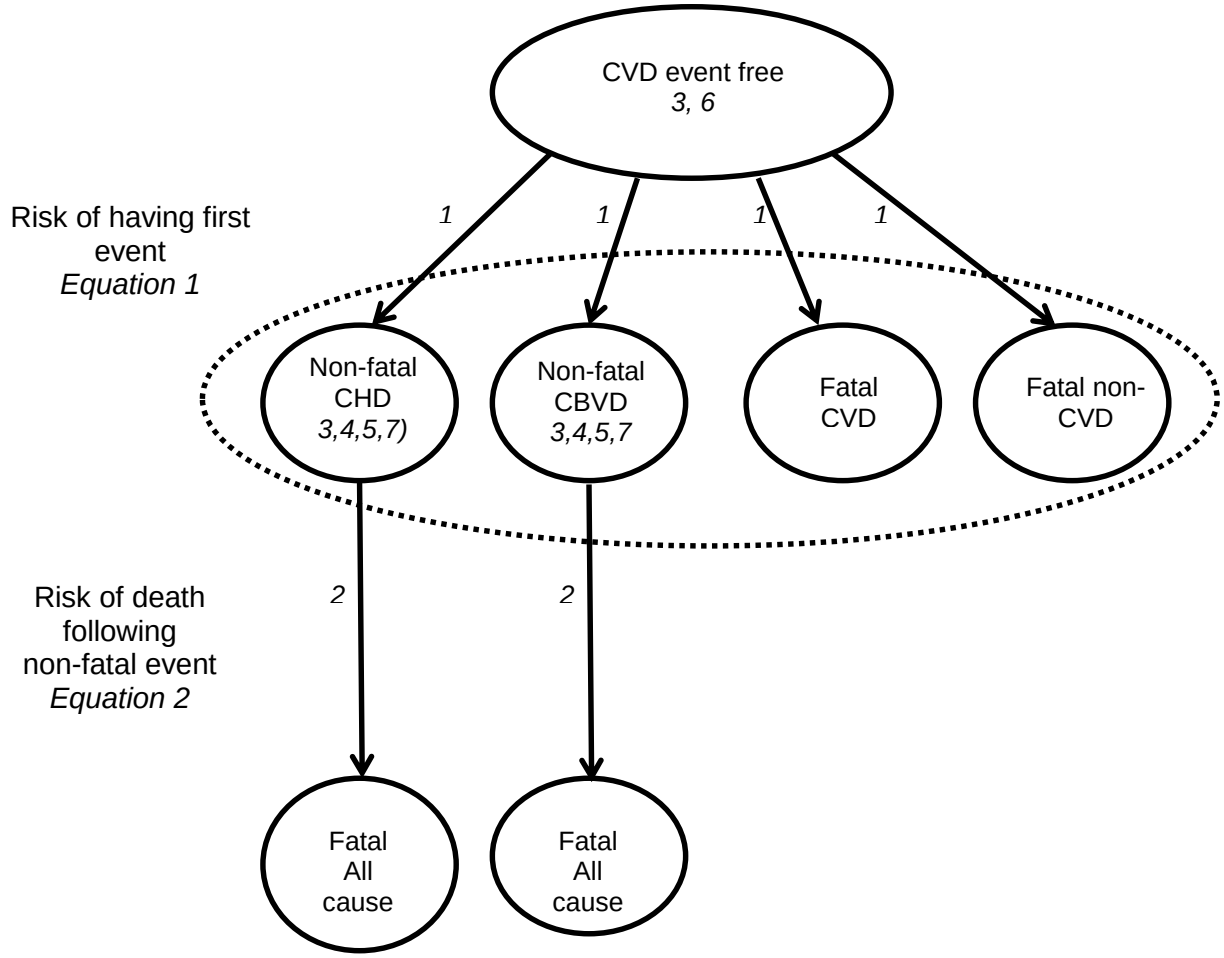

Figure 1. The structure of the state-transition model of the CVD Policy Model

In Figure 1, the numbers in italics refer to the following equations:

Equation 1: Function (age, systolic blood pressure, BMI, cigarettes per pay, diabetes, family history of CHD/stroke, SIMD)

Equation 2: Function (age at event, family history of CHD/stroke, SIMD)

Equation 3: Background morbidity = Function (age, SIMD)

Equation 4: Morbidity impact of non-fatal CVD events = Function (age, family history of CHD/stroke, SIMD)

Equation 5: Risk of subsequent CVD events = Function (age, family history of CHD/stroke, SIMD)

Equation 6: Costs prior to 1st event = Function (age, family history of CHD/stroke, SIMD)

Equation 7: Costs post 1st event = Function (age, family history of CHD/stroke, SIMD)

Quality of life: Quality-of-life adjustment is made in three ways as an individual transits through the model to account for: background morbidity (see *Equation 3);* impact of experiencing a first

non-fatal CVD event (see *Equation 4*); and impact of experiencing subsequent non-fatal CVD events (see *Equations 4* and *5*). These are then combined to generate overall quality-adjusted life expectancy.[5 6]

Table 1. Age-related utility scores estimated from SHeS 2003

Age (years)	Utility
25–34	0.8310
35–44	0.8200
45–54	0.8060
55–64	0.8010
65–74	0.7880
> 74	0.7740

For background morbidity, Scottish Health Survey (SHeS) 2003 cross-sectional survey data[7] were used to generate a preference-based weighted HRQoL utility score for each age group (as shown in Table 1).[8] These scores were used to weight survival probabilities in all arms of the model, and were then adjusted to account for the experience of non-fatal events using utility decrements (shown in Table 2) also estimated using data from SHeS 2003.[5 6]

Table 2. Utility decrements attributed to non-fatal events

Event	Utility decrement
Angina	0.0891
Myocardial infarction	0.0403
Irregular heartbeat	0.0499
Stroke	0.0938
Intermittent claudication	0.0199
Other cardiac	0.0336

Lifetime health service costs: Individuals accumulate health service costs as they transit through the model. These costs are a mixture of age-related costs (associated with increasing comorbidities) and costs associated with the experience of specific events. The linked SHHEC and SMR dataset provides information on all hospital episodes. [5 6] These episodes were costed using Method 1 in Geue et al[9] to generate annual age-related health-care costs. Costs accumulate in the period prior to the initial event (see *Equation 6*) and following a non-fatal CVD event (see *Equation 7*).

References

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