Decision Analytic Modelling

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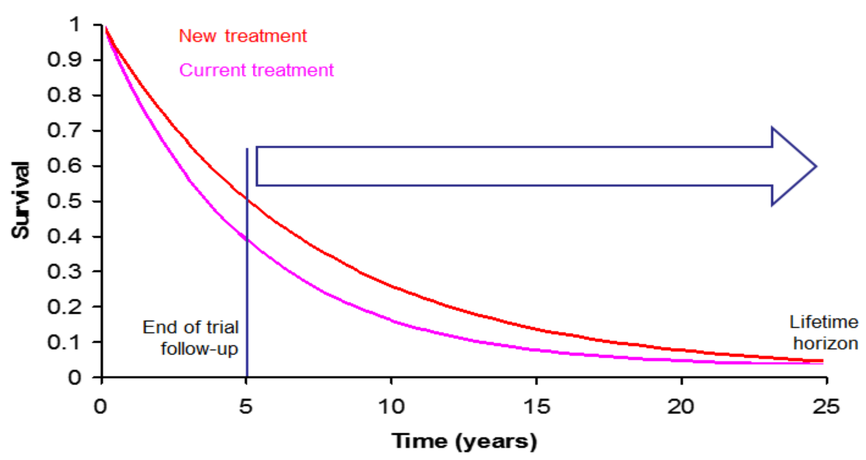
Rationale for decision models

HERC has developed several decision models evaluating the impact of interventions across a variety of diseases such as: blood disorders, breast cancer, chronic kidney disease, diabetes, hip fracture, inflammatory bowel disease, inherited metabolic diseases, malaria, cardiovascular disease, prostate cancer, and others.

Models are very useful to specify the decision problem, the disease of interest, set out all relevant interventions to be compared, combine evidence from several data sources, estimate unobservable parameters and states, and extrapolate effects of interventions beyond observed data.

Often we estimate lifetime effects, costs and cost-effectiveness to make sure that we have captured all differences between the interventions under comparison. Given the limited durations of trial or cohort data we need to extrapolate these data to a lifetime horizon to inform decisions now.

Figure 1: The need for extrapolation beyond observed data



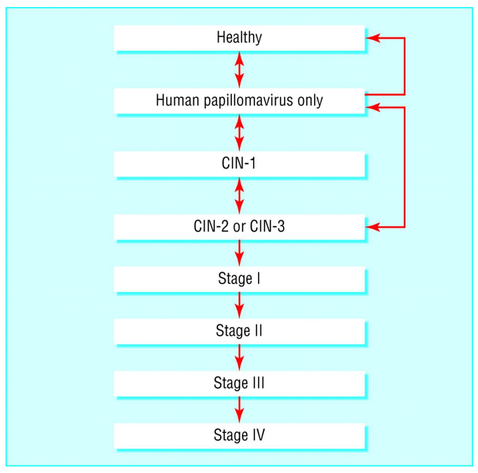
The lifetime extrapolation can be done by combining different data sources and/or analysing single large and detailed datasets. In this poster we present examples of our current and previous work.

Combining evidence from different sources

HPV testing to manage low-grade cytological abnormalities

A decision model was used which synthesised data from NHS pilot studies, published literature and meta-analyses to predict the incremental lifetime effects, costs and cost-effectiveness of using HPV testing to stratify women with borderline or mildly dyskaryotic smears for immediate colposcopy. The model predicted testing for HPV to be cost-effective. *BMJ 2006;332:79.*

Figure 2: Natural history of HPV disease model



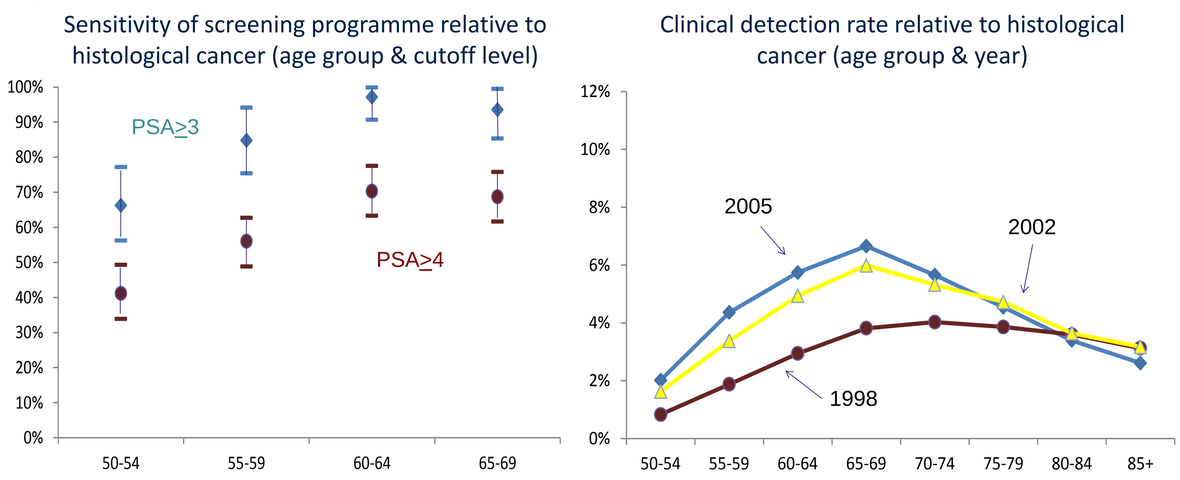
Antimalarial, antibacterial, and combined rectal formulations

Rectal antimalarial treatments are currently available but rectal antibacterial treatments are yet to be developed. The cost-effectiveness of antimalarial, antibacterial and combined rectal formulations for severe febrile illness in developing countries was assessed by pooling evidence from several sources, including expert opinion. These interventions were found to be cost-effective prompting research into the development of effective rectal antibacterials, *PLoS One 5:e14446.*

Prostate cancer screening

Combining all relevant data sources allows estimating and calibrating unobservable parameters such as accuracy of the screening programme and progression between untreated histological cancer stages. This enables estimating the cost-effectiveness of different screening rounds relative to current practice across several jurisdictions. *Ongoing work.*

Figure 3: Simultaneous estimation and calibration of unobservable inputs*



* Pooling cancer registry data, screening pilot data and other published sources within Bayesian framework that allows calibration to particular jurisdictions and evidence consistency checks

Using large and detailed datasets

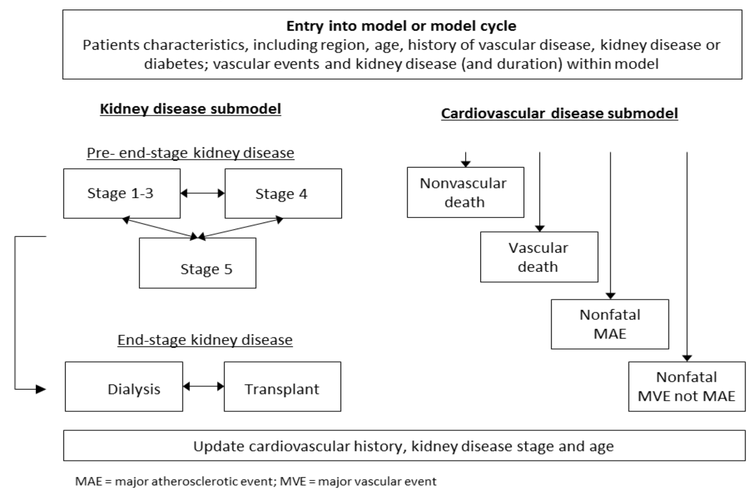
Early breast cancer model

A Markov model was used to simulate the natural progression of early breast cancer and the impact of chemotherapy on reducing the risk of recurrence following surgery The probability of a first recurrent event was estimated using a parametric regression-based survival model incorporating established prognostic factors, and estimated from a patient level dataset. Other probabilities, treatment effects, costs and quality of life weights were estimated primarily using data from the three UK-led RCTs, a meta-analysis of all relevant RCTs, and other published literature. The model predicted the lifetime costs, quality adjusted life years (QALYs) and cost-effectiveness of different chemotherapy regimens for women with differing prognoses. *Eur J Cancer 2011;47:2517*.

SHARP model

Data from the Study of Heart and Renal Protection (SHARP) is being used to develop and validate a chronic kidney disease (CKD) progression model with particular focus on cardiovascular risk over time. The model incorporates the interdependence between kidney disease progression and cardiovascular risk as kidney disease patients are at increased risk of cardiovascular events while cardiovascular events might contribute to kidney disease progression. The model will be used to evaluate lifetime health benefits and healthcare costs of LDL cholesterol lowering in CKD, and could inform further evaluations of effects of cardiovascular disease interventions in CKD. *Ongoing work.*

Figure 4: SHARP Chronic Kidney-Cardiovascular Disease model



MAE = major atherosclerotic event; MVE = major vascular event

HPS model

A Markov model was developed using data from the Heart Protection Study (HPS). Vascular event endpoints were estimated through parametric survival models. The model was used to evaluate survival of the HPS participants over lifetime, the overall absolute effects of 40mg simvastatin daily and showed that LDL-cholesterol lowering, particularly with generic statins, is very cost effective for a wider population than previously considered. *BMJ 2006;333:1145.*

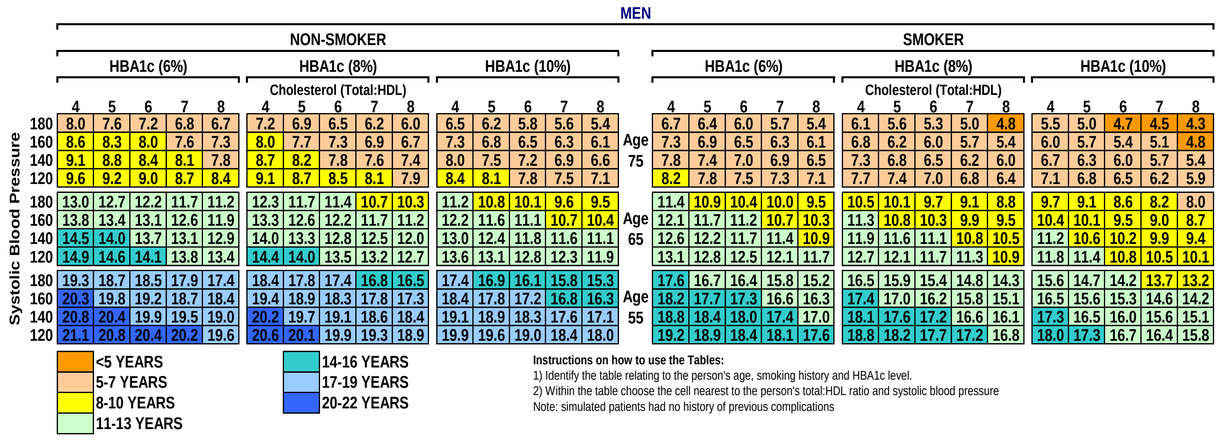
Table 1: predicted life years gained from lifetime use of 40mg simvastatin daily

Age at initiation of simvastatin	Quintiles of 5-year major vascular event risk in HPS study				
	12%	18%	22%	28%	42%
40-49	1.67	2.02	2.21	2.41	2.49
50-59	1.32	1.52	1.67	1.84	1.94
60-69	0.95	1.06	1.17	1.27	1.39
≥70	0.64	0.72	0.79	0.88	0.98

UKPDS Outcomes model

The United Kingdom Prospective Diabetes Study Outcomes Model (UKPDS-OM) is a simulation model based on patient data from the UKPDS which predicts the occurrence of diabetes-related complications over a lifetime and quantifies the respective (quality-adjusted) life expectancy and lifetime healthcare costs. The UKPDS-OM was developed primarily to simulate, at a patient level, mortality and a profile of complications and has been used for economic evaluations of diabetes-related interventions, health service planning and as a long-term prognostic tool. *Diabetologia 2013;56:1925 & Diabetologia 2004;47:1747.*

Figure 5: Life expectancy table for men with type 2 diabetes using UKPDS-OM*



* Eur Heart J 2009;30:834