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Facilitating external use with user-friendly interfaces: a health policy model case study

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on behalf of the SHARP Collaborative Group

useR! 2019

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Motivation: what is a health policy model?

A health policy model is a tool to inform policy decisions by projecting people's life courses. Predictions include

- disease events
- life expectancy
- quality of life
- healthcare costs
- effects of treatments
  - positive (disease risk reduction) and negative (adverse effects)

Projections made over long time periods (eg lifetime)

Motivation: why are health policy models needed?

Healthcare budgets are limited and not all treatments can be recomended even if effective

- Models show whether treatments are good value for money
- Health policy models are increasingly used by policy makers and clinicians
- In UK, cost-effectiveness analyses are required by NICE
  - Good-value-for-money: £20-30K per extra quality-adjusted life-year (QALY)
- Flexible models can help answer many policy questions
- Aim for transparency, reliability, reproducibility and usability

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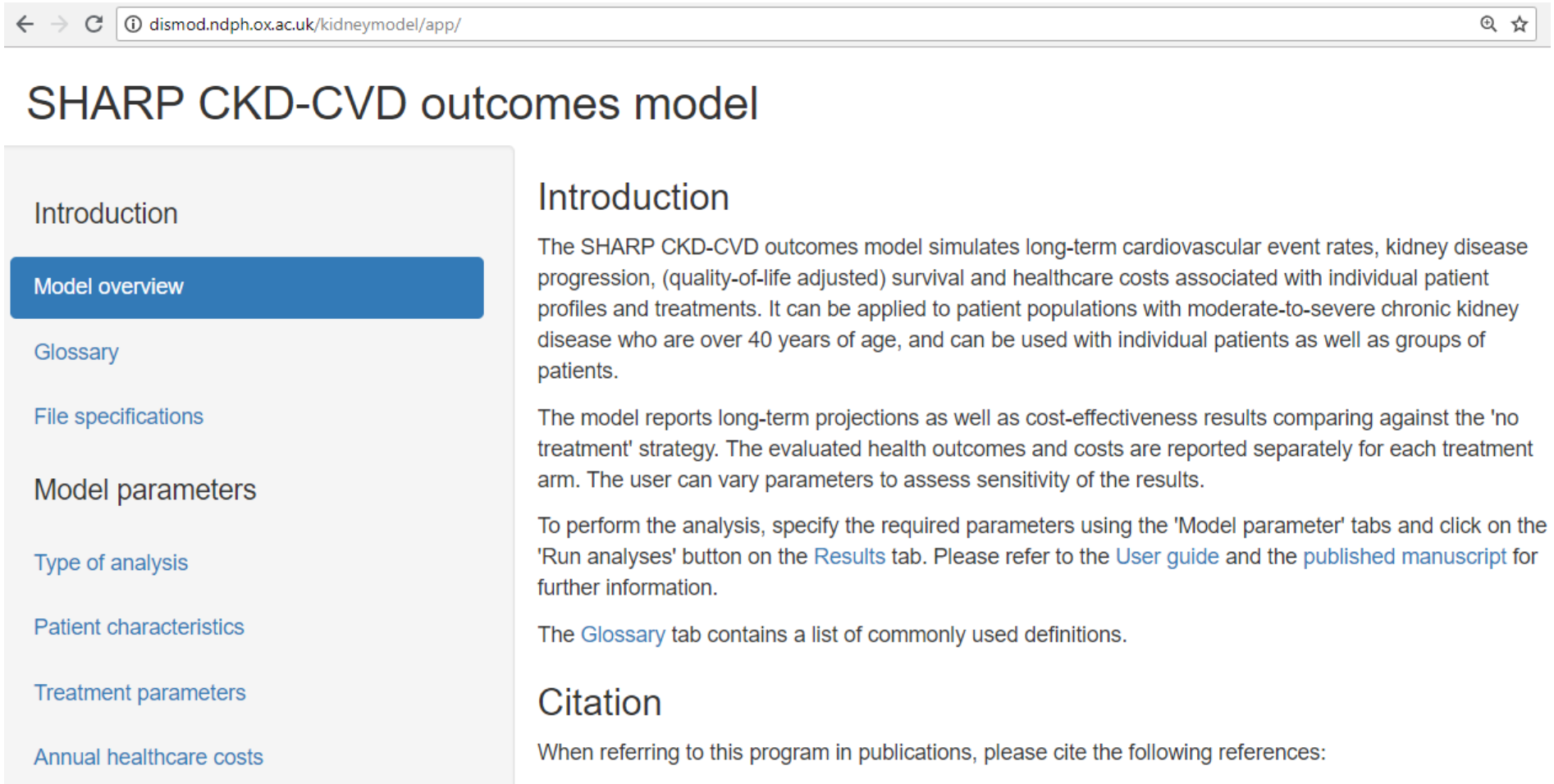
- Flexible models can help answer many policy questions
- Aim for transparency, reliability, ~~reproducibility~~ and usability
  - sensitive patient-level data often cannot be released

Motivation: how to facilitate usability?

	Transparency	Reliability	Usability
Release the code	😀	😀	☹️ useRs only code mis-use
Publish equations and methods	🙂	🙂	☹️ analysts only
Provide user-friendly interface	☹️ black box	☹️	😀 NB: user vs useR
Publish equations and methods and provide user-friendly interface	🙂	🙂	😀

SHARP CKD-CVD model: Shiny interface



Case study: SHARP CKD-CVD model Background

- Chronic kidney disease (CKD) increases cardiovascular (CV) risk
- Want to project long-term outcomes in CKD
  - cardiovascular events, CKD progression, life expectancy, quality of life, healthcare costs;
  - enable implementation of treatments to reduce cardiovascular risk
    - assess long-term effects and cost-effectiveness.
- Patient-level data from a trial
  - baseline characteristics, within-trial events
- Risk equations derived from the data
- Combined into a Markov model to do lifelong projections
  - validated internally and externally

SHARP CKD-CVD model: need for a user-friendly interface

- The model to be useful for NICE, other analysts, clinicians...
- User-friendly interface accessible from anywhere
- No need for knowledge / installation of R
- Adaptation to other scenarios/countries
  - national mortality rates
  - national healthcare costs
  - treatment to be assessed
- Customising parameters in the current setting
  - population characteristics
  - duration of treatment / time horizon
  - discount rate

SHARP CKD-CVD model: Shiny interface

http://one-elevenbooks.com/shiny-or-the-truth/

- Application accessed via a link
- The user only sees the front end
- All programs/data stored externally
- The front end can be modified using CSS themes, htmlwidgets, and JavaScript actions
  - fancy fonts, links, email addresses etc
  - error checking on data entry

http://dismod.ndph.ox.ac.uk/kidneymodel/app/

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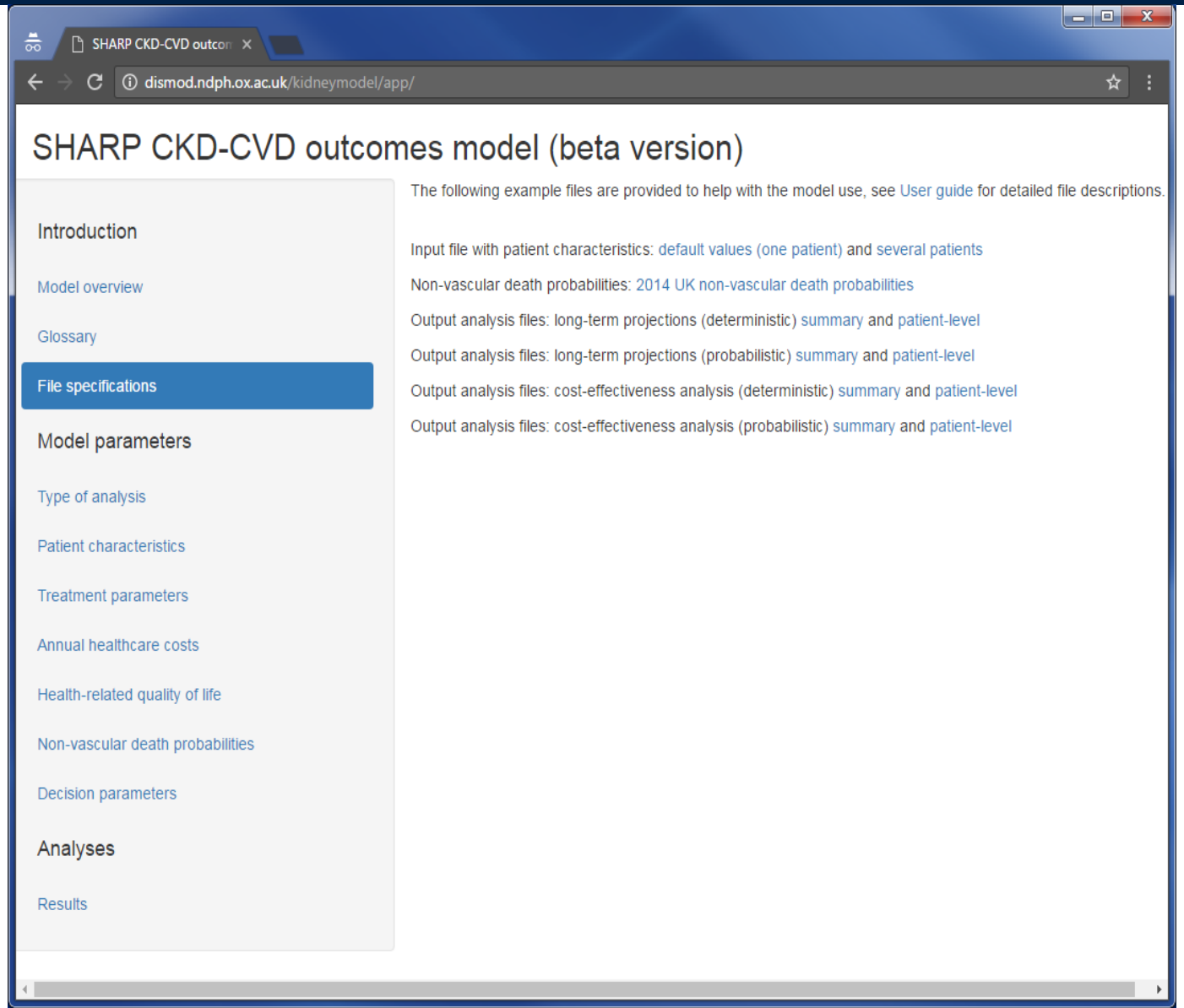

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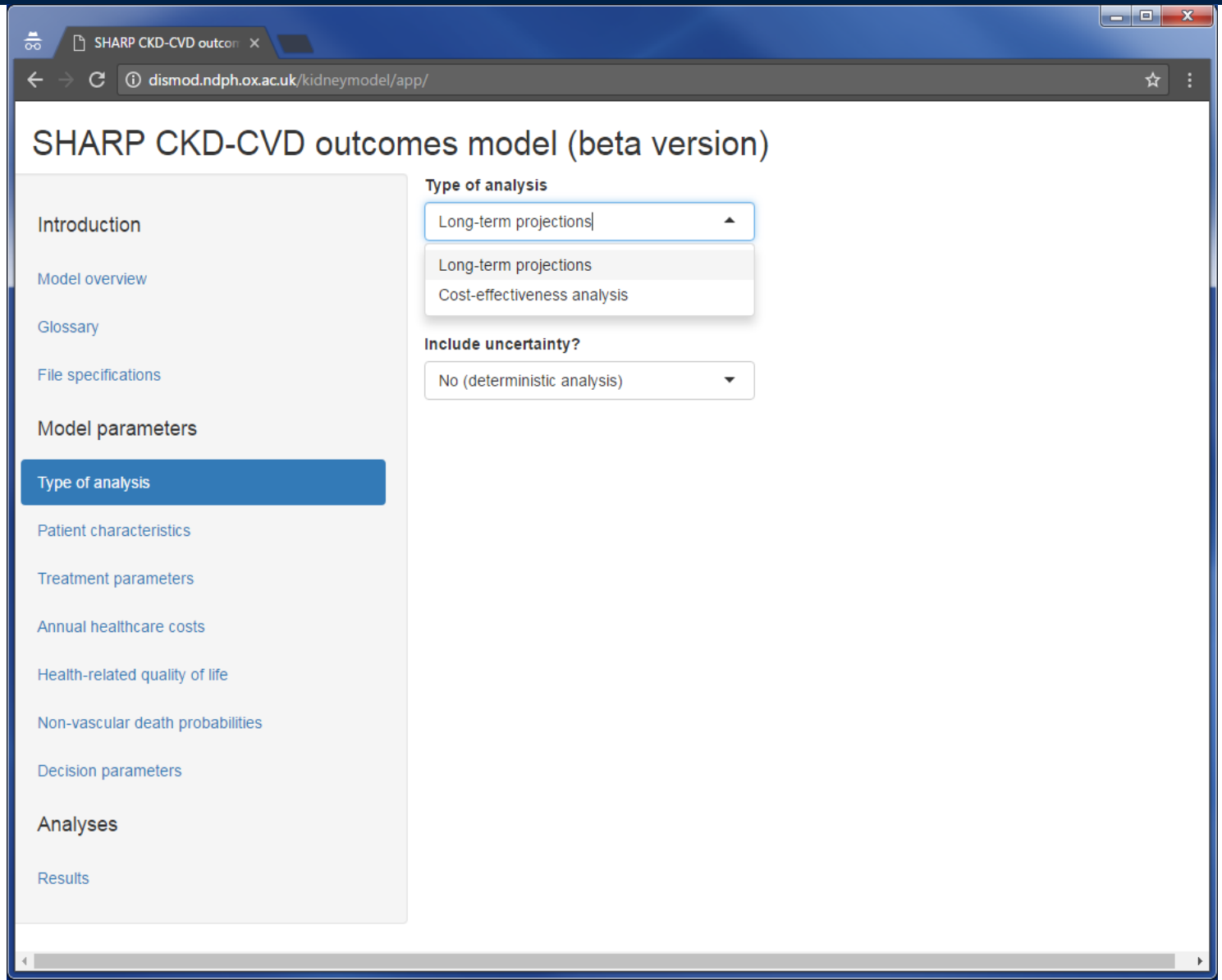

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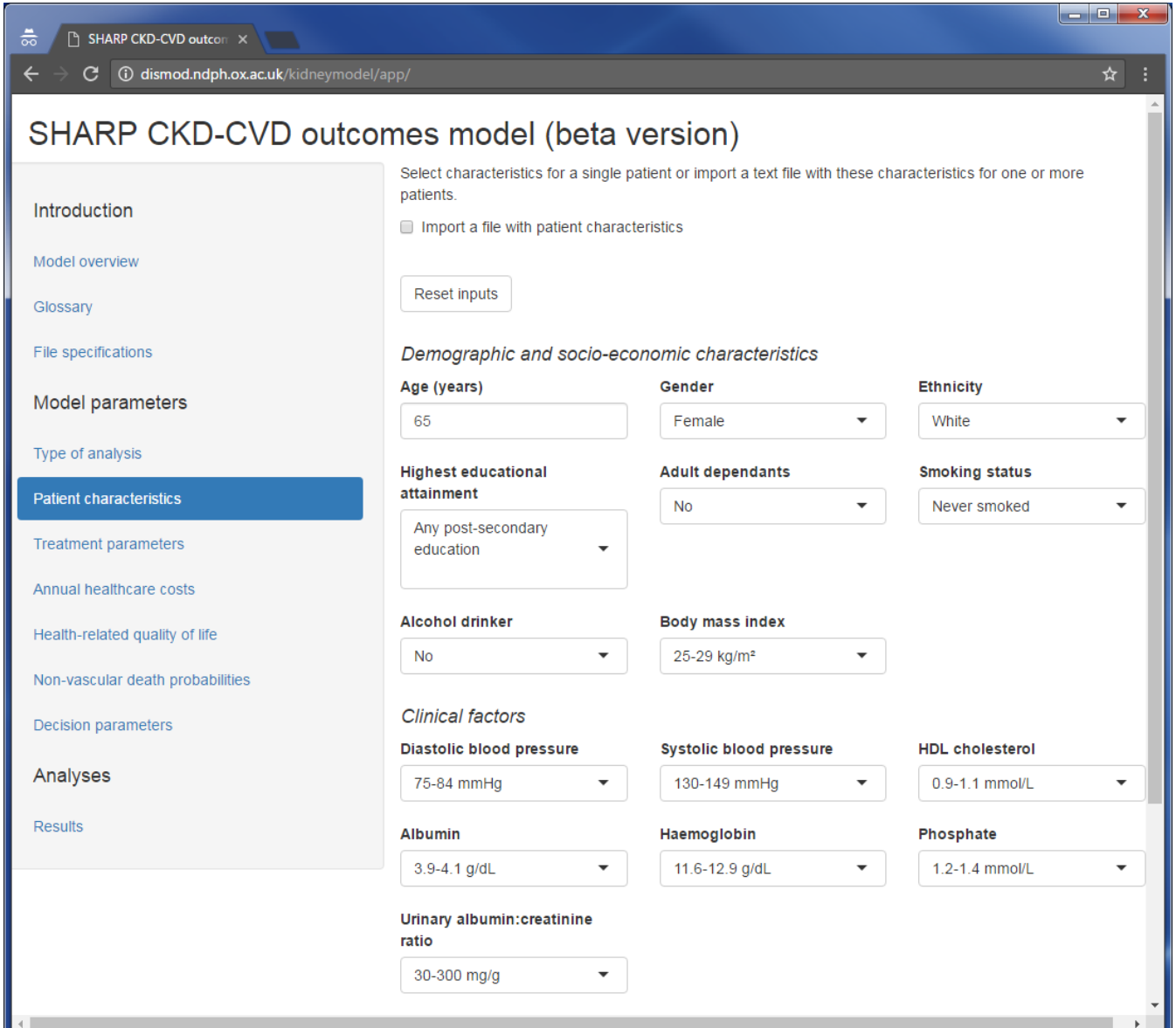

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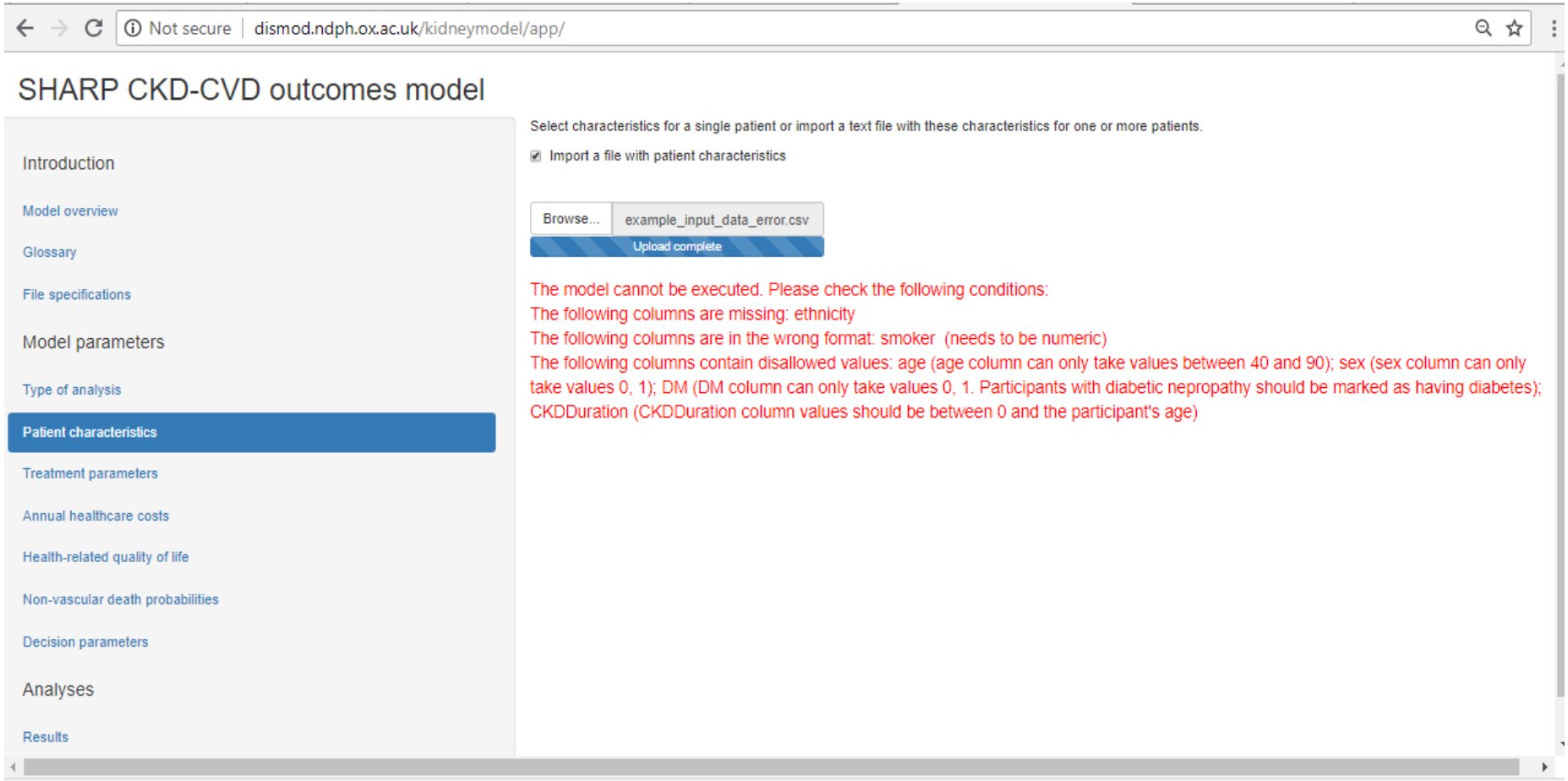

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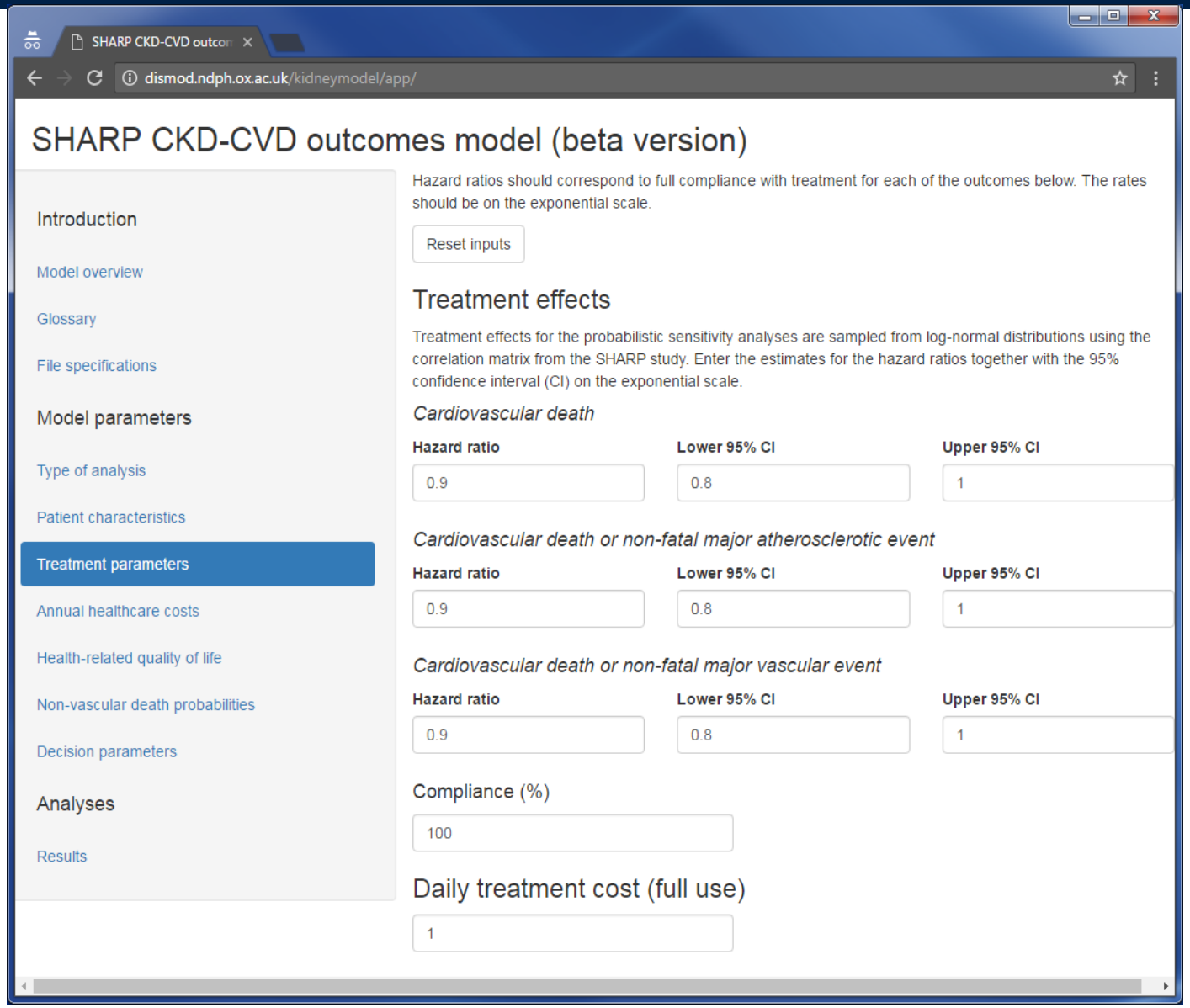

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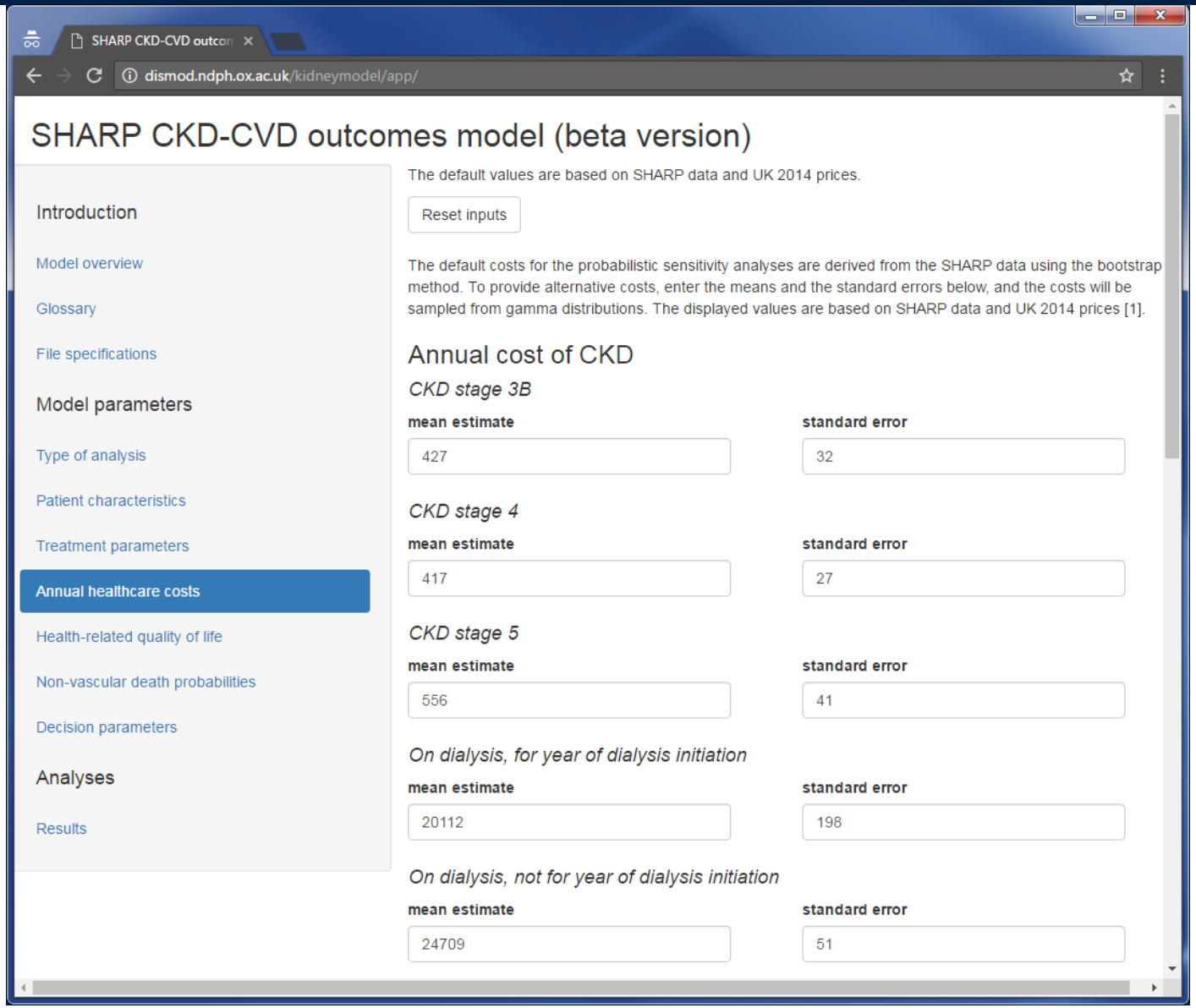

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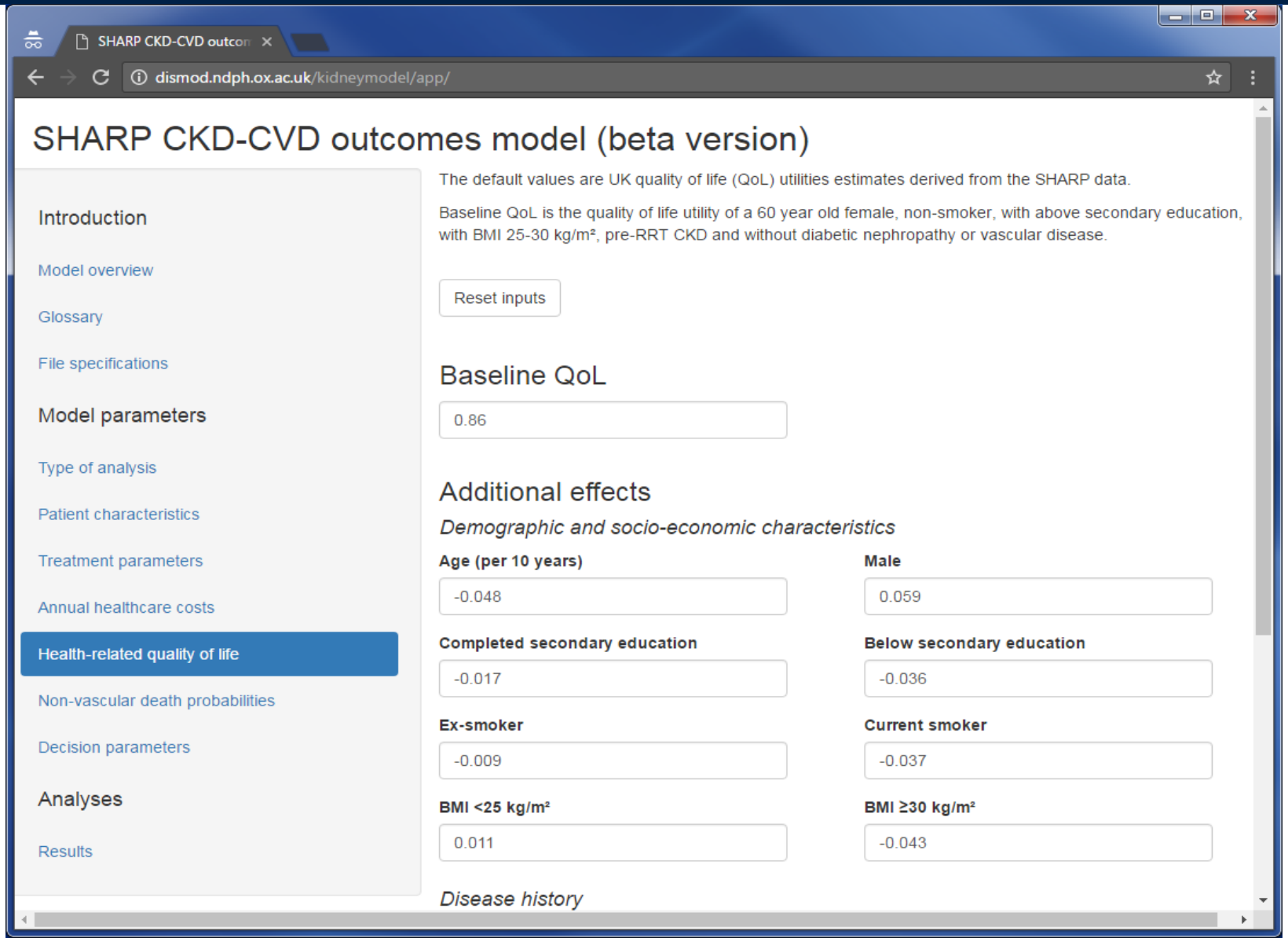


Discount cost-effectiveness results

Long-term projections in the control group (cumulative probabilities per 1,000 participants)

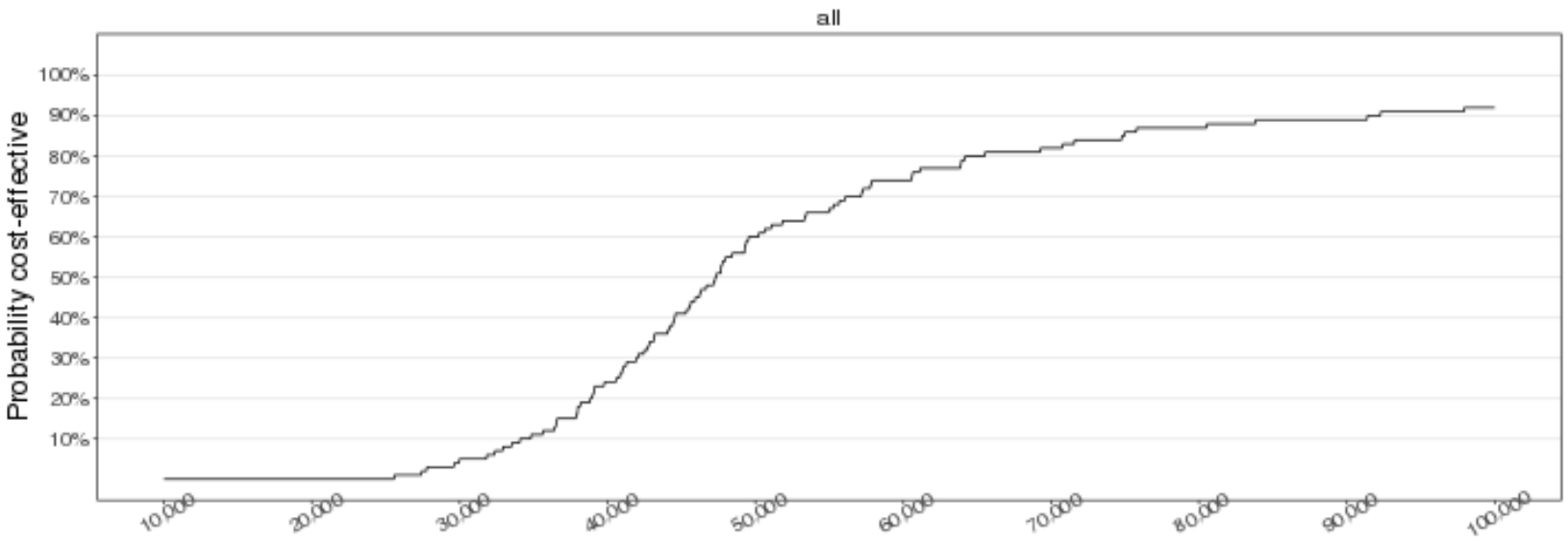
	MVE or VD	RRT	Vascular deaths	All deaths
At 5 years	184 (159, 213)	409 (357, 444)	57 (44, 76)	205 (194, 222)
At 10 years	281 (244, 319)	643 (594, 683)	118 (92, 155)	415 (398, 438)
Over simulation duration	419 (358, 501)	884 (826, 935)	292 (225, 379)	907 (897, 918)

Long-term projections in the treatment group (cumulative probabilities per 1,000 participants)

	MVE or VD	RRT	Vascular deaths	All deaths
At 5 years	169 (138, 193)	407 (355, 439)	51 (37, 70)	200 (189, 216)
At 10 years	263 (214, 299)	638 (593, 675)	106 (81, 140)	407 (389, 429)
Over simulation duration	397 (328, 477)	877 (813, 927)	271 (207, 371)	905 (896, 915)

Incremental cost-effectiveness over the simulation duration (results per 1,000 participants)

LYs gained	QALYs gained	Incremental hospital costs	Treatment costs	Cost per LY gained	Cost per QALY gained
135 (-4, 279)	107 (22, 227)	698,152 (-416,384, 1,306,000)	5,074,512 (4,904,776, 5,201,336)	42,646 (20,617, 304,068)	54,085 (27,412, 179,555)



User-friendly interface: help with debugging and transparency

User-friendly interface: help with debugging and transparency

- Face validity debugging
  - Easier to do on a user-friendly interface (even for the developers!)
- Feedback from external users
- Running several models against a reference simulation
  - Mount Hood diabetes challenge: models predicting long-term outcomes in diabetes patients
    - everyone gets the same tasks (eg change in life expectancy after statin initiation)
    - core assumptions same for everyone
    - additional assumptions must be documented in a pre-defined template
    - the results are presented, compared and (usually) published
    - user-friendly interface enables replication

SHARP CKD-CVD model: conclusions

- SHARP CKD-CVD model is a novel resource for evaluating health outcomes and cost-effectiveness of interventions in CKD
- User-friendly web-based freely available interface aids model use
- Together with the published equations / methods helps ensure reliability of the underlying code and methods transparency
- The user can enter with their own parameter values and perform calculations in different settings
- User's perspective should be taken into account:
  - simple menus, straightforward navigation, pretty looks
  - detailed user-guide
  - example input/output files, file descriptions and default values
  - error checking at data entry could (partially) prevent inappropriate use
  - which parameters should be modifiable?

SHARP CKD-CVD model: challenges and discussion points

- Day-to-day support
  - Replying to queries, fixing bugs
  - R/package updates may break everything!
  - Not updating is not an option (according to our IT team)
- Is R the best option for such an interface?
  - Might Python be faster and/or have better visualisation capabilities?
  - C++?
- Do the benefits of releasing the code outweigh the risks?

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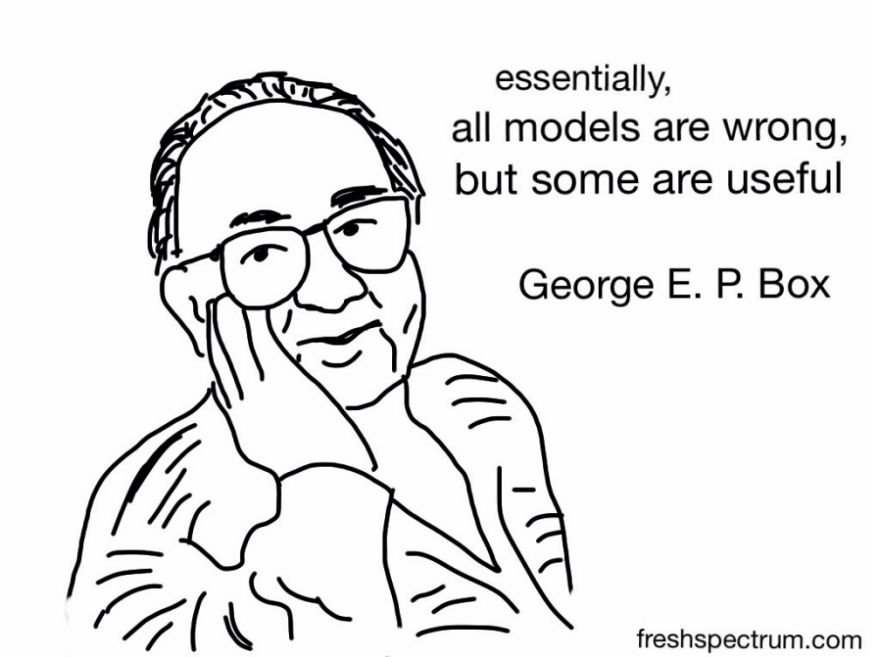
SHARP CKD-CVD model



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