Estimating the burden of chronic kidney disease (CKD) in the UK: Comparison of two health economic models

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Introduction

- Chronic kidney disease (CKD) represents an important health policy concern due to a growing population and its associated morbidity and mortality. Predicting the future burden of CKD overall and in high-risk populations such as patients with elevated albuminuria, type 2 diabetes (T2D) or heart failure (HF) is important if healthcare services are to be resourced properly.
- Epidemiological and health economic policy models provide a useful way by which to make such predictions, but methods vary.
- This study aims to compare and validate two different approaches to estimating the burden of CKD in the United Kingdom (UK), and to estimate how this is predicted to change by 2025.

Methods

Model 1 utilised an open cohort analysis based on a Markov framework, with CKD stages defined by discrete health states. Disease progression was modelled through the application of published estimates of the rate of estimated glomerular filtration rate (eGFR) decline, stratified by the presence of T2D, HF and albuminuria. Model 2 utilised an individual population simulation where each individual is given an independent eGFR and albuminuria value based on population level distributions for each variable. The combination of the two determines the individual's CKD status in any given year. CKD stage is further stratified by co-morbidity. Table 1 illustrates key data. Both analyses projected CKD burden and related co-morbidities in the UK from 2020-2025. A scenario involving a 20% reduction in albuminuria was run and the models compared and validated (Table 2).

Table 1. Summary Model data inputs

Parameter	Model 1	Model 2
Population Data	ONS 2016 35+ (1)	ONS dynamic age-sex pop projections (1)
CKD Prevalence	HSE 2016 (2); USRDS	eGFR/albuminuria 2016 (2)
Stroke & CHD	Go et al. (8)	BHF statistics 2018 (6)
Health State Costs Utilities	NHS ref costs (3) Eriksson et al. 2016 (4) Lee et al. 2005 (5)	

Table 2. Comparison of methodologies used in Model 1 and 2

Model 1	Model 2
A Markov trace	A stochastic Monte Carlo simulation
Disease progression modelled with a fixed annual rate of eGFR decline.	Individuals are given individual eGFR and albumin values based on population distributions and speed of progression.
Individuals in subgroups at high risk of rapid eGFR decline will have increased rates of decline	High risk groups will experience greater eGFR decline and/or increase in albumin.
The model has a fixed cohort of CKD patients. There are subgroups modelled who also have diabetes, heart failure, albuminuria, or a combination of all of these.	Total population-based simulation including both CKD and non-CKD individuals. Individuals can contract, die-from, survive a range of related co-morbidities.

Validation of the 2 models were assessed using four components described in Table 3 (7).

Table 3. Description of validation for Model 1 and Model 2

Parameter	Model 1	Model 2
Face validity	Consistency between model inputs, model outputs and previously published evidence	Core methods, assumptions and data input sources are published and peer-reviewed
Internal validity	Extreme value analysis, technical reviews	Robust quality control via Github, unit testing and peer-reviews
Cross validity	Current study	
External validity	Validation of model point estimates to previously published estimates	Extensive validation against published trends
Predictive validity	Comparison against published trends e.g. UK Renal Registry	Based on 5 predictive modules which have been published, validated and peer-reviewed.

Results

Table 4 provides a summary of results. In both models CKD prevalence, Renal Replacement Therapy (RRT) and costs were projected to increase by 2025.

Table 4. Summary of comparison between Model 1 and Model 2 in 2025

Model	5 year Prevalence	5 year RRT Prevalence	5 year NHS Cost *
Model 1	8,889,251	75,226	£17.3 billion
% change	11.7%	15.9%	8.8%
Model 2	9,592,213	76,000	£21.3 billion
% change	7%	8.6%	13.9%
Abs % difference	4.7%	7.3%	5.1%

(*) Costs presented are not discounted

Prevalence comparison

Model 1 projected an 11.7% increase, and Model 2 projected an 7.0% increase in CKD prevalence by 2025. However absolute numbers were higher in Model 2 (8.9 million in Model 1 compared with 9.6 million in Model 2 by 2025). This difference is likely to be due to the differences in assumptions and parameters. Model 1 includes static population figures from 2016 for age 35+. While Model 2 includes age-sex population projections from 2020. Differences in albumin distribution will also account for variation across models. Model 1 extrapolates percentage albumin by eGFR group from US Renal Data System; Model 2 includes a continuous albumin distribution from HSE.

Table 5. CKD Prevalence cases in 2020 and 2025 for Model 1 and Model 2 in the UK

Year	Prevalence – Model 1	Prevalence – Model 2
2020	7,960,510	8,973,051
2025	8,889,251	9,592,213

Projected RRT prevalence by 2025

Model 1 projected a 15.9% increase (64,886 to 75,226) in RRT while Model 2 projected an 8.6% increase (70,000 to 76,000) in RRT between 2020 and 2025 (Table 5).

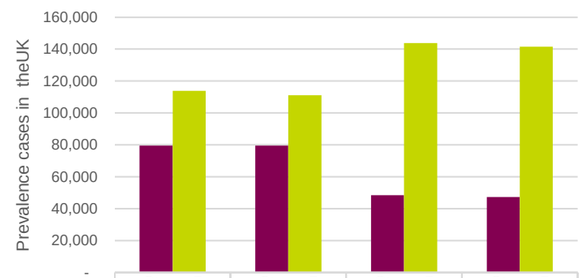
Projected cost of CKD by 2025

Model 1 projected that costs would increase from £15.9 billion in 2021 to £17.3 billion by 2025 (8.8% increase). Model 2 projected a larger increment from £18.7bn to £21.3bn (13.9%) reflecting the increased prevalence in Model 2 described above.

Impact of 20% reduction in prevalence of albuminuria

Reducing albuminuria made little difference to the prevalence of CKD (Figure 1) but slowed the progression of CKD by keeping people in earlier stages. The reduction in CKD stage 5 cases between baseline and scenario were 2.4% (Model 1) and 1.6% (Model 2) for each model respectively. These differences are due to variation in assumptions. Model 1 assumed 20% of patients with macroalbuminuria were shifted to the normal and microalbuminuria groups. Model 2 assumed that 20% of CKD patients with micro and macroalbuminuria were shifted to the normal albuminuria group.

Figure 1. Impact of the scenario on prevalence cases by Model and year



Conclusions

- This study showed two distinct and valid approaches to estimating the future burden of CKD in the UK, which could be applied to other countries.
- Both methods showed that the size and severity of the CKD population is likely to increase over the next 5 years, adding pressure to healthcare services.
- Healthcare policies aimed at early identification and proactive management of patients with CKD, especially high-risk groups should be a priority for policy makers.

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