

Estimating the future burden of chronic kidney disease through microsimulation methods



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Introduction

- Chronic kidney disease (CKD) is a debilitating and costly condition, affecting over 10% of the global population and linked with increased risk of cardiovascular disease (CVD) and all-cause mortality.¹ People in the early stages of CKD are often asymptomatic; as many as 44% may remain undiagnosed until CKD has progressed to a more advanced stage.¹
- Early diagnosis of the at-risk population may be possible through implementing routine screening policies. Early diagnosis and proactive medical management are known to mitigate the rates of progression of CKD to end-stage renal disease and may improve clinical outcomes.²
- The aims of this study were 1) to estimate the epidemiological and cost burden of CKD in the UK from 2020 to 2025 assuming no change to current practice and 2) to estimate the impact of routine screening and subsequent early intervention on future disease burden and healthcare costs.

Methods

A patient-level microsimulation, utilising an open cohort analysis, was developed to estimate the epidemiological and economic burden of CKD in the UK from 2020 to 2025. CKD stages were defined as discrete health states in line with KDIGO 2012² recommendations. Stage 5 CKD included patients undergoing renal replacement therapy (RRT). Patients were categorised according to estimated glomerular filtration rate (eGFR) and albuminuria status using data obtained from the Health Survey for England (HSE)³ extrapolated to the UK population. Input data sources are shown in **Table 1**. Two scenarios were modelled and compared.

- Baseline:** future population prevalence of CKD and associated healthcare costs were estimated. Analysis was also stratified by presence of albuminuria, type 2 diabetes (T2D), heart failure (HF) myocardial infarction (MI) and stroke.
- Early detection:** the impact of early detection (e.g. through screening via NHS health checks) of individuals in the 40-75 (at risk) age group, and subsequent proactive management was assumed to divert patients from fast progression of CKD to slow progression (rate of eGFR decline of 1.1).⁴⁻⁷ A 100% increase in the diagnosis of CKD in that age group was also assumed in year 1.

Table 1. Summary model data inputs

Parameter	Data sources
Population data	ONS 2020 ⁸
CKD prevalence	HSE 2016 ³ (diagnosed and undiagnosed)
Co-morbidities	HSE 2016 ³
Complications (MI, HF, stroke)	British Heart Foundation statistics 2019 ⁹
Costs	Baboolal et al 2008 ¹⁰ NHS costs ¹¹

Assumptions included the following:

- eGFR and albuminuria were independent predictors of CKD and related CVD.
- Individuals were randomly assigned a percentile in the albuminuria distribution (that relative position assumed fixed for the rest of the simulation).
- CKD patients could die from CVD or other causes in the model.

Results - projections based on current practice

Health and economic burden of CKD (2020-2025)

- The population prevalence of CKD in the UK is projected to increase from 13% to 14% of the population by 2025, irrespective of population growth. The size of the CKD population in the UK is projected to grow by over 7% by 2025 from 8.98 million people in 2020 to 9.59 million people in 2025 (**Figure 1**). The profile of CKD is projected to change between 2020 and 2025 (**Figure 1**), with an increase in the more advanced stages of CKD (stages 3b-5) and a slight reduction in the prevalence of earlier stages (1-3a). RRT is projected to increase by 10.9% (12.8% increase in dialysis and 9.5% increase in transplant).
- Annual healthcare costs associated with CKD in the UK (excluding costs associated with co-morbid conditions) are projected to increase by £4B (from £12.71B to £16.68B) by 2025 (**Figure 3**).
- The incidence of cardiovascular complications in patients with CKD, is expected to increase by 2025: 7% increase in HF, 8% increase in MI and 23% increase in stroke.

Figure 1. Annual burden of CKD by stage

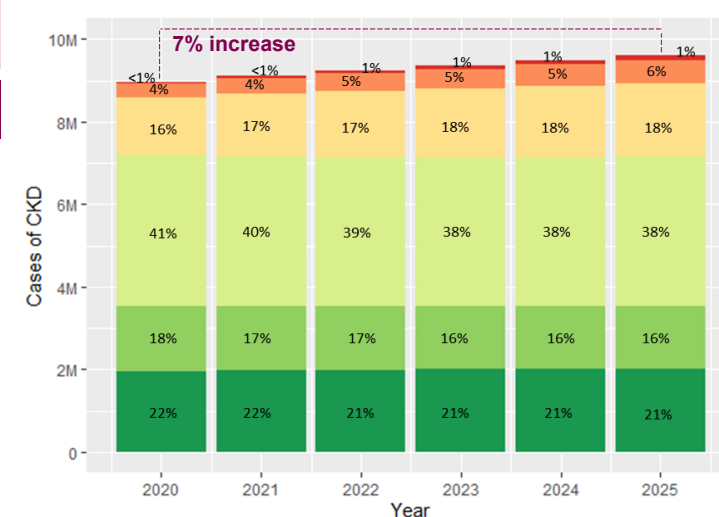
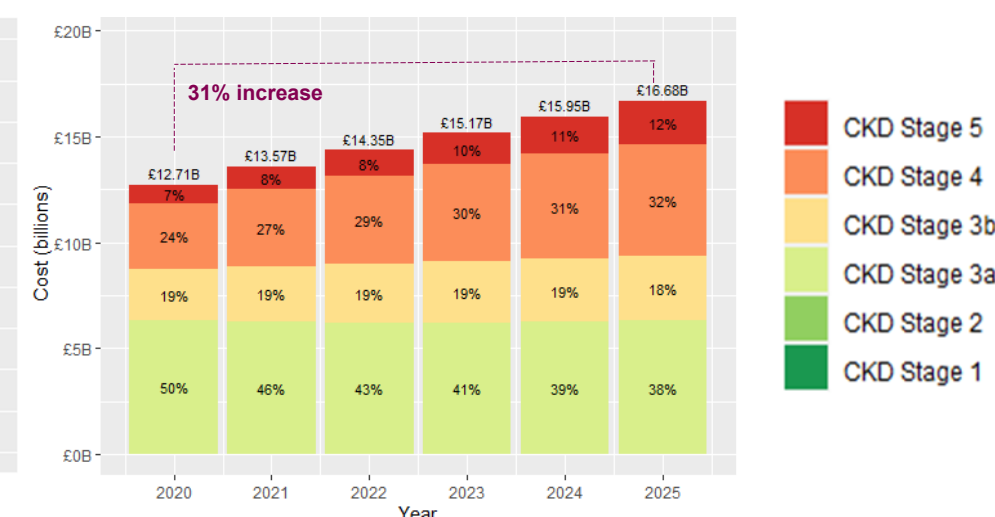


Figure 2. Costs of CKD by stage



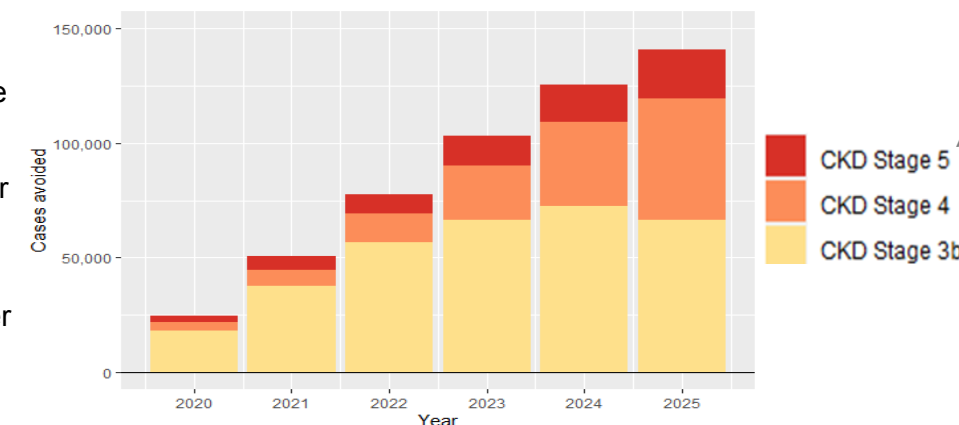
Results - "early detection" scenario

Screening of patients in the 40-75 age group

Promoting early identification of CKD through the screening of individuals aged 40-75, resulting in a 100% of screened patients diagnosed at the early stages of the condition, is projected to:

- Reduce the progression to advanced stages of CKD; stages 3b-5 account for 25% of projected cases under current systems by 2025, but are projected to reduce to 24% under a screening scenario, resulting in over 140,000 fewer individuals in stages 3b-5 (**Figure 3**).
- Save ~£15m in healthcare costs in 2025 due to slower disease progression in the modelled cohort (**Table 2**).

Figure 3. CKD cases avoided as a result of early intervention relative to baseline



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Table 2. CKD Prevalence and costs avoided as a result of early intervention relative to baseline in 2025

Prevalence parameter	Cases avoided by 2025	Costs avoided in 2025 (£m)
CKD stage 3b	66305	6.40
CKD stage 4	53250	3.82
CKD stage 5	21247	4.21

Results highlights

Health and economic burden of CKD is predicted to increase by 2025:

7% increase in the UK CKD population by 2025

£4B increase in CKD NHS spend by 2025

Screening of the 40-75 (at risk) age group is predicted to result in:

6% fewer patients with advanced stage CKD (3b-5) between 2020-2025

£15m Healthcare costs saved as a result of screening in 2025

Conclusions

- This model predicts that CKD prevalence and costs are expected to grow significantly over 5 years, representing a serious public health burden in the UK.
- Prevalence of the condition is increasing, with an increasing proportion of patients progressing to more advanced stages of the disease. This could put services like nephrology clinics or dialysis units, that are already under maximum capacity, under higher pressure.
- The costs of managing this condition are high and are projected to increase steeply, with costs associated with treating these patients projected to increase by 31% from 2020 to 2025.
- Our analysis projected that early detection of CKD through screening and resultant increased diagnosis rates, coupled with proactive treatment, may reduce the rate at which patients progress to more advanced stages of CKD whilst also reducing the long-term economic and clinical burden and increasing the quality of life of the CKD population.

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(*) Costs presented are not discounted.
(^*) Stage 5 CKD includes renal replacement therapy (RRT)