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Inside CKD: Modeling the Direct Economic Burden of Concomitant Chronic Kidney Disease and Type 2 Diabetes: Results from the UK and the US

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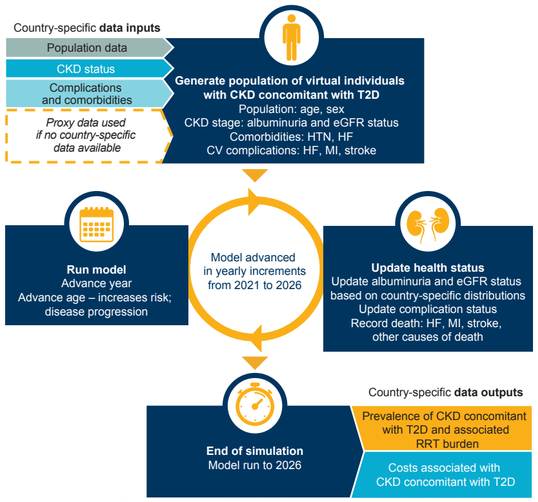
Introduction

- Type 2 diabetes (T2D) is the leading single cause of chronic kidney disease (CKD) and end-stage kidney disease in many developed countries.[1,2]
  - The prevalence of CKD in patients with T2D is estimated to be as high as 40%.[3]
- CKD concomitant with T2D places a significant burden on healthcare systems.[1]
- *Inside CKD* aims to model the future global clinical and economic burden of CKD.
  - Understanding the future trajectories of costs associated with the development and progression of CKD and renal replacement therapy (RRT) are key for informing healthcare provision and policy planning.
- The aim of this *Inside CKD* analysis was to model the direct costs associated with CKD (stages 3–5) concomitant with T2D.
  - Here, we present preliminary data from the UK and the US.

Methods

- We used the *Inside CKD* country-specific, patient-level microsimulation model to project the healthcare costs for patients with CKD concomitant with T2D from 2021 to 2026 (**Figure 1**).
  - The *Inside CKD* microsimulation uses validated software developed by HealthLumen (London, UK).
  - Separate microsimulations were run for the UK and the US.

Figure 1. Overview of the *Inside CKD* microsimulation model.



CKD, chronic kidney disease; CV, cardiovascular; eGFR, estimated glomerular filtration rate; HF, heart failure; HTN, hypertension; MI, myocardial infarction; RRT, renal replacement therapy; T2D, type 2 diabetes.

- Virtual populations were constructed using data from country-specific national surveys and published literature (e.g. National Health and Nutrition Examination Survey for the US;[4] Health Survey for England for the UK[5]). Proxy data were used where country-specific data were not available.
- Input data included:
  - demographics
  - prevalence of CKD (by stage) concomitant with T2D
  - incidence of complications (heart failure, myocardial infarction and stroke)
  - prevalence of other important comorbidities (e.g. uncontrolled hypertension and heart failure)
  - direct costs associated with CKD concomitant with T2D.
- CKD stages were defined as discrete health stages according to Kidney Disease: Improving Global Outcomes (KDIGO) 2012 recommendations.[6] eGFR and albuminuria were assumed to be independent predictors of CKD.
- Data presented here include direct healthcare costs associated with management of CKD and select complications (myocardial infarction, heart failure and stroke) in patients with T2D.
  - The UK model includes outpatient costs and general practitioner visits.
  - The US model includes both commercial and Medicare outpatient and prescription costs.
  - Costs associated with CKD stages 1 and 2 were assumed to be zero.
- All currencies are quoted in US dollars.

Results

Total Annual Healthcare Costs

- The overall prevalence of CKD stages 3–5 concomitant with T2D is projected to increase by 138 597 patients in the UK and by 1 234 371 patients in the US, from 2021 to 2026 **(Table 1)**.

Table 1. Projected overall prevalence of CKD stages 3–5 concomitant with T2D in the UK and the US from 2021 to 2026.

Country	Prevalence of CKD stages 3–5 concomitant with T2D					
	2021	2022	2023	2024	2025	2026
UK	1 038 234	1 073 064	1 104 938	1 135 610	1 160 806	1 176 831
US	4 581 875	4 892 030	5 193 056	5 466 838	5 687 341	5 816 246

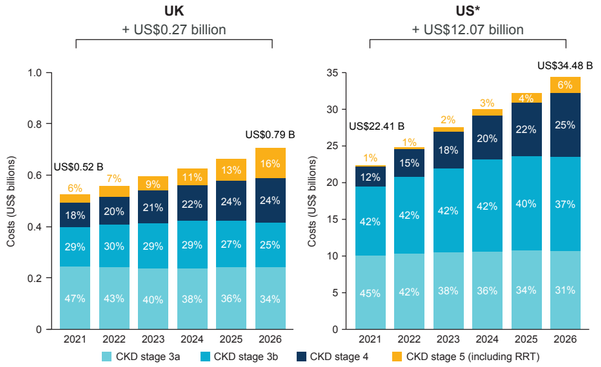
CKD, chronic kidney disease; T2D, type 2 diabetes.

- Annual healthcare costs for patients with CKD stages 3–5 concomitant with T2D (excluding RRT and hospitalizations) are projected to increase by US$0.27 billion in the UK and $12.07 billion in the US (commercial and Medicare costs) from 2021 to 2026 (**Figure 2**).
- Costs associated with CKD concomitant with T2D are projected to increase as a proportion of total annual healthcare expenditure in both the UK (0.27% to 0.37% of a total annual budget of US$206 billion[7]) and the US (0.59% to 0.90% of a total annual budget of US$3820 billion[8]) between 2021 and 2026 (**Figure 3**).
- From 2021 to 2026, the costs associated with CKD stages 4 and 5 (excluding RRT) as a proportion of total costs are projected to increase the most in both countries (**Figure 2**).
- Over the same period, the relative proportion of costs attributable to CKD stages 3a and 3b are typically projected to decrease, owing to the relatively larger increase in the projected costs of CKD stages 4 and 5 (**Figure 2**).

Annual Healthcare Costs Associated with Renal Replacement Therapy

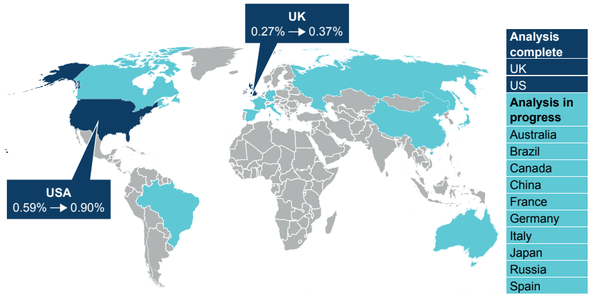
- Costs associated with RRT are projected to increase by US$0.05 billion in the UK and US$1.22 billion in the US from 2021 to 2026 (**Figure 4**).

Figure 2. Projected total annual increase in healthcare costs from 2021 to 2026 for CKD stages 3–5 (excluding RRT) concomitant with T2D.



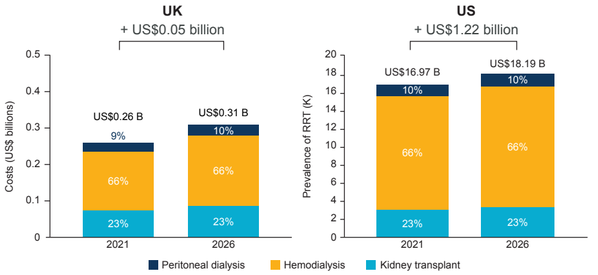
Percentages represent the projected contribution of each CKD stage to total annual CKD (stages 3–5) costs. Owing to rounding, the sum of percentages may not equal 100%. *US model includes both commercial and Medicare costs.
CKD, chronic kidney disease; RRT, renal replacement therapy; T2D, type 2 diabetes.

Figure 3. Projected change in national healthcare expenditure from 2021 to 2026 for patients with CKD concomitant with T2D in the UK and US.



Percentages represent the projected costs associated with CKD stages 3–5 concomitant with T2D in 2021 and 2026 as a percentage of each country's total annual healthcare budget.

Figure 4. Projected annual healthcare costs associated with RRT in 2021 and 2026 for patients with CKD concomitant with T2D.



Percentages represent the projected contribution of each type of RRT to total RRT costs. Owing to rounding, the sum of percentages may not equal 100%.
CKD, chronic kidney disease; RRT, renal replacement therapy.

Limitations

- Model inputs, outputs and assumptions are subject to additional review and update as part of a global model standardization; model outputs presented here should therefore be considered preliminary in nature.
- Projections presented here assume no major changes in the management of CKD (e.g. reimbursement, technology or intervention policy) over the projection period.

Conclusions

- Healthcare costs for patients with both CKD and T2D are projected to increase across these two countries from 2021 to 2026, both in absolute terms and as a proportion of national healthcare budgets.
  - Costs associated with CKD complications are projected to be substantially higher in the US than in the UK, owing to differences in populations as well as higher management costs in the US.
- Later CKD stages (stages 4 and 5) are associated with more pronounced cost increases.
  - This is likely because of increased prevalence and greater treatment complexity for later stage CKD.
- Costs associated with RRT are also expected to increase.
- Early diagnosis and interventions to slow CKD progression and avoid complications are needed to reduce the economic burden of CKD concomitant with T2D.

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Disclosures

JJGS, CC and SN are employees of AstraZeneca and hold stock options. AAS is a former employee of AstraZeneca. JÄ, MCB, SC, GMC, LDN, JMH, EK, GL, FSM, JFNG, AP, NT and JW are members of the *Inside CKD* Scientific Committee and have received financial support from AstraZeneca to attend committee meetings. JCG, LR, LW and MX are employees of HealthLumen, which has received funding from AstraZeneca.

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