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Inside CKD: projecting the economic burden of chronic kidney disease using patient-level microsimulation modelling

Francesco S Mennini,[1] Claudia Cabrera,[2] Joshua Card-Gowers,[3] Glenn M Chertow,[4] Luca De Nicola,[5] Jean-Michel Halimi,[6] Stephen Nolan,[7] Albert Power,[8] Lise Retat,[3] Laura Webber,[3] Jay B Wish,[9] Michael Xu,[3] Juan Jose Garcia Sanchez[10]

[1]Economic Evaluation and HTA, Department of Economics and Finance, Faculty of Economics, University of Rome "Tor Vergata", Rome, Italy; [2]Real World Science and Digital, BioPharmaceuticals Medical, AstraZeneca, Gothenburg, Sweden; [3]HealthLumen Limited, London, UK; [4]Stanford University School of Medicine, Palo Alto, CA, US; [5]Division of Nephrology, Department of Advanced Medical and Surgical Sciences, University of Campania "Luigi Vanvitelli", Naples, Italy; [6]University Hospital of Tours, Tours, France; [7]Global Medical Affairs, BioPharmaceuticals Medical, AstraZeneca, Cambridge, UK; [8]North Bristol NHS Trust, Bristol, UK; [9]Indiana University School of Medicine, Indianapolis, IN, US; [10]Health Economics, BioPharmaceuticals Medical, AstraZeneca, Cambridge, UK.

Correspondence: juanjose.garciasanchez@astrazeneca.com

Introduction

- Chronic kidney disease (CKD) is a debilitating and progressive condition that affects ~10% of the global population.[1]
- CKD is associated with an increased risk of cardiovascular (CV) events, end-stage kidney disease, the need for renal replacement therapies (RRTs) and premature mortality.[2]
- Management of CKD and its complications is associated with significant healthcare costs and substantial resource use.[3,4]
- Therefore, detailed projections of CKD prevalence and associated costs are critical considerations for public health and policy planning.

Objective

- *Inside CKD* aims to project the global clinical and economic burden of CKD from 2021 to 2026 using country-specific, patient-level microsimulation-based modelling.

Method

- We used the *Inside CKD* microsimulation model to project the burden of disease and healthcare costs for patients with CKD from 2021 to 2026 for the following 11 countries: Australia, Belgium, Brazil, Canada, China, Germany, Italy, Japan, Spain, the UK and the US (**Figure 1**).
- The *Inside CKD* microsimulation uses validated software developed by HealthLumen (London, UK).[5–8]

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

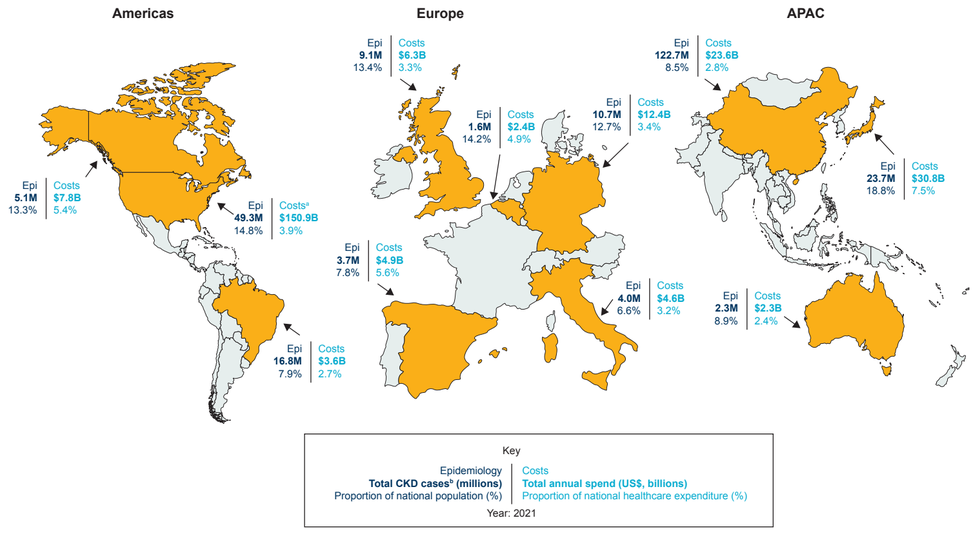
CKD, chronic kidney disease; CV, cardiovascular; eGFR, estimated glomerular filtration rate; HF, heart failure; HTN, hypertension; MI, myocardial infarction; RRT, renal replacement therapy; T2D, type 2 diabetes.

- A dynamic open-cohort, virtual general population was developed for each country using national surveys, published literature and country-specific estimates.
- Country-specific inputs were used, including demographics, the prevalence of CKD, RRTs, comorbidities and CV complications, CKD- and RRT-associated costs, and the threshold values for RRT initiation.
- For any given input, if no country-specific data were available, a predefined algorithm was used to select proxy data methodically.
- Validity assessments and sensitivity analyses were conducted to assess the impact of input parameters and to validate projections. Part of these analyses included the validation of inputs and outputs by country-specific members of the *Inside CKD* scientific steering committee.
- CKD stages were defined according to Kidney Disease Improving Global Outcomes (KDIGO) 2012 recommendations, and patients were categorized according to estimated glomerular filtration rate (eGFR) and albuminuria status.[3]
- When possible, RRT modelling was calibrated against historical trends from country-specific renal registries.
- The following cost assumptions were included in the model.
  - Costs associated with CKD stages 1 and 2 were assumed to be zero.
  - Costs are presented as US dollars and were calculated for patients with diagnosed CKD.

Results

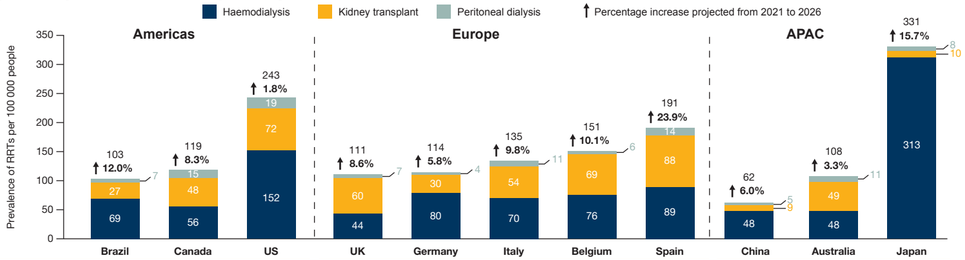
- In 2021, the prevalence of CKD in each national population was 6.6–18.8% across the 11 countries included (**Figure 2**). Costs associated with CKD represent a substantial burden, with each country spending billions of US dollars annually; these costs represent 2.4–7.5% of national annual healthcare expenditures.
- From 2021 to 2026, the prevalence of CKD is projected to increase across the 11 countries included (**Figure 3**).
- The projected increase in CKD prevalence correlates with a projected increase in prevalence of RRTs of 1.8–23.9% across the 11 countries included (**Figure 3**).
- Annual costs associated with CKD and RRTs are projected to increase by 5.7–22.8% from 2021 to 2026 for the 11 countries (**Figure 4**).
- Although patients receiving RRTs in 2026 are projected to account for 2.3–7.7% of the diagnosed CKD population in the 11 countries, RRT costs are expected to represent 19–57% of the total cost burden (**Figure 4**).

Figure 2. Epidemiological and economic burden of CKD, including RRTs, in 2021.



[a]US costs include Medicare costs only. [b]CKD cases include diagnosed, undiagnosed and RRT populations.
APAC, Asia-Pacific region; CKD, chronic kidney disease; Epi, epidemiology; RRT, renal replacement therapy.

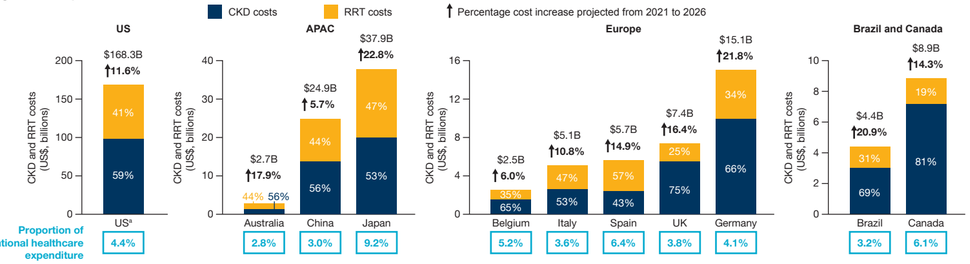
Figure 3. Projected burden of RRT by modality in 2026.



Modality	Projected number of cases										
	Brazil	Canada	US	UK	Germany	Italy	Belgium	Spain	China	Australia	Japan
CKD pre-RRT[a]	18 664 358	5 501 897	52 309 805	9 455 885	11 005 610	4 428 313	1 673 656	3 968 277	125 780 722	2 600 805	25 756 364
Haemodialysis	152 085	22 155	521 825	30 881	66 849	42 089	8876	41 202	700 061	12 950	385 692
Kidney transplant	59 413	19 066	247 892	41 548	25 358	32 157	8053	40 731	126 184	13 226	11 957
Peritoneal dialysis	16 028	5913	64 812	4719	3447	6317	698	6626	72 145	3065	9506
Total CKD cases[b]	**18 891 883**	**5 549 030**	**53 144 334**	**9 533 032**	**11 101 263**	**4 508 876**	**1 691 283**	**4 056 836**	**126 679 113**	**2 630 046**	**26 163 519**
Prevalence[c]	8.5%	13.9%	15.3%	13.6%	13.2%	7.4%	14.3%	8.6%	8.6%	9.6%	20.9%

Data labels represent the projected number of RRT cases by modality per 100 000 people.
[a]Projected diagnosed and undiagnosed CKD cases, pre-RRT. [b]Total CKD cases include diagnosed, undiagnosed and RRT populations. [c]Prevalence is expressed as a proportion of national population.
APAC, Asia-Pacific region; CKD, chronic kidney disease; RRT, renal replacement therapy.

Figure 4. Projected annual costs of CKD and RRTs in 2026.



Data labels show the proportionate spend on CKD and RRTs, expressed as a percentage of total CKD and RRT costs. Country cost definitions varied and may not be directly comparable. Each graph has a distinct y-axis range.
[a]US costs include Medicare costs only.
APAC, Asia-Pacific region; CKD, chronic kidney disease; RRT, renal replacement therapy.

Conclusions

- *Inside CKD* demonstrates that the clinical and economic burden of CKD is projected to increase by 2026 for all 11 countries included in the analysis.
- In all 11 countries, the number of patients receiving RRTs is substantially lower than the pre-RRT populations but contributes disproportionally to the economic burden of CKD.
- These results demonstrate the continued need for national policies aimed at early diagnosis and intervention to slow disease progression and to reduce the costs associated with CKD.

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