Inside CKD: quantifying the Future Impact of Chronic Kidney Disease Screening Programs in Belgium

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Introduction/Background:

- Chronic kidney disease (CKD) has remained under-diagnosed, particularly in earlier stages, associated with lower awareness about the disease globally[1,2].
- Timely diagnosis by screening and risk-stratification, followed by guideline-based intervention is recommended to avoid inequitable, poor outcomes in CKD patient population[3].
- In Belgium, the diagnoses are being made mainly in the later stages, with more than half of the prevalence remaining unmeasured[4].
- In addition, the treatment-rate by renin-angiotensin-aldosterone system inhibitors (RAASi) for CKD patients was lowest - 44% - in Belgium compared to some other developed healthcare systems (such as the Netherlands - 59%, Canada - 48%, Sweden - 61%, Switzerland - 68%, Israel - 70%, and Portugal - 70%)[4].
- Belgium does not have any proactive screening program for high-risk patients, even if the population is aging.
- It is, therefore, essential to understand the impact of implementing screening-related policies in the context of national-level healthcare resources and burden.

Objective:

- This study (*Inside CKD* henceforth) aims to estimate the long-term benefit of investing in the urinary albumin-to-creatinine ratio (UACR) testing in a long-term by assessing cost-effectiveness of different screening strategies[5].

Method:

- Cost-effectiveness were projected in 10 years' timeline by a microsimulation model that constructs virtual and dynamic population cohorts that are based on current Belgian demographic characteristics.
- Each virtual individual is assigned age, sex, and baseline eGFR and UACR values.
- Based on current Belgian demographics, prevalence rates, and diagnosis rates, an individual falls into either of the 3 exclusive groups: No CKD, CKD undiagnosed (stages I to V inclusive), and CKD diagnosed (stages I to V inclusive).
- In addition, a chance of overlapping comorbidities is also assigned to a virtual individual, based on national prevalence of comorbidities (fig.1).
- Every year, an individual advances in demographics and eGFR rates and may be subject to develop CKD, receiving RAASi treatment, developing cardiovascular complications (such as heart failure, myocardial infarction, and stroke), kidney damage, and death (fig. 2).

Figure 1 *Population eligible to be included in the virtual microsimulation, including overlap of comorbidities*

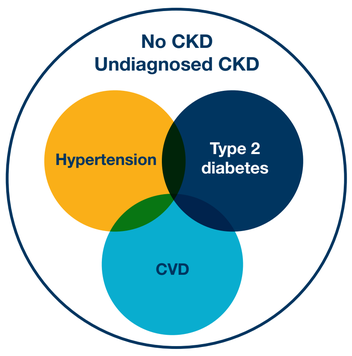
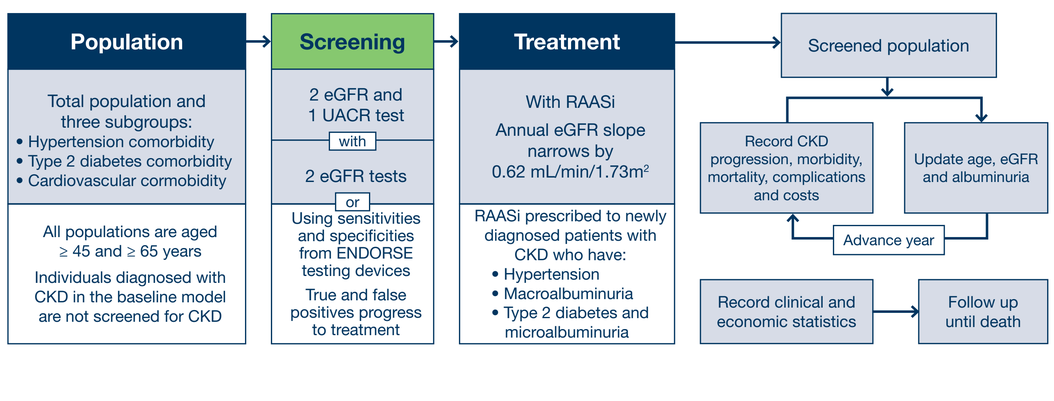


Figure 2 *Schematic of the microsimulation for the included virtual population*



- In the undiagnosed or no-CKD populations, two hypothetical screening strategies were assessed:
  - i) 2 estimated glomerular filtration rate (eGFR) tests; and
  - ii) 2 estimated glomerular filtration rate (eGFR) tests + 1 UACR test.
- The two strategies were compared with the current scenario, i.e., the standard practice where no additional screening was employed (meaning the current rates of diagnosis were carried on and undiagnosed individual would've remained undiagnosed).
- Clinical pathway of an undiagnosed individual, subject to 2 eGFR + 1 UACR test, is depicted in the flow-diagram (fig. 3).
- The inputs for costs and quality-of-life (QoL) data are described in table 1.

Figure 3 *Flow diagram of screening strategy with 2 eGFR tests + 1 UACR test*

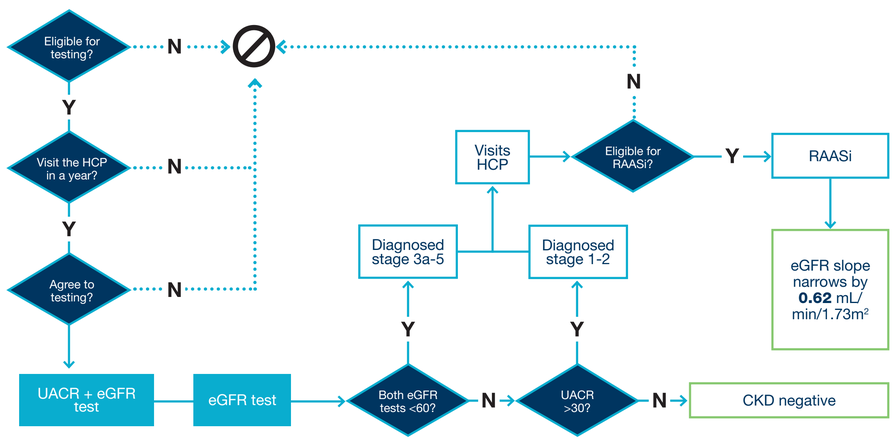


Table 1 *Input parameters and data sources*

Health economics	
Costs by CKD stages	IQVIA hospital disease database in Belgium
Costs of dialyses, transplants, HF events	IQVIA hospital disease database in Belgium
GDP; total healthcare expenditure	The World Bank[7]; KCE, 2019[8]
Utilities by CKD stages	Cooper et al., 2020[9]
Utilities of diabetes; hypertension	Sullivan et al., 2011[10]; Laires et al., 2015[11]
Utilities of HF; stroke	Calvert et al., 2005[12]; Rivero-Arias et al., 2010[13]
Screening	
Sensitivity & Specificity of Allegro UACR	Personal communication with ENDORSE authors
Sensitivity & Specificity of NovaMax eGFR	Begos et al., 2022[14]
Compound sensitivity & specificity	Weinstein et al., 2005[15]
Costs for screening	RIZIV/INAMI[16]

- In addition, sensitivity and specificity of the tests were considered to account for true/false positive and true/false negatives.
- Discount rates of 3.0% and 1.5% were applied to the costs and QoL, respectively according to the Belgian guidelines[6].
- The model projects cost-effectiveness of these 2 strategies from 2022 to 2032, across the full CKD population (age ≥ 45 years) and several sub-groups at high-risk: type-2 diabetes, hypertension, cardiovascular diseases, and age ≥ 65 years.

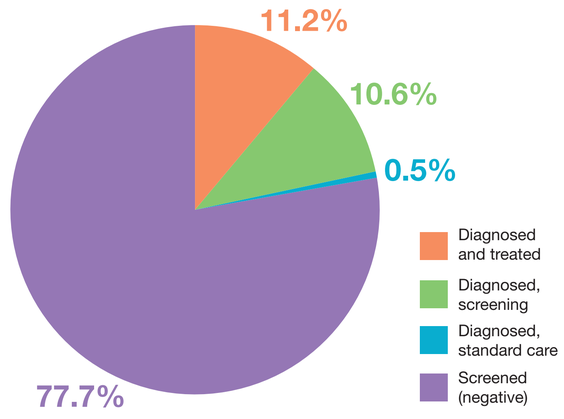
Results:

- Baseline characteristics of the included population (no CKD + undiagnosed CKD) in the microsimulation is described in table 2.
- By implementing both screening programs, i.e., strategy of 2 eGFR tests + 1 UACR test, the diagnosis rate increased by 21.8% from 2022 to 2032.
- This additional percentage of people comprises 11.2% who are diagnosed and treated with RAASis and 10.6% who are diagnosed but are not eligible for RAASi treatment (fig. 4)

Table 2 *Baseline characteristics of total population screened within virtual microsimulation*

Total aged ≥45, n per 100,000 (%)	
Population by sex	
Female	50,994 (51.0%)
Male	49,006 (49.0%)
Population by age group	
45-64	62,935 (62.9%)
65+	37,065 (37.1%)
Population by CKD stage	
CKD stage 1	2,243 (2.2%)
CKD stage 2	3,736 (3.7%)
CKD stage 3a	7,881 (7.9%)
CKD stage 3b	2,920 (2.9%)
CKD stage 4	474 (0.5%)
No CKD	82,745 (82.7)
Comorbidities	
Type 2 diabetes	6,787 (6.8%)
Hypertension	19,055 (19.1%)
Heart failure	3,316 (3.3%)

Figure 4 *Population screening outcomes after implementation of 2 eGFR tests + 1 UACR test*



- Compared to the current scenario for the full CKD population, the 2eGFR only strategy showed incremental cost-effectiveness ratio (ICER) of 5,925.88 € per QALY.
- This ICER further decreased to 5,143.73 € per QALY when UACR testing was added to 2eGFR tests (i.e., second testing strategy).
- When this strategy of 2 eGFR tests + 1 UACR test compared to the current scenario was assessed in different high-risk sub-groups, the ICERs lower down substantially up to ~ 3,000 € per QALY
- Detailed description of accumulated costs and QALYs for the 2 eGFR tests + 1 UACR test compared to the current scenario in total population as well as high-risk sub-groups is described in table 3.

Table 3 *Cost-effectiveness of screening strategy with 2 eGFR tests + 1 UACR test in total as well as high risk population, for timehorizon between 2022 and 2032*

Cohort	Cumulative years of life gained per patient	Cumulative QALYs gained per patient	Cumulative costs gained per patient	ICER	ICER (life-year)	NMB*
Total aged ≥45 years	**0.037**	**0.025**	**€142.67**	**€5,143.73**	**€3,508.92**	**€755.65**
Type 2 diabetes	**0.133**	**0.086**	**€380.09**	**€3,846.15**	**€2,502.78**	**€2,770.50**
Hypertension	**0.180**	**0.123**	**€512.87**	**€3,640.40**	**€2,502.37**	**€3,988.12**
CVD	**0.096**	**0.063**	**€269.78**	**€3,869.56**	**€2,535.44**	**€2,024.00**

*NMB is calculated as (incremental benefit x willingness-to-pay threshold) – incremental cost.

- In addition, fig. 5 and 6 respectively demonstrate how the annual prevalence of CKD by stage and that of renal replacement therapies will evolve by implementation screening with 2 eGFR tests + 1 UACR test.

Figure 5 *The impact of screening with 2 eGFR tests + 1 UACR test on the prevalence of CKD by stage*

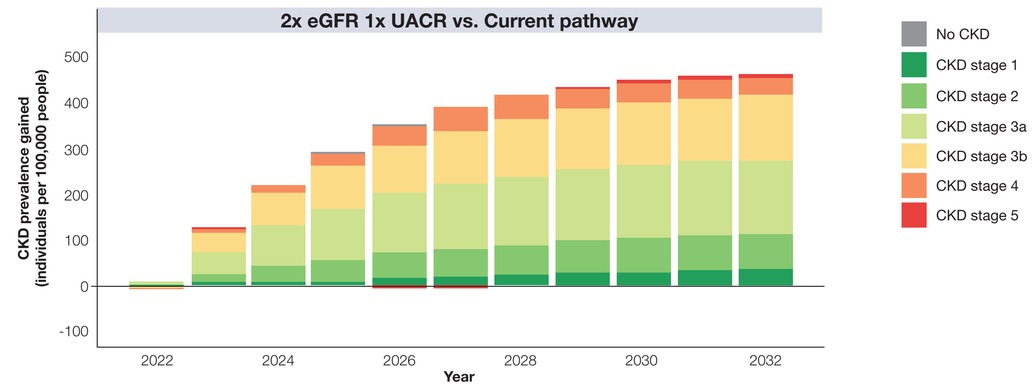
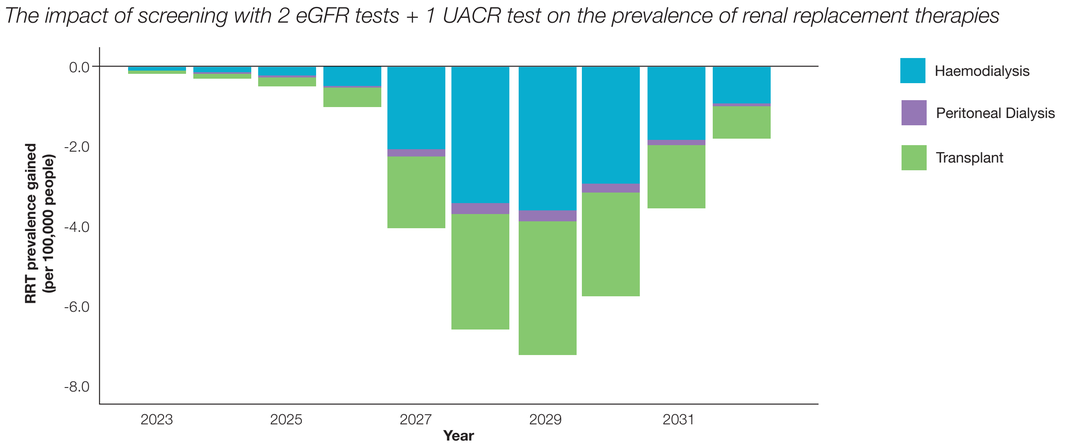


Figure 6 *The impact of screening with 2 eGFR tests + 1 UACR test on the prevalence of renal replacement therapies*



Conclusions:

- Both the screening strategies via Inside CKD projections are cost-effective in 10-year timeline for the Belgian healthcare system, considering a willingness-to-pay equal to Belgian GDP per capita (i.e., ~ 43,300 €).
- Addition of UACR testing in primary care will diagnosis significantly higher number of CKD cases than the current scenario with the standard care practices.
- However, the higher number of diagnosed cases at earlier stages will be compensated by avoiding progression to severe stages by timely and optimal treatment and improving patient outcomes.
- The incremental cost per patient by implementing the screening strategy of 2 eGFR tests + 1 UACR test is accompanied by incremental gain in QALYs, reducing disease burden in 10 years' time-horizon.
- It even becomes more cost-effective when considered for high-risk subgroups such as type-2 diabetes patients, hypertension patients, patients of cardiovascular diseases, and patients aged above 65 years.

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