Evaluation of Payer Budget Impact Associated with the Use of Artificial Intelligence *in vitro* Diagnostic, KidneyIntelX™, to Modify DKD Progression

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BACKGROUND

Chronic Kidney Disease (CKD) is a critical public health challenge and it is estimated that 15% (~37 million) of US adults have CKD.[1] Over 30% of CKD patients (~12 million) have type 2 diabetes (T2DM) and existing kidney disease (diabetic kidney disease or DKD). DKD accounts for ~50% of patients who will experience rapid kidney function decline (RKFD) and are at the highest risk for progressing to end-stage renal disease (ESRD) requiring dialysis and kidney transplants.[2]

Unmet Need:

Currently DKD is routinely risk-stratified through measurement of eGFR and urine albumin levels. This method fails to identify ~50% of patients who will have RKFD and kidney failure in the future. It is estimated that up to 63% of existing DKD patients initiate dialysis acutely due to a "crash".[3] Many high risk patients are not referred from their Primary Care Physician (PCP) or Endocrinologist to a Nephrologist and do not undergo the necessary treatment changes that are proven to delay CKD progression to ESRD. It is estimated that CKD and ESRD costs the United States Medicare system alone a total of $114 billion annually.[4]

The KidneyIntelX™ Solution

KidneyIntelX is an artificial intelligence-enabled clinical diagnostic that uses an advanced machine learning algorithm to generate a patient-specific score for assessing the five-year risk of RKFD or kidney failure in DKD patients. This test analyzes biomarkers and electronic health record (EHR) features to categorize patients as low, intermediate or high risk of developing DKD. The test is currently indicated in patients with T2DM and DKD stages 1-3b (excluding G1&A1 and G2&A1). This test has been granted Breakthrough Device designation by the US Food and Drug Administration (FDA).

Recommendations for management for the risk categories stratified by the KidneyIntelX score align with published Kidney Disease Improving Global Outcomes (KDIGO) guideline recommendations:

- *High risk patients:* >60% risk of RFKD or kidney failure in 5 years; should be considered for more intensive therapy and/or referral to a nephrologist and aggressive medical management
- *Intermediate risk patients:* Risk of progression is at population level (≈20%); can be considered for PCP or endocrinologist monitoring 2 to 3 times per year
- *Low risk patients:* < 10% progress over 5 years; can be considered for monitoring by their PCP or endocrinologist on at least an annual basis

AIM

The goal of this study is to develop a 5-year budget-impact model to assess potential cost savings associated with KidneyIntelX in supporting optimized treatment pathways compared to standard of care (SOC) (no KidneyIntelX) in patients with T2DM and early DKD.

METHODS

A hypothetical cohort of 100,000 patients with T2DM and DKD stages 1-3b (excluding stages G1&A1 and G2&A1) was followed for up to 5 years. The model is based on cost savings associated with use of KidneyIntelX to identify patients at risk for RKFD and earlier implementation of effective interventions to achieve the following outcomes:

- Slowed progression through DKD stages
- Delayed or prevented dialysis and transplants
- Reduction in dialysis crashes

The model compares differences in the following treatment costs between KidneyIntelX and SOC patients:

- Costs of preventative measures (treatments and office visits) in KidneyIntelX high-risk patients (*Table 1*)
- Costs of each stage of DKD (*Table 1*)
- Costs of dialysis, transplants (including post-transplant care), and crashes (*Table 2*)
- Costs of KidneyIntelX test ($1,050; $950 test cost + $100 administration cost)

Table 1. Annual Costs per Patient at Each DKD Stage[5,6,7,8]

DKD Stage	Cost of DKD stage (USD)	Cost of preventative measures by DKD stage (KidneyIntelX high-risk cohort only) (USD)
DKD Stage 1 (Excluding G1&A1)	$16,612	$1,562
DKD Stage 2 (Excluding G2&A1)	$18,807	$2,024
DKD Stage 3a	$21,861	$2,003
DKD Stage 3b	$31,978	$2,662
*DKD Stage 4**	*$42,239*	*N/A*
*DKD Stage 5**	*$72,768*	*N/A*
ESRD (treatment cost, not including dialysis)	*$118,181*	*N/A*

*Note: KidneyIntelX is not intended for administration in DKD stages 4 and 5, but their costs have to be considered because people progress through these stages and incur these costs.

Published literature was used to estimate annual costs associated with each stage of DKD, annual incremental costs to SOC associated with the actionable results of the KidneyIntelX Test, cost of preventative measures for KidneyIntelX group, and cost of dialysis, transplants, and crashes. All costs were inflation-adjusted to 2019 dollars.

Table 2: Costs for Dialysis, Transplants, Crashes per Patient

Event	Cost
Cost of dialysis[9]	$88,000 per year
Additional cost of an initial unplanned dialysis (crash)[10]	$49,199 one time
Cost of a transplant[11]	$262,000 one time
Annual cost of post-transplant care*[12]	$40,000 per year

*Note: The cost reported in this article is specific to the Medicare population. It was extrapolated to the all-payer population ($40,000 per year) before using in the model.

Assumptions:

- Of the 100,000 patients tested with KidneyIntelX, 16% patients were assumed to have a high-risk test result.[13]
- Savings that are predicted to occur in the future are usually valued less than present savings. Since this was a 5-year model, a discount rate of 3% was applied to future savings to obtain present savings.
- Proportion of patients insured by Medicare vs. Commercial insurance was assumed to be 60% vs. 40%.
- Progression rate assumptions:
  - Patients identified using KidneyIntelX were assumed to have a 20% slowed progression rate through DKD stages compared to SOC. A sensitivity analysis was conducted by changing this slowed progression rate over a range from 5% to 35%.
  - 100% adherence to preventative measures was assumed in these patients.
  - Progression rate data was obtained from KidneyIntelX validation studies. A sensitivity analysis was conducted using three different definitions of 'progression' to the next DKD stage.
    - Least Stringent: ≥1 eGFR value(s) in the next stage.
    - Stringent: ≥2 eGFR values 3 months apart in next stage
    - Most Stringent: ≥2 eGFR values 3 months apart in the next stage, only in the 21% of patients that ultimately experienced RFKD or kidney failure (79% stable)

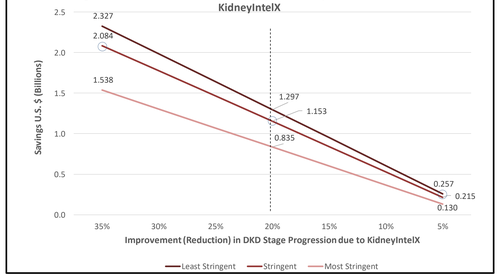
  Thus, in the least stringent definition of progression, more patients were assumed to progress through DKD stages, resulting in more cost savings compared to the most stringent definition.

RESULTS

Of the 100,000 patient cohort in the model tested with KidneyIntelX, 18,000 patients were assumed to be flagged as "high-risk" and received additional medical management and preventive measures.

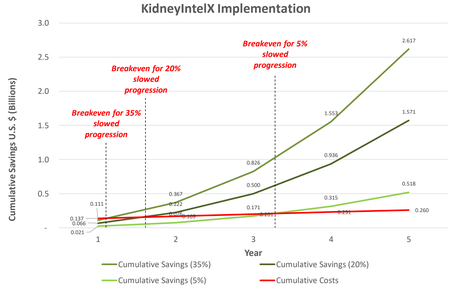
When slowed progression rate owing to KidneyIntelX was assumed to be 20% compared to SOC, the NPV of savings due to slowed progression, delayed/avoided dialysis & transplants, and fewer crashes was estimated to range between $835 million and $1.297 billion over a 5-year time horizon for the most-stringent and least –stringent definitions of progression respectively (Figure 1). The estimated savings realized for the 'Stringent' definition of progression or "base case" were $1.153 billion (Figure 1).

Figure 1: Net Present Value of Savings (discounted) over 5 Years due to KidneyIntelX



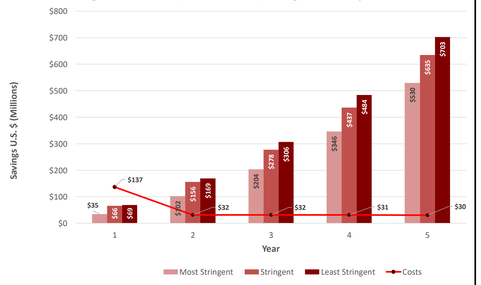
When the slowed progression rate owing to improved medical management associated with KidneyIntelX was changed from 20% to 5% and 35%, the highest cost savings were seen in the 'Least Stringent'/ '35% progression decline' scenario (~$2.327B savings), while the lowest cost savings were seen in the 'Most Stringent'/ '5% progression decline' scenario (~$130M savings) (Figure 1).

Figure 2: Cumulative (undiscounted) Savings vs Cost of KidneyIntelX Implementation



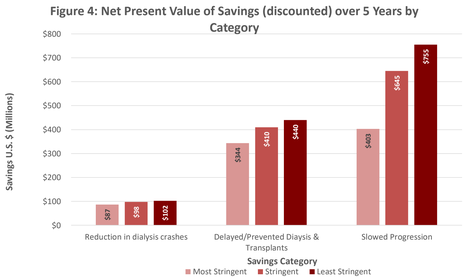
The breakeven point for KidneyIntelX is between 1 and 2 years following implementation ('Stringent'/20% slowed progression scenario). After this, the cumulative savings are expected to start increasing compared to costs of implementation (Figure 2).

Figure 3: Annual (undiscounted) Savings for KidneyIntelX



Total annual savings associated with KidneyIntelX compared to SOC are presented in Figure 3 (assumed slowed progression rate of 20%). Annual savings are expected to increase from year 1 through 5, with savings reaching $635 million in year 5 alone (stringent/20% slowed progression scenario).

Figure 4: Net Present Value of Savings (discounted) over 5 Years by Category



The majority of savings over five years for KidneyIntelX are expected to be realized due to slowed progression through DKD stages, followed by delayed/prevented dialysis and transplants and reduction in dialysis crashes (Figure 4). Savings from slowed progression are expected to be ~$645 million (stringent/20% slowed progression scenario).

CONCLUSIONS

Through early and accurate risk stratification of patients with DKD likely to experience RKFD or kidney failure, use of the KidneyIntelX test has the ability to achieve significant cost savings for payers. The KidneyIntelX test will support the primacy care physician and/or endocrinologist in determining appropriate monitoring and intervention for their patients, and referral to a specialist/nephrologist for patients determined to be high risk for RKFD.

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