# Economic Burden Associated with Chronic Kidney Disease Progression Based on Kidney Disease: Improving Global Outcomes (KDIGO) Risk Categories in Type 2 Diabetes

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## BACKGROUND & OBJECTIVE

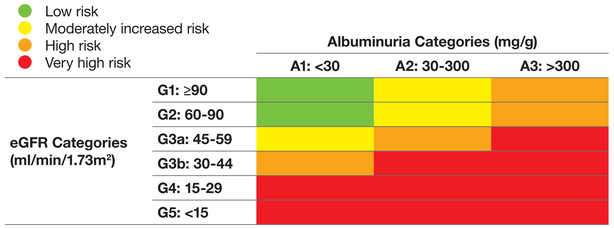
- Chronic kidney disease (CKD) is highly prevalent among patients with type 2 diabetes (T2D) and poses a substantial economic burden.[1,2] As the severity of CKD increases, so does the associated healthcare resource utilization (HRU) and medical costs[3]
- However, the traditional method of using estimated glomerular filtration rate (eGFR) to define the severity of CKD does not incorporate another important domain of kidney health (i.e., glomerular damage), which is usually represented by urine albumin-to-creatinine ratio (UACR)[4]
- This study aimed to assess the economic burden associated with CKD progression based on the KDIGO risk categories, which evaluate both eGFR and UACR, in patients with CKD associated with T2D

## METHODS

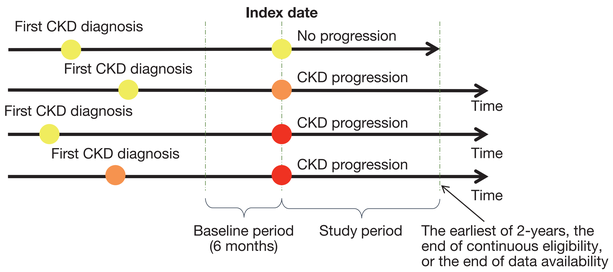
- Data from the Optum electronic healthcare records (EHR) database (January 2007 to December 2019) were used
- Patients with CKD associated with T2D who had eGFR and UACR values indicating moderate or high risk based on the KDIGO heat map were included (**Figure 1a**)
- Study cohorts with CKD progression included patients with moderately increased risk at diagnosis who progressed to a high- or very high-risk category and those with high risk at diagnosis who progressed to a very high-risk category (**Figure 1b**). The index date was defined as the date of the earliest record indicating CKD progression
- Study cohorts without CKD progression included patients with moderately increased risk or high risk at diagnosis who did not progress to a higher risk category (**Figure 1b**). The index date was defined as the date two years before the end of follow-up or the date of patients' first identified risk category if the follow-up period is less than two years

**Figure 1. Definitions of CKD Progression and KDIGO risk categories**

**a) KDIGO heat map**




**b) CKD progression pattern**




- Statistical analysis
  - Frequency of all-cause HRU, including inpatient (IP) visits, emergency room (ER) visits, and outpatient (OP) visits, were annualized (in PPPY)
  - All-cause medical costs (2020 USD) were estimated by multiplying the frequencies of each HRU component with the corresponding unit costs generated from the Optum Clinformatics® claims data
  - Total medical costs were defined as the sum of IP costs, OP costs and ER costs
  - CKD-related medical costs were defined as costs associated with diagnosis for CKD or related diseases and complications

## RESULTS

- Out of 470,430 patients with CKD of moderate or high risk and T2D in the Optum EHR database, a total of 269,085 patients met all inclusion and exclusion criteria and were included in the study; 209,756 had no progression, 41,986 progressed from moderate to high risk, 3,102 from moderate to very high risk, and 14,241 from high to very high risk (**Table 1**)
- Patients who progressed to a higher risk group were older and had lower eGFR, higher UACR, and more comorbidities at baseline than patients who did not progress (**Table 1**)

**Table 1. Baseline characteristics of patients with CKD associated with T2D**

| | No Progression N = 209,756 | Progression Pattern: Moderate to High N = 41,986 | Progression Pattern: Moderate to Very High N = 3,102 | Progression Pattern: High to Very High N = 14,241 |
|---|---|---|---|---|
| **Demographics** | | | | |
| Age (year), mean ± SD | 65.7 ± 12.5 | 70.9 ± 10.5 * | 72.0 ± 9.7 * | 73.9 ± 9.6 * |
| Male, n (%) | 101,918 (48.6%) | 20,261 (48.3%) | 1,375 (44.3%) * | 6,554 (46.0%) * |
| Race, n (%) | | * | * | * |
| African American | 22,105 (10.5%) | 3,792 (9.0%) | 297 (9.6%) | 1,375 (9.7%) |
| Asian | 4,675 (2.2%) | 700 (1.7%) | 45 (1.5%) | 222 (1.6%) |
| Caucasian | 171,019 (81.5%) | 35,777 (85.2%) | 2,648 (85.4%) | 12,054 (84.6%) |
| Other/Unknown | 11,957 (5.7%) | 1,717 (4.1%) | 112 (3.6%) | 590 (4.1%) |
| **Lab tests, mean ± SD** | | | | |
| eGFR, ml/min/1.73 m² | 76.9 ± 21.9 | 57.8 ± 18.8 * | 40.3 ± 10.3 * | 40.6 ± 9.7 * |
| UACR, mg/g | 89.3 ± 314.1 | 189.7 ± 458.2 * | 306.5 ± 723.3 * | 421.1 ± 1,030.5 * |
| HbA1c, % | 7.2 ± 1.5 | 7.2 ± 1.4 * | 7.2 ± 1.5 * | 7.2 ± 1.3 * |
| **Comorbidities, n (%)** | | | | |
| Hypertension | 149,175 (71.1%) | 32,426 (77.2%) * | 2,548 (82.1%) * | 11,414 (80.1%) * |
| Hyperlipidemia | 136,860 (65.2%) | 28,923 (68.9%) * | 2,159 (69.6%) * | 9,722 (68.3%) * |
| Obesity | 42,673 (20.3%) | 7,563 (18.0%) * | 668 (21.5%) | 2,527 (17.7%) * |
| Ischemic heart disease | 35,480 (16.9%) | 10,036 (23.9%) * | 948 (30.6%) * | 4,315 (30.3%) * |
| Chronic pulmonary disease | 33,240 (15.8%) | 7,550 (18.0%) * | 724 (23.3%) * | 2,885 (20.3%) * |

* indicates significant difference comparing each progression category with the no progression category, $p < 0.05$

- Patients who progressed to a higher risk group had a higher number of all-cause IP, ER, and OP visits and longer IP stays per year during the follow-up than those who did not progress (**Table 2**)
  - Compared to patients who progressed to a high risk group, those who progressed to a very high risk group had higher all-cause HRU (**Table 2**)

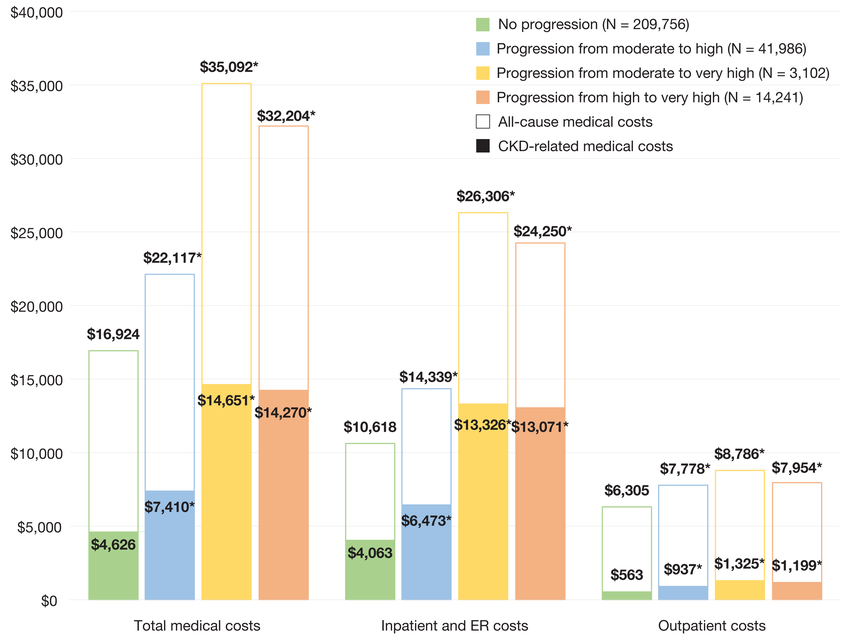
**Table 2. All-cause HRU by CKD progression category**

| | No progression N = 209,756 | Progression Pattern: Moderate to High N = 41,986 | Progression Pattern: Moderate to Very High N = 3,102 | Progression Pattern: High to Very High N = 14,241 |
|---|---|---|---|---|
| **IP visits** | | | | |
| Patients with at least one IP admission, n (%) | 46,423 (22.13%) | 11,524 (27.45%) * | 1,143 (36.85%) * | 4,944 (34.72%) * |
| Number of IP admissions (PPPY), mean ± SD | 0.32 ± 1.10 | 0.43 ± 1.35 * | 0.77 ± 2.46 * | 0.71 ± 2.27 * |
| Days of IP stay (PPPY), mean ± SD | 2.34 ± 11.00 | 3.21 ± 14.79 * | 6.00 ± 20.46 * | 5.54 ± 19.24 * |
| **ER visits** | | | | |
| Patients with at least one ER visit, n (%) | 63,765 (30.40%) | 12,995 (30.95%) * | 1,098 (35.40%) * | 4,798 (33.69%) * |
| Number of ER visits (PPPY), mean ± SD | 0.45 ± 1.32 | 0.50 ± 1.94 * | 0.68 ± 1.73 * | 0.62 ± 3.12 * |
| **OP visits** | | | | |
| Patients with at least one OP visit, n (%) | 208,375 (99.34%) | 41,560 (98.99%) * | 3,059 (98.61%) * | 14,014 (98.41%) * |
| Number of OP visits (PPPY), mean ± SD | 18.57 ± 17.30 | 22.91 ± 19.94 * | 25.88 ± 23.55 * | 23.43 ± 19.88 * |

* indicates significant difference comparing each progression category with the no progression category, $p < 0.05$

- Patients who progressed to a higher risk group had higher all-cause medical costs than patients who did not progress, mainly driven by higher IP costs (**Figure 2**)
- CKD-related medical costs contributed to 27%, 34%, 42%, and 44% of total medical costs in the four groups, highest in patients who progressed to a very high risk group (**Figure 2**)

**Figure 2. Annual medical costs per patient (2020 USD) by progression category[a]**




[a] * indicates significant difference comparing each progression category with the no progression category, $p < 0.05$.

## LIMITATIONS

- Medical services and lab tests outside of the healthcare network were not captured; coding inaccuracy may have led to misclassifications of T2D patients identified based on ICD codes
- Variable measures of eGFR may have caused misclassification of CKD risk categories; infrequent lab testing, especially of UACR, may have delayed the identification of disease progression
- Medical costs were calculated using unit costs generated from claims data which might not capture the actual costs incurred

## CONCLUSIONS

- This study described the incremental economic burden of CKD progression defined based on the KDIGO risk categories and demonstrated the value of UACR in evaluating the severity of CKD
- Patients with CKD associated with T2D had significantly higher HRU and medical costs when they progressed to a higher KDIGO risk category compared to those without progression
- Delaying progression could reduce the incremental costs in patients with CKD associated with T2D

## References

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## Conflict of Interest:

We have provided disclosure for each author to ASN during the abstract submission stage.

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