Poster # PO2301-2

Validation of Machine-Learning-Based Screening Tools for Early Detection of Chronic Kidney Disease in Patients With Type 2 Diabetes

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BACKGROUND

- Chronic kidney disease (CKD) is a progressive condition affecting over 850 million individuals globally.[1-3]
- Type 2 Diabetes (T2D) is a major risk factor with over 40% of diabetic patients CKD. Therefore, annual screening for CKD is recommended in people with T2D.[3-5]
- Burden of CKD is high in low- and middle-income countries (LMICs). Limited laboratory facilities and access to CKD screening tests remain a major unmet need in LMICs.[6]
- Machine learning (ML), a subset of artificial intelligence, holds significant promise for the early detection of CKD. This technology enables timely and effective interventions, potentially improving patient outcomes and streamlining healthcare processes.[7]
- A previously established and internally validated minimal resource ML model using Arkangel AI™ Platform has been developed to predict the risk of estimated glomerular filtration rate (eGFR) below 60 ml/min/1.73m^2 in T2D patients based on 6 non-invasive variables: age, gender, duration of diabetes, body mass index (BMI), blood pressure and history of hypertension. The model is reported to achieve an area under the receiver operating curve (AUC) of 0.7, the sensitivity of 0.8, and specificity of 0.6 in predicting eGFR <60 ml/min/1.73m^2.

OBJECTIVE

To externally validate Arkangel AI ML model for CKD prediction in diabetic patients from iCaReMe global registry across 6 LMICs.

METHOD

- A retrospective observational study was performed with data of T2D patients from iCaReMe Global Registry enrolled in Argentina, Mexico, Egypt, India, Malaysia and the Philippines. The Arkangel AI™ ML model was applied across the datasets to predict the probability that a patient's eGFR is below 60 ml/min/1.73m^2 and evaluated model performance metrics; sensitivity, specificity, positive predictive value, accuracy, F1 Score and discrimination (AUC).
- iCaReMe Global Registry (NCT03549754) is an ongoing real-world evidence program to assess the management and quality of care of patients with type 2 diabetes and/or hypertension, and/or heart failure and/or CKD.
- iCaReMe registry dataset, consisting of data collected from patients with T2D enrolled in 59 primary care sites between June 2020 and December 2021.
- Adults (aged 18 and over) with a diagnosis of T2D and available records of age, gender, duration of diabetes, BMI, blood pressure, history of hypertension and serum creatinine levels were included.

Eligibility	
Inclusion criteria	Adult patients (≥18 years of age), diagnosed with T2D and no prior history of cardiorenal complications (CRCs)
Exclusion criteria	Diabetic patients without eGFR or serum creatinine values and without clinical notes

Statistical analysis

- Descriptive statistics were used to summarize patient socio-demographics characteristics. Continuous variables were summarized using the number of observations and arithmetic mean.
- Performance metrics were calculated from the ensemble learning model and were presented using a 95% CI.

RESULTS

Table 1: Summary of Baseline Characteristics (N = 4342)

Quantitative variables	Mean (SD)
Age (years)	57.62 (12.11)
Systolic Blood Pressure (SBP) (mm Hg)	128.33 (17.09)
Diastolic Blood Pressure (DBP) (mm Hg)	76.56 (10.23)
Body Mass Index (BMI)	29.19 (6.24)
Diabetes duration	14.38 (8.25)
Qualitative variables	**N (%)**
Sex (Females)	2238 (51.54%)
Hypertension	1458 (33.58%)
CKD	909 (20.94%)

Table 2: Summary of Performance Metrics for Ensemble Model (N = 4342)

Metric	iCareMe 3.7DB/3.1NDB Model (N = 4342)	95% Confidence intervals
Sensitivity	90.05%	92.04%-88.05%
Specificity	36.11%	37.71%-34.52%
Precision (PPV)	25.93%	27.50%-24.37%
Accuracy	46.84%	48.32%-45.36%
F1 Score	40.27%	-
AUC	63.08%	-

Figure 1: ROC Curve of the Ensemble Model

The Receiver operating characteristic (ROC) curve was plotted with the true positive rate (recall, sensitivity) against the false positive rate (1-specificity) at different probability thresholds to determine the discriminative ability of the model. The ROC curve illustrated model's ability to identify positive instances while minimizing false cases. The area under the ROC curve was 0.63 for the model indicating fair prediction of patients with CKD.

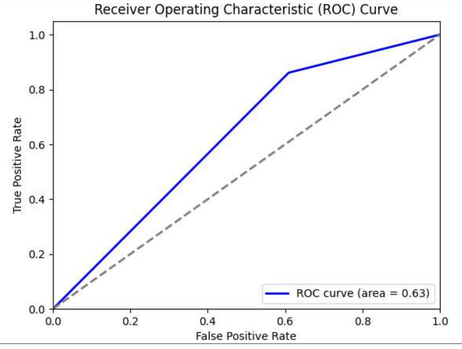
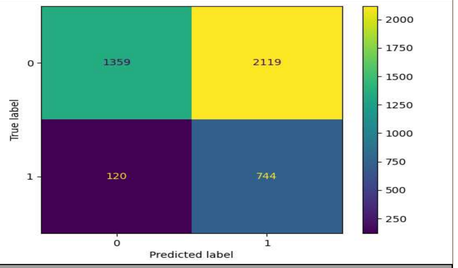


Figure 2: The Confusion Matrix of Ensemble Model

The confusion matrix reported 1359 (31.2%) patients as true positives and 744 (17.1%) patients as true negatives indicating an efficient classification performance of the ensemble model.



RESULTS HIGHLIGHTS

- A total of 4342 patients (mean age of 57.62 years) with validated eGFR measurements were tested with the model of which 51.54% were females.
- The mean duration of diabetes in this study was 14.38 years.
- About 33.6% of the patients reported hypertension with a mean (± SD) SBP of 128.3 mmHg and DBP of 76.5 mmHg.
- The ensemble learning model reported 90.05% (95% CI: 92.04%-88.05%) sensitivity, and 36.11% (95% CI: 37.71%-34.52%) specificity. The model showed PPV of 25.93% (95% CI: 27.50%-24.37%) indicating a moderate proportion of true positive cases with CKD.
- The F1 score of 40.27% indicated a good predictive performance.
- The area under curve (AUC) was 63.08% showed that the model can distinguish between patients with and without CKD.

CONCLUSION

Arkangel AI™ ML model demonstrated good performance in predicting the risk of CKD among individuals with T2D managed in routine clinical practice. This validation underscores the model's potential utility in primary care settings, particularly where screening is often underutilized, and access to laboratory testing is constrained.

ABBREVIATIONS

AI: artificial intelligence; AUC: Area under curve; BMI: Body Mass Index; CKD: chronic kidney disease; CRCs: cardiorenal complications; DBP: Diastolic Blood Pressure; eGFR: estimated glomerular filtration rate; LMIC: low- and middle-income countries; ML: machine learning; PPV: Positive predictive value; SD: Standard deviation; SBP: Systolic Blood Pressure; T2D: Type 2 Diabetes

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ACKNOWLEDGEMENT

As per the GPP 2022 guidelines, the authors would like to thank Jella Tarun and Mukku Lakshmi Sravanthi of Fortrea Scientific Pvt. Ltd., for medical writing support for the poster content development that was funded by AstraZeneca.

FUNDING AND DISCLOSURES

iCaReMe study was funded by AstraZeneca
The emsemble learning model was developed by Arkangel AI, funded by AstraZeneca.
Martinez, Julian; Perez-Rondon, Alejandra; Zea, Jose; Llano, Isabella and Castano-Villegas, Natalia are employees at Arkangel AI.
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