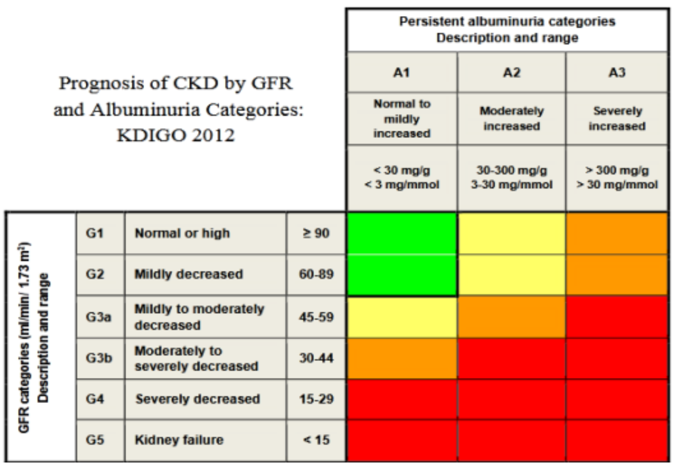
Early Detection of Chronic Kidney Disease using Machine Learning

Literature Survey:

On either side of the spine, the kidneys are located in the abdominal cavity. They typically weigh five times as much as their body weight yet only receive 20% of the heart's blood supply. Each kidney excretes urine into the urinary bladder, which is located in the pelvic region, through a separate urethra. Because it regulates fluid balance, electrolyte balance, and other factors that keep the body's internal environment constant and comfortable, the kidney is the most crucial organ in the human body. Conditions known as renal disorders affect the way that the kidneys work. Kidney failure can result from advanced renal diseases. The functioning of the kidneys is impacted by renal disorders. When kidneys are hurt, they are unable to function as they should. The term for this is chronic renal disease (CKD). A chronic kidney illness can strike anyone.

Nephrologists typically use two main assays to detect CKD in medical studies. a urine test to measure albumin and a blood test to measure glomerular filtration rate (GFR) [1]. Age, genetics, diabetes, obesity, hypertension, and other variables can all affect CKD. The Kidney Disease Outcomes Quality Initiative (KDOQI) and KDIGO (Kidney Disease Improving Global Outcome) of the US National Kidney Foundation and other international standards organisations provide important information and updates on CKD.

According to the KDIGO CKD and English National Institute for Health and Care Excellence (NICE) CKD recommendations, the renal patient is identified by two tests, both of which are blood tests to check the kidneys' ability to filter out creatinine, a result of normal muscle breakdown. An examination of the urine, in contrast, will reveal that protein is still present. The kidney filter typically does not allow protein (albumin), a blood component, to enter the urine. Albumin in the urine indicates a problem with the kidney filters and may be a sign of chronic renal illness. A glomerular filtration rate (GFR) of less than 60 ml/min/1.73 m2 for more than three months is considered chronic kidney disease (CKD), which has major health consequences.



Prognosis of CKD by GFR and Albuminuria Categories: KDIGO 2012			Persistent albuminuria categories Description and range		
			A1	A2	A3
			Normal to mildly increased	Moderately increased	Severely increased
			< 30 mg/g < 3 mg/mmol	30-300 mg/g 3-30 mg/mmol	> 300 mg/g > 30 mg/mmol
GFR categories (ml/min/ 1.73 m²) Description and range G1	Normal or high	≥ 90			
G2	Mildly decreased	60-89			
G3a	Mildly to moderately decreased	45-59			
G3b	Moderately to severely decreased	30-44			
G4	Severely decreased	15-29			
G5	Kidney failure	< 15			

GFR and Albuminurea categories KDIGO 2012.

In medical research, nephrologists typically employ two key tests to identify CKD. A blood test is used to determine GFR, whereas a urine test is used to determine albumin. Genetics, high blood pressure, diabetes, obesity, age, and other factors can all have an impact on CKD. International kidney disease development guidelines and standards foundations like the US National Kidney Foundation Kidney Disease Outcomes Quality Initiative (KDOQI) and KDIGO (Kidney Disease Improving Global Outcome) provide significant information on CKD facts and developments.Two blood tests that assess how effectively the kidneys filter blood to remove creatinine are used to identify the renal patient, in accordance with KDIGO CKD and English National Institute for Health and Care Excellence (NICE) CKD guidelines. a side effect of muscle breakdown On the other hand, a urine test will show that protein is still present in the urine. A component of blood called protein (albumin) is typically not eliminated by the kidney filter. Finding albumin in the urine is a sign that the kidney filters are malfunctioning and may indicate chronic renal disease. A glomerular filtration rate (GFR) of less than 60 ml/min/1.73 m2 for more than three months is referred to as chronic kidney disease (CKD), which has serious health consequences.

By utilizing machine learning techniques to identify CKD at an early stage and concentrating on applying various machine learning classification algorithms to a dataset of 400 patients and 24 CKD-related characteristics, N.A. Almansour et al. hope to contribute to the prevention of CKD. Artificial neural networks and support vector machines are used as classification techniques, and any missing values in the dataset are substituted by the appropriate features. The final models of the two suggested strategies were built using the best parameters and traits that had been gathered. The results of the experiment demonstrated that ANN outperformed SVM, with accuracy rates of 99.75 percent and 97.75 percent, respectively.

References:

1) G. Chen et al., “Prediction of Chronic Kidney Disease Using Adaptive Hybridized Deep Convolutional Neural Network on the Internet of Medical Things Platform,” IEEE Access, vol. 8, pp. 100497–100508, 2020, Doi: 10.1109/ACCESS.2020.2995310.

2) P. T. Coates et al., “KDIGO 2020 Clinical Practice Guideline for Diabetes Management in Chronic Kidney Disease,” Kidney Int., vol. 98, no. 4, pp. S1– S115, 2020, doi: 10.1016/j.kint.2020.06.019.

3) L. Chen, “Overview of clinical prediction models,” Ann. Transl. Med., vol. 8, no. 4, pp. 71–71, 2020, Doi: 10.21037/atm.2019.11.121.

4) H. Kriplani, B. Patel, and S. Roy, Prediction of chronic kidney diseases using deep artificial neural network technique, vol. 31. Springer International Publishing, 2019.

5) T. O. Ayodele, “Atherosclerotic Cardiovascular Disease,” Atheroscler. Cardiovasc. Dis., 2012, Doi: 10.5772/711.

6) Abdi, “Three types of Machine Learning Algorithms List of Common Machine Learning Algorithms,” no. November 2016, Doi: 10.13140/RG.2.2.26209.10088.

7) S. Y. Yashfi et al., “Risk Prediction of Chronic Kidney Disease Using Machine Learning Algorithms,” 2020 11th Int. Conf. Comput. Commun. Netw. Technol. ICCCNT 2020, 2020, Doi: 10.1109/ICCCNT49239.2020.9225548.

8) N. A. Almansour et al., “Neural network and support vector machine for the prediction of chronic kidney disease: A comparative study,” Comput. Biol. Med., vol. 109, no. October 2018, pp. 101–111, 2019, doi:10.1016/j.compbiomed.2019.04.017.

9) Sobrinho, A. C. M. D. S. Queiroz, L. Dias Da Silva, E. De Barros Costa, M. Eliete Pinheiro, and A. Perkusich, “Computer-Aided Diagnosis of Chronic Kidney Disease in Developing Countries: A Comparative Analysis of Machine Learning Techniques,” IEEE Access, vol. 8, pp. 25407–25419, 2020, Doi: 10.1109/ACCESS.2020.2971208.

10) N. V. Ganapathi Raju, K. Prasanna Lakshmi, K. G. Praharshitha, and C. Likhitha, “Prediction of chronic kidney disease (CKD) using Data Science,” 2019 Int. Conf. Intell. Comput. Control Syst. ICCS 2019, no. Iciccs, pp. 642–647, 2019, Doi: 10.1109/ICCS45141.2019.9065309.

11) P. Kotturu, V. V. S. Sasank, G. Supriya, C. S. Manoj, and M. V. Maheshwarredy, “Prediction of chronic kidney disease using machine learning techniques,” Int. J. Adv. Sci. Technol., vol. 28, no. 16, pp. 1436–1443, 2019, Doi: 10.17148/IJARCCE.2018.71021.

12) Deep Learning,” 2018 Int. Conf. Innov. Eng. Technol. ICIET 2018, pp. 1–6, 2019, Doi: 10.1109/CIET.2018.8660844.