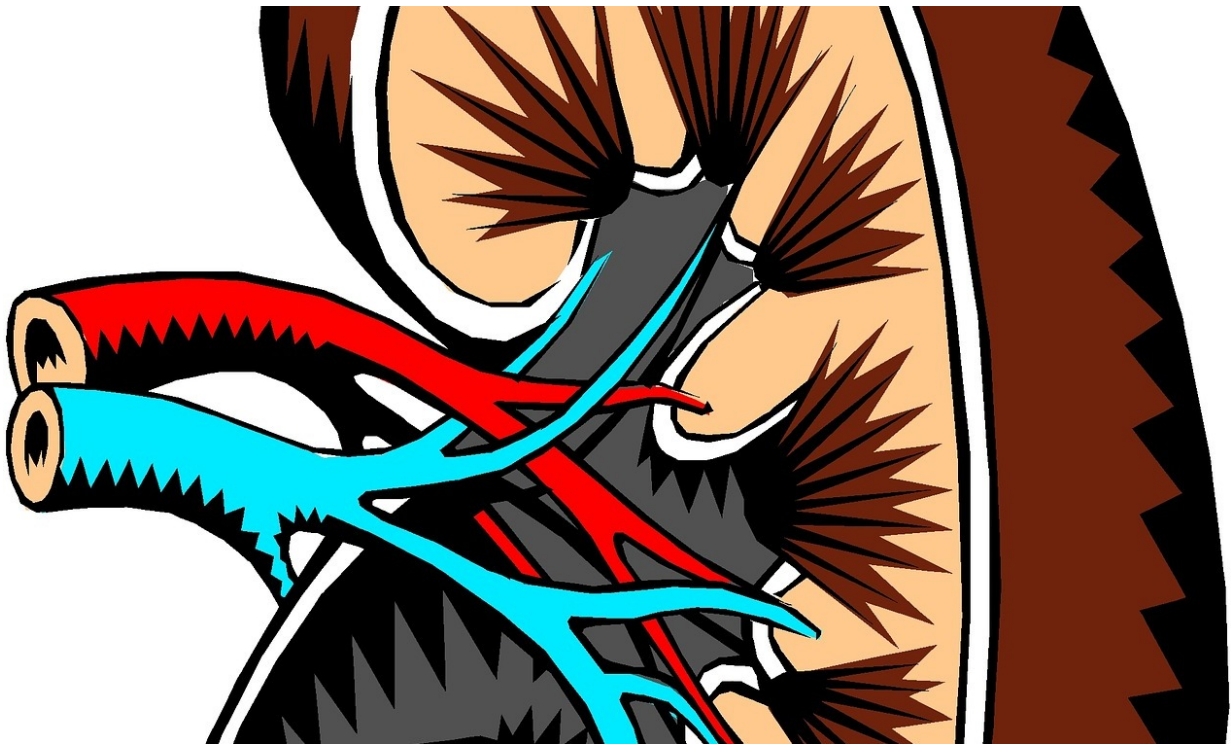# Artificial intelligence approaches may improve diagnostics of kidney disease

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Credit: CC0 Public Domain

Two new studies reveal that modern machine learning—a branch of artificial intelligence in which systems learn from data, identify patterns, and make decisions—may augment traditional diagnostics of kidney disease. The findings appear in an upcoming issue of *JASN*.

Pathologists often classify various kidney diseases on the basis of visual assessments of biopsies from patients' kidneys; however, machine learning has the potential to automate and augment the accuracy of classifications.

In one study, a team led by Pinaki Sarder, Ph.D. and Brandon Ginley, BS (Jacobs School of Medicine and Biomedical Sciences at the University at Buffalo) developed a computational algorithm to detect the severity of diabetic kidney disease without human intervention. The algorithm examines a digital image of a patient's kidney biopsy at the microscopic level and extracts information on glomeruli, the small blood vessels of the kidney that filter waste from the blood for excretion. These structures are known to become progressively damaged and scarred over the course of diabetes.

There are typically 10 to 20 individual glomeruli per biopsy, and the algorithm detects the location of each glomerular sub-component in the digital images, and then makes many measurements on each sub-component. "The algorithm then views all of the features measured from one patient's biopsy in a series, just like a doctor would scan a patient's biopsy going from glomerulus to glomerulus and examining each one's structure," explained Dr. Sarder. "The algorithm has a long and short term memory as it examines the glomerular structure, so it can remember and incorporate information from all glomeruli into its final analysis," added Mr. Ginley.

The researchers used their method to digitally classify biopsy samples from 54 patients with diabetic kidney disease and found substantial agreement between digital classifications and those by 3 different pathologists.

In another *JASN* article published at the same time, a team led by Jeroen van der Laak, Ph.D. and Meyke Hermsen, BSc (Radboud University

Medical Center, Nijmegen, the Netherlands) applied machine learning to examine kidney transplant biopsies and went beyond glomeruli to assess multiple tissue classes in the kidney. The researchers developed a machine learning model called a "convolutional neural network" (CNN) and found that it could be applied to tissues from multiple centers, for biopsies and nephrectomy samples, and for the analysis of both healthy and diseased tissues. In addition, they validated the CNN's results with standard classification methods.

"In this research we applied artificial intelligence to accurately analyze kidney transplant tissue. This will facilitate kidney transplant research by yielding highly accurate and reproducible data characterizing disease processes, and in the longer term also lead to improved diagnoses for transplant patients, which may improve organ survival," said Dr. van der Laak. He noted that the performance of the CNN exceeded their expectations, especially the accuracy with which it could distinguish proximal tubuli from distal tubuli—two different types of kidney tubules. "We included 8 more tissue classes and the network did not perform equally good for all of them. For instance, determining if a tubule is in an atrophic state can be difficult for a human observer, and the network struggled with this as well. We are working on making the network better at this classification."

Ms. Hermsen added that machine learning has only been sparsely applied in the kidney field, mostly limited to detecting a single structure. "We felt that much more information should—and can—be extracted from kidney tissue in order to fully support graft assessment," she said.

An editorial that accompanies the two studies highlights the strengths and weaknesses of machine learning.

  More information: The article, entitled "Computational Segmentation and Classification of Diabetic Glomerulosclerosis," will appear online on

September 5, 2019, DOI: 10.1681/ASN.2018121259

The article, entitled "Deep Learning-Based Histopathologic Assessment of Kidney Tissue," will appear online on September 5, 2019, DOI: 10.1681/ASN.2019020144

The accompanying editorial, entitled "Machine Learning Comes to Nephrology," will appear online on September 5, 2019, DOI: 10.1681/ASN.2019070664

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