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Integrating AI into Nephrology: Applications and Challenges

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Artificial intelligence (AI) is increasingly transforming nephrology, offering new opportunities to improve diagnosis, prediction, and management of kidney disease. Machine learning models have shown strong performance in predicting acute kidney injury, chronic kidney disease progression, and dialysis-related complications, often identifying risk earlier than traditional clinical tools. In pathology and imaging, AI enables more standardized and scalable interpretation of kidney biopsies and radiographic studies. Natural language processing further expands capabilities by extracting actionable insights from electronic health records, supporting clinical decision-making and population health strategies. Despite this promise, significant challenges limit the translation of AI into routine nephrology practice. Many models are developed using retrospective datasets and lack robust external validation, raising concerns about generalizability across different healthcare systems and patient populations. Bias in training data may exacerbate existing health disparities if not carefully addressed. In addition, issues related to data quality, interoperability, and infrastructure can hinder implementation, particularly in real-world clinical environments. Equally important are human and system-level barriers. Many AI models function as "black boxes," limiting interpretability and clinician trust. Integration into clinical workflows remains suboptimal, and regulatory frameworks are still evolving. Without clear evidence of improved patient-centered outcomes, adoption may remain limited. To realize the full potential of AI in nephrology, future efforts must focus on prospective validation, transparent and interpretable model design, and integration into clinician workflows. Multidisciplinary collaboration between clinicians, data scientists, and policymakers will be essential. Ultimately, AI should be viewed as a tool to augment clinical expertise, enhancing decision-making, improving efficiency, and promoting more equitable kidney care.

Keywords: validation, bias