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Artificial intelligence in hemodialysis: a comprehensive overview
(AI in Hemodialysis 에 대한 전반적인 Review)

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Artificial intelligence in hemodialysis: a comprehensive overview
Hemodialysis (HD) is the most widely utilized renal replacement therapy worldwide, yet long-term outcomes for patients with end-stage kidney disease remain suboptimal, underscoring the urgent need for innovation in dialysis care.[1] Artificial intelligence (AI) and machine learning (ML) have emerged as transformative tools across medicine, and the HD setting — characterized by highly standardized workflows, large longitudinal datasets, and routinely captured biosignals — provides a uniquely fertile ground for their application.[2]
This lecture offers a broad overview of the current landscape of AI in HD, organized around four major domains. First, **complication prediction**: intradialytic hypotension (IDH), occurring in 8–40% of sessions, has been the most intensively studied target, with recurrent neural network and transformer-based models achieving AUROCs exceeding 0.94 for real-time risk stratification.[3][4] Second, **treatment optimization**: AI-driven anemia control models — currently among the few AI tools in routine clinical use in dialysis — have demonstrated improved hemoglobin target achievement and reduced erythropoiesis-stimulating agent dosing.[5] Third, **prognosis and mortality prediction**: ML models incorporating clinical, laboratory, and dialysis-prescription variables have shown promise in stratifying long-term mortality risk, supporting a shift toward precision medicine in HD care.[6] Fourth, **vascular access management**: AI has shown strong performance in predicting AVF maturation, detecting access dysfunction, and assessing aneurysm severity, enabling earlier intervention and improved point-of-care decision-making in this dialysis-specific domain [7–9,2].

Beyond these core domains, increasing attention is being directed toward multimodal data integration, particularly the incorporation of biosignals such as electrocardiography. Deep learning applied to 12-lead ECGs has shown potential for identifying cardiovascular risk in HD patients through latent waveform features.[10] In addition, wearable or single-lead ECG systems have demonstrated feasibility for noninvasive monitoring of conditions such as hyperkalemia and

arrhythmia, suggesting a scalable approach for continuous risk surveillance in this high-risk population.[11–13]
Despite promising research results, routine clinical adoption of AI in HD remains limited, constrained by challenges including data privacy, algorithmic opacity, interoperability, and regulatory uncertainty.[2] This lecture concludes by outlining a vision for precision dialysis — leveraging AI to shift care from a population-driven, reactive model to a proactive, individualized one — and identifying the translational steps required to bridge research advances and bedside practice.[1]

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