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Trends and Future of Medical Artificial Intelligence Technologies

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Artificial intelligence (AI) is rapidly transforming the field of medicine by augmenting clinical decision-making, improving diagnostic accuracy, and enabling personalized interventions. This presentation explores the latest global advancements in medical AI, with a focus on nephrology-related applications, providing a curated synthesis of technical developments, clinical validation studies, and regulatory perspectives. The session begins with a foundational overview of what constitutes medical AI—encompassing machine learning algorithms, deep learning models, large language models (LLMs), and AI-based Software as a Medical Device (SaMD). We outline the exponential growth of medical AI research, driven by the convergence of big data availability (e.g., EHRs, imaging, omics), improved computing infrastructure (e.g., GPUs, cloud-based services), and breakthroughs in neural network architectures. A detailed examination of regulatory guidance by WHO and the FDA is presented, including their frameworks for evaluating safety, efficacy, fairness, and explainability. We introduce the WHO's recent governance recommendations for large multimodal models (LMMs), which emphasize the importance of transparency, reproducibility, and human oversight in AI deployment. Several real-world SaMD case studies approved in Korea are introduced, such as VUNO BoneAge, Lunit INSIGHT CXR, VUNO DeepCARS, AITRICS-VC, Mediwhale Reti-CVD and DeepCatch. To directly address nephrology, the presentation reviews a series of landmark AI studies from the last year: - UWF-CKDS: A deep learning model trained on 26,539 ultra-wide-field fundus images predicting CKD risk, achieving AUROC 0.86 (internal) and 0.81 (external). - TriNetX-based ML models: Predicting post-COVID AKI and CKD using EHRs from 104,565 patients, with top-performing models (XGBoost, RF) achieving AUROC up to 0.896. - LightGBM + SHAP model: Predicting AKD progression and in-hospital mortality in elderly ICU patients with AKI; validated on MIMIC-IV and Xiangya Hospital data. - CVEformer: An attention-based transformer model for predicting MACE in peritoneal dialysis patients using multivariate time-series data. - KidneyOnline app: Demonstrated significant slowing

of CKD progression through AI-assisted lifestyle interventions in a 2-year matched cohort study. We also explore the rise of generalist and multimodal AI systems—like Med-PaLM 2 and CONCH—as well as the integration of LLMs (Large Language Models) into clinical reasoning tasks. With models like ChatGPT achieving human-comparable or even superior scores in USMLE-style diagnostic tasks and delivering empathetic patient interactions, their role in decision support, education, and patient communication is rapidly expanding. Finally, the session introduces emerging paradigms such as Multi-Agent Systems for Healthcare (MASH), where coordinated AI agents operate collaboratively across clinical and operational layers, promising scalable and personalized care in the future nephrology clinic. Through this session, nephrologists will gain a comprehensive and panoramic understanding of how artificial intelligence is currently transforming, and will continue to shape, the field of kidney care. By bridging cutting-edge technical developments with practical clinical applications, the presentation encourages a proactive, evidence-driven adoption of AI tools. It highlights opportunities to improve patient outcomes, enable earlier disease detection, and optimize nephrology workflows. Furthermore, this talk not only presents the current capabilities of medical AI but also outlines a future-oriented roadmap for the trustworthy, ethical, and impactful integration of AI technologies into routine kidney care practice.

Keywords: Medical Artificial Intelligence, AI SaMD, Machine Learning for Kidney Disease Prediction, Ethical and Trustworthy AI in Healthcare, Multi-Agent Systems for Healthcare