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Deep Reinforcement Learning-Based Personalized Treatment Strategies for IgA Nephropathy

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Objectives : IgA nephropathy, a common glomerular disorder characterized by the deposition of IgA antibodies in renal glomeruli, exhibits a diverse clinical course, making the development of an optimal treatment strategy challenging. This study applies deep reinforcement learning (DRL) in nephrology to create an individualized treatment recommendation system for IgA nephropathy patients, leveraging their unique clinical and histopathological profiles.
Methods : We compiled a dataset consisting of 100 cases of IgA nephropathy, including comprehensive clinical records, renal histopathological images, and five-year treatment outcomes. Data preprocessing involved image segmentation, feature extraction, and standardization. Deep reinforcement learning agents were trained to provide personalized treatment recommendations. These agents interacted with a simulated environment, making sequential treatment decisions to maximize long-term patient outcomes.
Results : Our novel DRL-based approach yielded impressive individualized treatment recommendations for IgA nephropathy patients. By considering and adapting treatments to patients' changing conditions, our model achieved personalized treatment strategies that significantly improved clinical outcomes. Specifically, the DRL agent reduced the risk of disease progression by 42.6% compared to standard protocols, with a 95% confidence interval of (37.1%, 48.2%). Furthermore, the model's interpretable policies provided detailed treatment adaptations based on specific histopathological features, patient demographics, and disease trajectories.
Conclusions : Our study emphasizes the potential of deep reinforcement learning for personalized IgA nephropathy treatment. Tailoring strategies to individual patient needs, our DRL system shows promise in improving outcomes for this complex condition. This approach has the potential to significantly advance IgA nephropathy management and serve as a model for personalizing treatments in other renal diseases.