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MACHINE LEARNING DETECTS ASSOCIATIONS BETWEEN RETINA FEATURES AND BLOOD PRESSURE STATUS IN RICE DIET PROGRAM PATIENTS

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Abstract:
The retina provides direct evidence of target-organ damage, and in hypertension, it may reflect vascular disease status in conjunction with clinical measurement of blood pressure (BP). However, outcomes of the examination of the retina varies from one clinician to another due to various reasons. Machine learning methods have been used as a supportive tool in identifying deep retina features objectively and consistently. The Kempner Rice Diet Program, developed in the early 1940s, used a low-salt and low-protein diet intervention (Rice Diet) to treat patients with severe hypertension before effective drug treatment was available. The meticulously documented medical records of the Rice Diet Program patients and their retina photographs provide a rare opportunity to examine the association of BP trajectories and target-organ damage as reflected in the retina. We trained a deep neural network on systolic BP and funduscopic changes from the UK Biobank Project. We achieved an R^2 value of 0.36 on 16,357 validation retina images from the UK Biobank. Our model predicts BP values for specific retinal areas by producing heatmaps of higher or lower hypertensive findings. We then applied the model on 975 retina photographs of 165 patients of the Rice Diet Program. We observed a significant correlation between retina features and systolic BP (Correlation= 0.35, p = $2*10^{-29}$), showing that the model generalizes to patients with hypertension and images taken under a variety of conditions between 1944-1971. We suggest that deep-learning-based predictions for retinal analysis could be useful in monitoring treatment progress and recovery from hypertension-induced target-organ damage. This assessment serves as an adjunct to point-of-care BP measurements in the subset of 165 patients. Our findings underscore the potential utility of machine learning in hypertension evaluation and treatment. Further, it may allow us to elucidate individual responses to hypertension treatment beyond BP measurement alone. Findings from this first-step analysis may promote development of more effective BP control strategies.

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