Kawasak.AI: A Robust Deep Ensemble Network with Joint Detection for Differential Diagnosis of Kawasaki Disease

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Kawasaki disease (KD) is the leading cause of acquired heart disease in children, and its early diagnosis is crucial for effective intravenous immunoglobulin treatment within ten days, significantly reducing risk of coronary artery aneurysms from 25% to <5%. However, KD is often misdiagnosed as it shares clinical findings with look-alike diseases, leading to risk of myocardial infarction or death of a child. This study investigates methods to reliably early diagnose KD and overcome the bottleneck of data for deep learning in medical applications through three phases: algorithm development with variable testing, ensemble modeling, and real-world data validation and prototyping. KD and febrile control data is collected from scratch through public Internet domains and crowdsourced from KD patients, then adjudicated by a KD expert. To combat the challenge of deep learning for uncommon disease diagnosis, methods including random data augmentation, adaptive weighted loss function, and gradient descent optimization are developed which improve generalizability despite orders of magnitude less data and imbalance. An AUC-ROC of 0.90 is achieved optimizing sensitivity and specificity performance across 10-fold cross validation and six clinical criteria, and a joint detection ensemble network incorporates all features of early diagnosis. A Raspberry Pi prototype further illustrates feasibility in real-world implementations to aid doctors in early diagnosing KD, especially in regions where immediate medical assistance may not be available. The image analysis-based deep ensemble shows promising results for improving KD early diagnosis, thus reducing its morbidity and mortality, and methodologies can be potentially applied towards diagnosing other uncommon diseases.

Awards Won:
Third Award of $1,000