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Artificial Intelligence in Ophthalmology: A Meta-Analysis of Deep Learning Models for Retinal Vessels Segmentation

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Abstract

Background and Objective: Accurate retinal vessel segmentation is often considered to be a reliable biomarker of diagnosis and screening of various diseases, including cardiovascular diseases, diabetic, and ophthalmologic diseases. Recently, deep learning (DL) algorithms have demonstrated high performance in segmenting retinal images that may enable fast and lifesaving

diagnoses. To our knowledge, there is no systematic review of the current work in this research area. Therefore, we performed a systematic review with a meta-analysis of relevant studies to quantify the performance of the DL algorithms in retinal vessel segmentation.

Methods: A systematic search on EMBASE, PubMed, Google Scholar, Scopus, and Web of Science was conducted for studies that were published between 1 January 2000 and 15 January 2020. We followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) procedure. The DL-based study design was mandatory for a study's inclusion. Two authors independently screened all titles and abstracts against predefined inclusion and exclusion criteria. We used the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) tool for assessing the risk of bias and applicability.

Results: Thirty-one studies were included in the systematic review; however, only 23 studies met the inclusion criteria for the meta-analysis. DL showed high performance for four publicly available databases, achieving an average area under the ROC of 0.96, 0.97, 0.96, and 0.94 on the DRIVE,

STARE, CHASE_DB1, and HRF databases, respectively. The pooled sensitivity for the DRIVE, STARE, CHASE_DB1, and HRF databases was 0.77, 0.79, 0.78, and 0.81, respectively. Moreover, the pooled specificity of the DRIVE, STARE, CHASE_DB1, and HRF databases was 0.97, 0.97, 0.97, and 0.92, respectively.

Conclusion: The findings of our study showed the DL algorithms had high sensitivity and specificity for segmenting the retinal vessels from digital fundus images. The future role of DL algorithms in retinal vessel segmentation is promising, especially for those countries with limited access to healthcare. More compressive studies and global eorts are mandatory for evaluating the cost-e ectiveness of DL-based tools for retinal disease screening worldwide.

Biography

I am a PhD apprentice at Taipei Medical University, Taiwan. I am interested in Machine learning, deep learning, pharmacy informatics, public health informatics, e-health literacy, and healthcare policy.