Machine Learning Classifiers In The Diagnosis And Follow-up Of Glaucoma Using Short-wavelength Automated Perimetry (SWAP)

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Commercial Relationships: C. Boden, None; K. Chan, None; M. Goldbaum, None; T.W. Lee, None; T. Sejnowski, None; A.G. Boehm, None; M. Aihara, None; R.N. Weinreb, None; P.A. Sample, None.
Grant Identification: Support:NIH Grant EY08208; LM05759;RPB

Abstract

Purpose: To evaluate the performance of machine classifiers in diagnosing glaucoma from short-wavelength automated perimetry (PHASE 1) and to evaluate the ability of machine classifiers to predict the development of abnormal fields at follow-up in eyes with a normal baseline field (PHASE 2).

Methods: PHASE 1 Raw thresholds and ages from 158 eyes with glaucomatous optic neuropathy (GON) and 186 normal eyes served as training input to a linear discriminant function (LDF) and two types of support vector machine (SVM\textsuperscript{L} and SVM\textsuperscript{G}), a mixture of Gaussian classifier (MoG), a constrained MoG (QDF) and a multilayer perceptron (MLP). PHASE 2 Serial SWAP fields from 68 eyes with IOP greater than 24, a normal baseline field, at least 4 fields and optic disc stereophotographs were included. Machine classifiers from Phase 1 categorized fields as normal or abnormal. Specificity was set at 95\% for the machine classifiers using longitudinal data from 94 normal eyes, matching the specificity of the statpac-like analysis (STAT). Specificity cut-offs required confirmation of abnormality on two successive visual fields.

Results: PHASE 1. Areas under the ROC were 0.77 for LDF, 0.80 for MLP, 0.82 for SVM\textsuperscript{L}, and 0.83 for QDF and SVM\textsuperscript{G}. PHASE 2. A mean±SD of 5.99±1.93 visual fields were completed over 6.67±2.40 years. 19\% (13/68) of eyes converted by STAT. Of those eyes, 6 to 9 eyes were found to have converted by SVM (SVM\textsuperscript{L} and SVM\textsuperscript{G}). However, 20 eyes converted by at least 1 machine classifier that did not convert by STAT and 15 of these had GON. LDF identified the most converts (22 eyes) of which 17 had GON.

Conclusion: The sensitivity in Phase 1 was not as good as our previous results with SAP. It is possible that SWAP may be influenced to a greater extent by generalized depression than SAP. We are currently pursuing this hypothesis. However, in Phase 2 the machine classifiers identified a larger number of GON as converts than STAT.

Keywords: 624 visual fields • 511 perimetry