Scottish Government Health Directorates Chief Scientist Office

CHIEF SCIENTIST OFFICE

FOCUS ON RESEARCH

Can automated analysis of sequential retinal images of people attending diabetic retinopathy screening predict future referral to ophthalmology?

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Aim
Retinal screening for diabetic retinopathy, involving taking images of the retina, has been shown to be cost-effective. This project explored the feasibility of using automated analysis of sequential retinal images to identify specific features, which could be used to identify those people at risk of their disease progressing and require referral to ophthalmology.

Project Outline / Methodology
This was a retrospective cohort study using record linkage of routinely collected diabetes databases – National Diabetes Information Management System (SCI-Diabetes) and National Diabetic Retinopathy Screening programme (Sorian). The study dataset consisted of 12754 subjects who attended the screening programme initially between 2005 and 2008 of whom there was information on the outcome of 3 or more screens.

We added new algorithms and further developed the automated retinal imaging analysis software which we previously developed. It has been part of the Scottish screening programme since 2010. Autograder-2 can assess disease changes in sequential retinal photographs. It measures whether or not the same microaneurysm (MA), the main indicator of retinopathy, appeared in sequential images and whether new MAs appeared, how close the MAs were to the fovea (the area of best vision), and the number of MAs within each quadrant of the retina. It also assessed the presence of other indicators of retinopathy, namely exudates and haemorrhages. We then examined whether these new features predicted the later development of retinopathy requiring referral to ophthalmology.

Key Results
A number of the novel features derived from the automated analysis of retinal images were independently associated with retinopathy progression. These key features identified including counts of MAs, turnover of MAs (new and disappeared), and presence of haemorrhages and exudates independently contributed to the risk of progression after adjusting for the grades of retinopathy determined by manual examination of images and for other known patient risk factors.

Models were developed to estimate the risk of progression to severe retinopathy during next 15 months following screening. In addition a scoring system has been proposed based on these and other known risk factors (type of diabetes, duration of diabetes, blood glucose control) to be assigned to each individual assessing their risk of progression at a subsequent screen over the next 5 years.

Conclusions
Features of retinopathy derived from automated analysis of sequential photographs can help predict the risk of progression, from any non-referable retinopathy, to retinopathy needing referral to ophthalmology.

What does this study add to the field?
This is the first study to develop a fully automated system to analyse sequential retinal images obtained from people with diabetes as part of routine screening. We have used this automated data to develop a novel model for predicting the risk of retinopathy progression.

Implications for Practice or Policy
Implementation of novel scoring system using Autograder-2 can be used to identify high risk subgroups of patients that may benefit from more intensive medical management and screening.

Where to next?
The risk algorithms developed need to be validated using Scottish and other national datasets of retinal images. We will explore the relationship of these novel automated features with other cardiovascular outcomes. We also plan to investigate the role of alternate methods of communicating the risk of progression of retinopathy to people with diabetes.

Further details from
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