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| **Title:** | | TG-Ophthalmo: Proposal for sub-topic - AI based Aetiological Classification of Red Eye | | |
| **Purpose:** | | Discussion | | |
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| **Abstract:** | Eye problems are the reason for 2-3% visits to primary health centres and emergency facilities, the majority of which are cases of red eye. Recognising the need for emergent referrals to an ophthalmologist for some causes is the key in the primary care management of red eye. We propose to assess the use of smartphone images for the differential diagnosis of red eye and creation of gold standard annotations for use in an artificial intelligence algorithm. We would like to include this proposal as a sub-topic under TG-Ophthalmology. |

# 1. Overview

Eye problems are the reason for 2-3% visits to primary health centres and emergency facilities, the majority of which are cases of red eye [1]. The red eye is one of the most common problems seen in most eye clinics in developing countries. The majority of red eyes are seen at community clinics, primary health centres and health sub centres, where diagnosis and management are done by primary care physician, community health nurses, midwives and health workers. [2]

Conjunctivitis is the most common cause of red eye. Other causes include blepharitis, corneal abrasion, foreign body, subconjunctival haemorrhage, keratitis, iritis, glaucoma, chemical burn, and scleritis. Although most causes are usually benign and can be managed by primary care physicians, certain uncommon conditions with red eye like keratitis, iritis and glaucoma require early recognition, initiation of treatment and quick referral to a higher centre for appropriate management. There is a high likelihood of complications including irreversible loss of vision if referral is delayed.

# 2. Relevance

Recognising the need for emergent referrals to an ophthalmologist for some causes is the key in the primary care management of red eye. If primary health care workers can accurately diagnose the cause of red eye and provide primary level treatment, then patients can be managed quicker and closer to where they live [2]. Furthermore, secondary centres will be relieved of treating simple conditions, allowing more time and resources for eye conditions that need the attention of specialists. This tool will help to differentiate serious causes of red eye from innocuous ones.

# 3. Impact

In the problem we aim to address here, an AI solution could be aimed at providing better eye care to those living in rural areas. In most rural health centres, the healthcare provider may be a nurse, midwife or a non-ophthalmologist doctor. This holds true in most developing countries.

An AI solution would be able to accurately diagnose the cause of red eye and recommend treatment or referral to an expert ophthalmologist. Such a solution would also increase the efficiency of treatment of red eye cases in rural centres.

# 4. Existing Work

The Edinburgh red eye diagnostic algorithm:

The Edinburgh Red Eye diagnostic algorithm was designed by Timlin et. al. to assist clinicians referring patients to the acute ophthalmology service within Edinburgh. This algorithm aims to aid primary care physicians to diagnose anterior segment conditions resulting in red eye in the same way an experienced ophthalmologist approaches such a patient- analysing the symptoms and signs and using a combination of pattern recognition and deductive reasoning to arrive at a diagnosis.

The accuracy of this algorithm was tested by analysing the concordance between the algorithm-assisted diagnosis (made by primary care physicians) and the ‘gold-standard’ diagnosis (made by expert ophthalmologists).

The results showed a 72% diagnostic accuracy for the Edinburgh red eye diagnostic algorithm, which rises to 76% when only severe eye conditions are included (iritis, keratitis and AACG).

Clinical Validation of Smartphone Based Adapter: Peek Retina for Optic Disc Imaging in Kenya:

This study was aimed at designing and validating a smartphone-based retinal adapter to enable image capture and remote grading of the retina.

In this validation study, efficacy of grading of optic nerves from smartphones images was compared with that of a Digital Fundus Camera. Both image sets were independently graded at Moorfields Eye Hospital Reading Centre. A sub-set of 100 optic disc images from both methods were further used to validate a grading app for the optic nerves.

Non-clinical photographers using the low-cost Peek Retina adapter and smartphone were able to acquire optic nerve images at a standard that enabled comparable independent remote grading of the images to those acquired using a desktop retinal camera operated by an ophthalmic assistant.

Artificial intelligence based algorithms to detect DR from retinal images have been tested previously. Newer advances incorporate deep learning into these algorithms in order to improve diagnostic accuracy.

In the study conducted by Abramoff et. al, total of 900 participants were enrolled, of which 892 participants completed all procedures. The AI system correctly identified 173 of the 198 fully analysable participants with fundus mtmDR.

The results of this study show that the AI system in a primary care setting showed a sensitivity of 87.2% (>85%), a specificity of 90.7% (>82.5%), and an imageability rate of 96.1%.

AI-based diagnosis of Red Eye:

From a preliminary review, no previous studies concerned with AI-based etiological diagnosis of anterior segment conditions of the eye were found.

# 5. Feasibility

This approach seems feasible from our pilot study. We are creating a dataset of annotated images of the red eye, then training an AI model with the annotated images.

# 6. Data Availability

The images are to be obtained from the St John’s Medical College Hospital Ophthalmology Department. We are making and annotating a dataset of red eye images for this study. Currently there are no available datasets of red eye images, as concluded from a preliminary literature survey. Currently the test data cannot be made available to individuals outside SJNAHS, because of ethical concerns and policies. However we may be open to contributing to an open database in the future.

# 7. Data Quality

Our data is standardised and of high quality. The images are captured and annotated by expert ophthalmologists at SJMCH. We are interested in collaborating with other institutes to expand our dataset.

# 8. Annotation/label Quality

The annotations are relevant, of high quality and are made by expert ophthalmologists at SJMCH.

# 9. Data Provenance

The data is being collected in a professional and ethical way as per the guidelines set down by the Institutional Ethics Committee at SJMC. The data comes from both urban and rural clinical backgrounds as we are affiliated with various rural healthcare centres, from where we will be obtaining data.

# 10. Benchmarking

This section will be discussed in detail in future meetings.

# 11. Organizer

St John’s Medical College has conducted various programs to help primary health care workers and physicians to improve healthcare at the grassroots level. We have rural service centres across the country.

St John’s Research Institute has also worked with several start-ups on problems addressing the possible applications of AI in health care.

# 12. References

[1] Pflipsen, M., Massaquoi, M. and Wolf, S., 2016. Evaluation of the Painful Eye. American family physician, 93(12).

[2] Baba, I., 2005. The red eye–first aid at the primary level. Community Eye Health, 18(53), p.70.

[3] Cronau, H., Kankanala, R.R. and Mauger, T., 2010. Diagnosis and management of red eye in primary care. Am Fam Physician, 81(2), pp.137-144.

[4] Timlin, H., Butler, L. and Wright, M., 2015. The accuracy of the Edinburgh red eye diagnostic algorithm. Eye, 29(5), p.619.

[5] Gilani, C.J., Yang, A., Yonkers, M. and Boysen-Osborn, M., 2017. Differentiating Urgent and Emergent Causes of Acute Red Eye for the Emergency Physician. Western Journal of Emergency Medicine, 18(3), p.509.

[6] Abràmoff, M.D., Lavin, P.T., Birch, M., Shah, N. and Folk, J.C., 2018. Pivotal trial of an autonomous AI-based diagnostic system for detection of diabetic retinopathy in primary care offices. Npj Digital Medicine, 1(1), p.39.

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