# The Ultimate "Must Know" for Sustainable Diabetic Retinopathy Screening Program

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We all know that you can lose a foot, a kidney, an eye; one each, both or all to diabetes mellitus (DM).

We know what causes a lost eye. It is diabetic retinopathy (DR). The retinal changes being related to chronic levels of hyperglycemia leading to dysregulation and damage of retinal microvasculature. DR occurs in almost all individuals with DM. According to the World Health Organization (WHO), DR will continue to rise as the trend of DM rises. A global study in 2017 found that the leading cause of visual impairment and blindness, the "crude global prevalence in all ages", is DR.[1] Worldwide, DM continues to "thrive" as a pandemic with a WHO estimate of 642 million by 2040 which will invariably be associated with a continuing rise of DR; 1/3 of patients developing some retinopathy.[1]

We know who. The onus of responsibility to save vision rests on

1) the internist and/or optometrist who should make the referral to the EyeMD;
2) the EyeMD who documents the retinopathy, monitors changes and intervenes when needed with laser, intraocular drug injections or surgery: all evidence-based interventions; and
3) the patient who needs to realize that the entity of "asymptomatic diabetic retinopathy" is a reality and heed advice to go for retinal evaluation despite the absence of any vision problems.

We know why. It is because DM-associated sight loss or vision impairment can be prevented by early detection of the retinopathy. It is evident from the natural history of DR that there is a recognizable latent or early symptomatic phase. It is in this "window of time" that the retinopathy should be identified.

We know when. Patients with DM should be referred to the eyeMDs as a matter of course, since the progression of DR is gradual and *asymptomatic diabetic retinopathy* may be present. That is, patients should be referred for eye checks by their internists (1) immediately upon diagnosis of diabetes in Type 2 DM, (2) 5 years after diagnosis in Type 1 and (3) quarterly among pregnant women.[2]

We know how. It is via Diabetic Retinopathy Screening Programs. DR screening is one of WHO's recommended effective interventions for noncommunicable diseases. The purpose of a DR screening is to "identify people with diabetes who are at higher risk of developing sight-threatening DR so that early treatment or intervention can be offered to reduce the incidence of vision impairment or blindness"[1] that would impact on quality of life, psychological well-being, and economic productivity.

Currently, digital retinal photography is regarded as the most cost-effective method for DR screening taken through dilated or non-dilated pupils using slit-lamp biomicroscopic attached cameras, hand held cameras or smartphones. These photos can then be sent via teleophthalmology to remote imaging centers for interpretation and grading.

Teleophthalmology is the *antepenultimate must-know***.** It has proven to be reliable and cost efficient when compared to traditional clinical exams for retinal screening.[1] The advantage of telemedicine rests on its ability to transmit images to a central reading center for grading and data storage. This e-technology increases the opportunity to specialized eye care in rural and urban communities.[3,4]

For example, the United Kingdom for the first time in 5 decades, after 7 years of screening has been able to remove DR as the leading cause of legal blindness in the working population in England and Wales due to the early detection of DR by screening and improved control of blood sugar levels. This DR screening program in England screened 2.8 M people with a coverage of 83%.[5]

However, "even with teleophthalmology, the sheer volume of images that needs to be graded in a timely manner is a huge challenge" since manual grading by EyeMDs can be slow, time consuming, and costly. This is where artificial intelligence (AI) comes in (R. Salongay, personal communication, December 13, 2021).

AI is deep learning by a machine to detect and classify diabetic retinopathy based on fundus photos. AI is the *penultimate must-know*. AI can provide DR assessment at the point of care (R. Salongay, personal communication, December 13, 2021) identifying eyes with DR automatically, within minutes and can grade fundus images in the thousands.[6]

AI systems can further lower cost and increase patient access to DR screening. The challenge of AI is ensuring accuracy (i.e. specificity and sensitivity) that should be at par with how human graders/clinicians are performing. Additionally, legal/regulatory approvals on the application of this relatively new technology in healthcare must be secured (R. Salongay, personal communication, December 13, 2021).[7]

Teleophthalmology plus AI allow for expanded coverage of patients with problematic access to eye care. This e-health system fills in the gap which will take many years if we rely on a physician or a health professional to do the first line screening.[5]

This tandem of teleophthalmology and AI provides patients in remote and resource poor settings more equitable opportunities to prevent visual loss.[7] Digital photos sent to reading centers and graded by AI can effectively triage patients based on retinal findings. Minimal retinopathy are referred as less urgent follow up and the more advanced stages of retinopathy are referred for prompt ophthalmic care (R. Salongay, personal communication, December 13, 2021).

Locally, Dr. Paolo Silva together with the Department of Science and Technology – Philippine Council for Health Research and Development (DOST-PCHRD) and the United Kingdom Medical Research Council (UK-MRC) launched the UK-Philippines Remote Retinal Evaluation Collaboration in Health: Diabetic Retinopathy (REACH-DR). This collaborative team was successful in validating an AI algorithm in Nueva Ecija. They completed a DR screening project in a community that identified the presence of DR in the population using a handheld retinal camera imaging device.[5]

Likewise, the Vitreoretina Society of the Philippines (VRSP) together with the National Institute of Health-Philippine Eye Research Institute (NIH-PERI) have set up a plan to do "telescreening" using portable cameras and AI (J. Pajarillo, personal communication, December 13, 2021).

Recently, resources have been slowly shifting from handheld cameras to smartphones to capture digital retinal images. The smartphone shows promise as an effective means for detecting patients with DR. Smartphones are accessible, portable, and affordable. They can be used in remote communities with limited access to retina specialists and/or more sophisticated fundus cameras to allow for screening and monitoring of patients with DR under the guidance of retina subspecialists via teleophthalmology.[8,9,]

The potential of the smartphone to help in DR screening combined with telemedicine has been the

subject of several fellow and resident research papers. There have been a few local studies evaluating the efficacy of dilated (pupil) smartphone fundus imaging to screen for DR, namely Duyongco *et al.* in 2018 (Dilated smartphone imaging for the detection and grading of diabetic retinopathy, unpublished data), Locaylocay *et al.* in 2019 (Utilization of dilated smartphone fundus imaging for screening of diabetic retinopathy in an urban community setting in Pasig City, Philippines, unpublished data), Chacon in 2017 (Proposed approach in the development of a digital fundusccopic viewing system, unpublished data), and Retinopathy of Prematurity by Chao *et al.* in 2015 (Determination of the validity and reliability of using smartphone imaging as a screening tool for referral-warranted retiniopathy of prematurity [RW-ROP]: a pilot study , unpublished data) as well as anterior segment diseases by Orteza-Sorra in 2021 (Designing a smartphone application for anterior segment photography in ophthalmology, unpublished data).

However, dilation of pupils will still need the supervision of eyeMDs to ensure a patient's eye safety. This brings the issue back to the dirth of manpower and the cost of training. Thus, it would seem that the capability to take smartphone retina photos through undilated pupils is the *ultimate must-know* in order to sustain a DR screening program. Sustain being defined as the ability to preserve and maintain the mission of DR screening programs to ensure that every patient with DM gets screened at appropriate intervals and those with vision-threatening disease are properly identified and offered treatment options if required (R. Salongay, personal communication, December 13, 2021).

The use of smartphones can empower every diabetic patient to take their own retinal image at the recommended intervals then send them via teleophthalmology to a prescribed reading center with AI capability. Undilated smartphone fundus photos will relieve the dilemma of cost, accessibility, ease of use; allow for continuous screening and not just a one-time screening test, allow for follow-up, monitoring and very importantly facilitate recording, tracking, referral, overall feedback and importantly constant, durable communication with each patient.[1]

It is the adaptation of the common smartphone to take fundus photos that will increase patient compliance with doctor visits.[1] Afterall, the success of a DR screening program hinges on the compliance of the patient with the recommendations given them by the DR screening program, i.e. to consult when asked to. Otherwise, all efforts of a DR screening program become moot.

Smartphone digital retinal photos through dilated pupils for now; then, through *the ultimate must know:* undilated pupils in the near future, and teleophthalmology plus AI will contribute to the reality of efficient, effective wholistic and sustainable screening programs for diabetic retinopathy.

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