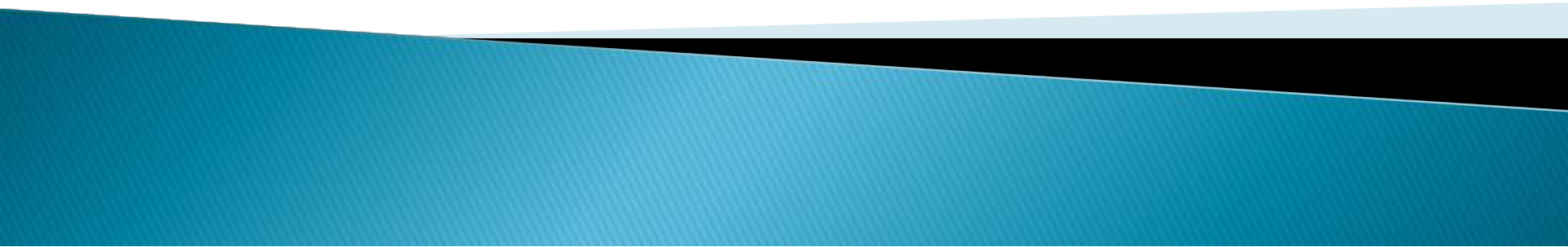


L'intelligenza artificiale nella gestione della retinopatia diabetica

Alberto Piatti
ASL To5





Feasibility and accuracy of the screening for diabetic retinopathy using a fundus camera and an artificial intelligence pre-evaluation application

A. Piatti¹ · F. Romeo² · R. Manti² · M. Doglio² · B. Tartaglino³ · E. Nada² · C. B. Giorda² 

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Abstract

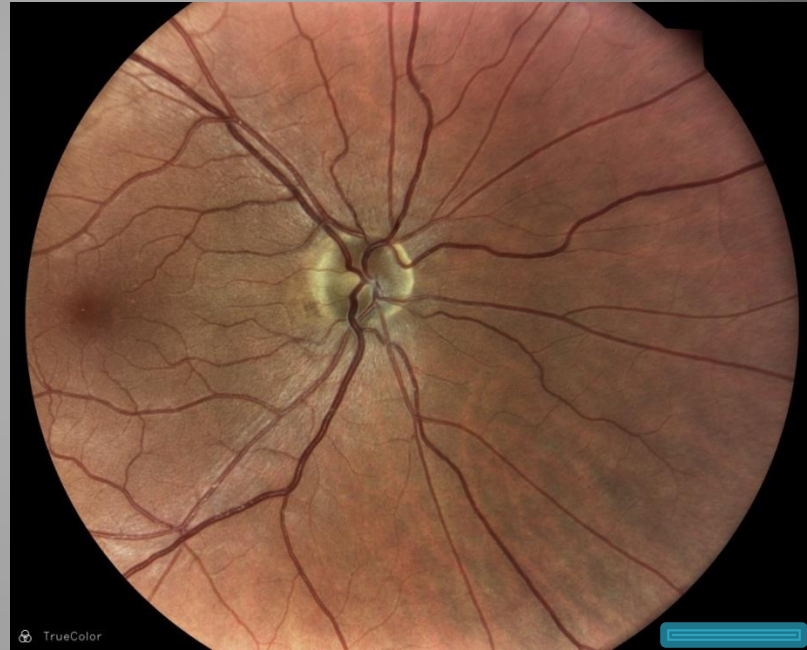
Aims Periodical screening for diabetic retinopathy (DR) by an ophthalmologist is expensive and demanding. Automated DR image evaluation with Artificial Intelligence tools may represent a clinical and cost-effective alternative for the detection of retinopathy. We aimed to evaluate the accuracy and reliability of a machine learning algorithm.

Methods This was an observational diagnostic precision study that compared human grader classification with that of DAIRET[®], an algorithm nested in an electronic medical record powered by Retmarker SA. Retinal images were taken from 637 consecutive patients attending a routine annual diabetic visit between June 2021 and February 2023. They were manually graded by an ophthalmologist following the International Clinical Diabetic Retinopathy Severity Scale and the results were compared with those of the AI responses. The main outcome measures were screening performance, such as sensitivity and specificity and diagnostic accuracy by 95% confidence intervals.

Results The rate of cases classified as ungradable was 1.2%, a figure consistent with the literature. DAIRET[®] sensitivity in the detection of cases of referable DR (moderate and above, “sight-threatening” forms of retinopathy) was equal to 1 (100%). The specificity, that is the true negative rate of absence of DR, was 80 ± 0.04 .

Conclusions DAIRET[®] achieved excellent sensitivity for referable retinopathy compared with that of human graders. This is undoubtedly the key finding of the study and translates into the certainty that no patient in need of the ophthalmologist is misdiagnosed as negative. It also had sufficient specificity to represent a cost-effective alternative to manual grade alone.

SCREENING CON RETINOGRAFO DIGITALE SENZA MIDRIASI



Screening digitale

polo posteriore



nasale





Ordinamento Default

Diario



curante - Si rinvia al curante per controllo Glicemia e Hb Glicata tra 3 mesi
cardio - Si consiglia di esegui...

Anamnesi



Ateromasia vasi epiaortici -
Con stenosi <60%

Occhio



Non Retinopatia Diabetica
RETINOGRAPHIA in MIOSI

Rene



Non nefropatia diabetica
(albuminuria <30 mg/24 h o
<20 µg/min o <30 mg/g
creatinina o <3 mg/mmol cre...

Cuore



ECG - Nella norma
ECG NELLA NORMA

Vasi
perifericiNervi
periferici

Visite Occhio



Nuova Data

28/10/2019 07/12/2017 30/08/2013

Classificazioni

Aggiungi

Storico Diagnosi

Descrizione	Dal	Al	Ricovero
Non Retinopatia Diabetica	30/08/2013		No

Prestazioni



Modifica

Data	Descrizione	Referto	Risultato
28/10/2019	Fotografia fundus (retinografia) - occhio destro		
28/10/2019	Fotografia fundus (retinografia) - occhio Sinistro		

Questionario ipercolesterolemia

Note

Modifica

RETINOGRAPHIA in MIOSI

Ultima modifica:PIATTI Piatti (28/10/2019 14:54)

BMI / Peso

23/10/2019 28,0 / 81,0

20/11/2018 28,7 / 82,8

Aggiungi

Mostra altri

C-LDL

02/10/2019 - / 111,8

16/10/2018 - / 97,2

Aggiungi

Mostra altri

Creatinina / GFR

02/10/2019 1,17 / -

16/10/2018 1,02 / -

Aggiungi

Mostra altri

HbA1c

02/10/2019 62,0 / 7,8

16/10/2018 50,0 / 6,7

Aggiungi

Mostra altri

PAS / PAD

23/10/2019 120 / 70

26/10/2018 120 / 70

Aggiungi

Mostra altri

Smart Digital Clinic - Paziente: DAIRET1 TEST, Data di nascita: 27/02/1960, 60 anni

PAZIENTI

SCHEDA

ESAMI

TERAPIE

DATA MANAGEMENT

DASHBOARD

PEDIATRIA

DOCUMENTI

ASSISTENZIALE

SCREENING

Schede

Tarifario nazionale

Contratto Terapeutico

Allegati

Eventi

Promemoria

FollowUp

Anagrafica

STATISTICHE

UTENTI

Ordinamento Default

Diario

Anamnesi

Occhio

Rene

Cuore

Vasi periferici

Nervi periferici

Piede

Vasi cerebrali

Visite Occhio

Nuova Data

27/02/2020

Classificazioni

Aggiungi

Prestazioni

Aggiungi

Questionario ipercolesterolemia

Nota

Aggiungi

DAIRET

Modifica

Risultato elaborazione: Screening Positivo - Raccomandato approfondimento oftalmologico

9001066400_20190905145402766.jpg

9001066400_20190905145401026.jpg

9001066400_20190905145358552.jpg

9001066400_20190905145355838.jpg

BMI / Peso

Aggiungi

Mostra altri

C-LDL

Aggiungi

Mostra altri

Creatinina / GFR

Aggiungi

Mostra altri

HbA1c

Aggiungi

Mostra altri

PAS / PAD

Aggiungi

Mostra altri

Score Q

nessun dato

nessun dato

Screening della retinopatia diabetica

SENSITIVITY RATE

CLASSIFICATION OF RETINAL IMAGES BY MANUAL GRADE

- ▶ R0 : no retinopathy
- ▶ R1 : mild non proliferative retinopathy
- ▶ R2 : moderate non proliferative retinopathy
- ▶ R3 : severe non proliferative retinopathy

RETINOPATHY GRADE (by manual grade)	DaiRet Sensitivity (95% confidence interval)	FN
R1	0,69 (± 0,09)	0,31
R2	1	0

637 patients were included, enrolled between june 2021 and february 2023

Screening della retinopatia diabetica

SPECIFICITY RATE

RETINOPATHY GRADE (by manual grade)	DaiRet Specificity (95% confidence interval)	FP
R0	0,80 (± 0,04)	0,20

Piatti A, Doglio M, Tartaglino B, Nada E, Giorda CB : Diabetic Retinopathy Screening with Artificial Intelligence: A Pivotal Experience in Italian Healthcare System – Preliminary Report . DOIJ – RA – 22-275, 2022,

Diabetic retinopathy screening with confocal fundus camera and artificial intelligence - assisted grading

European Journal of Ophthalmology
1–10

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R. Manti⁴, M. Doglio⁴, E. Nada⁴ and C.B. Giorda⁴

Abstract

Purpose: Screening for diabetic retinopathy (DR) by ophthalmologists is costly and labour-intensive. Artificial Intelligence (AI) for automated DR detection could be a clinically and economically alternative. We assessed the performance of a confocal fundus imaging system (DRSplus, Centervue SpA), coupled with an AI algorithm (RetCAD, Thirona B.V.) in a real-world setting.

Methods: 45° non-mydratic retinal images from 506 patients with diabetes were graded both by an ophthalmologist and by the AI algorithm, according to the International Clinical Diabetic Retinopathy severity scale. Less than moderate retinopathy (DR scores 0, 1) was defined as non-referable, while more severe stages were defined as referable retinopathy. The gradings were then compared both at eye-level and patient-level. Key metrics included sensitivity, specificity all measured with a 95% Confidence Interval.

Results: The percentage of ungradable eyes according to the AI was 2.58%. The performances of the AI algorithm for detecting referable DR were 97.18% sensitivity, 93.73% specificity at eye-level and 98.70% sensitivity and 91.06% specificity at patient-level.

Dati del paziente

Identificativo paziente	PLYE5sSUIBgA
Nome paziente	-
Numero di accesso	-

Data dell'esame	31-10-2022
Data di elaborazione	31-10-2022

Raccomandazione per il paziente

Risultato dell'analisi RetCAD™
Nessuna anomalia rilevata.

Raccomandazione
Nessun follow-up consigliato.



Qualità dell'immagine a destra: buona



Qualità dell'immagine a sinistra: buona



RetCAD™ interpretazione dei risultati

Retinopatia diabetica (RD)
punteggio si riferisce alla classificazione di
gravità ICDR*

- 0: No RD rilevata
- 1: RD Lieve rilevata
- 2: RD Moderata rilevata
- 3: RD Severa rilevata
- 4: RD proliferativa rilevata

* International Clinical Diabetic Retinopathy

RETINOPATHY GRADE (by manual grade)	RetCAD Sensitivity (95% confidence interval)	RetCAD Specificity (95% confidence interval)
REFERABLE ($\geq R2$)	98,70%	91,06%
NOT REFERABLE (R1)	90,97%	76,71%



Diabetic retinopathy screening telemedicine-based compared with standard of care : an economic analysis in a pilot experience of Italian healthcare

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© Associazione Medici Diabetologi / Association of Diabetologists (AMD), Società Italiana di Diabetologia / Italian Society of Diabetology (SID) 2025

Abstract

Purpose This study aimed to provide an economic analysis of the Local Health Authority Turin 5 (ASL TO 5) teleophthalmology diabetic retinopathy screening program.

Methods A retrospective chart analysis was performed on the diabetologists' digital folder to compare the costs of ASL TO5 screening program to the Italian standard of care based on in-office examination by ophthalmologist. The total cost was calculated for the two methods of screening. Mean annual unadjusted cost data per patient have been calculated by type of cost component.

Results The study included 3,635 patients with diabetes mellitus screened for diabetic retinopathy (DR) in 2023-24. The total (direct and indirect) cost for teleophthalmology screening program was € 48,976 while the estimated cost for the same quantity of patients screened with traditional examination by ophthalmologist would have been € 148,486. The mean cost per patient of telescreening was € 13.5 ± 5.3. Conversely traditional screening would have a mean cost € 40.9 ± 28 per patient (p-value < 0.001).

Discussion Advances in telemedicine are enhancing the DR screening strategies. Telescreening showed cost-savings of approximately € 100,000 for the Local Health Powered by Editorial Manager® and Prodxion Manager® from Aries Systems Corporation Authority ASL TO5 over a period of 2 years and for a screened population of 3,635. Telemedicine-based screening emerges as a less costly solution for the Italian National Health Service and can improve accessibility and compliance to this procedure.

Conclusions This study provides an economic analysis of teleophthalmology DR screening program and highlights significant implications for patients, healthcare professionals and policymakers.

Keywords Diabetic retinopathy screening · Teleophthalmology · Economic assessment

	Teleophthalmology-based screening			Traditional in-office examination			p-value
	mean	SD	%	mean	SD	%	
Direct medical cost	10,0	0	74,1	14,7	0	35,9	
Indirect costs							
Patient's productivity loss	3,5	5,3	25,9	18,5	28	45,2	
Caregiver's productivity loss				7,7	0	18,9	
overall	3,5	5,3	25,9	26,2	28	64,1	
Overall cost	13,5	5,3	100	40,9	28,0	100	0,000

In total 3635 individuals were screened over 2 years.

The prevalence of any DR was 16,8% in 2023 and 17,1% in 2024. The prevalence of mild DR was 13,2% in 2023 and 14,5 in 2024.

The total cost of telemedicine-based screening over the 2 years was € 48,976. In-office screening costs were estimated to be € 148,486

Unadjusted mean cost per patient by DR screening method (€)

AIMO AMD SID SISO

L'attuazione dello screening della retinopatia diabetica nella realtà assistenziale italiana

Documento intersocietario di buona pratica clinica

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Coordinamento: Carlo Bruno Giorda e Alberto Piatti

Vantaggi dell ' AI nello screening della retinopatia diabetica

1. Elevata accuratezza diagnostica: studi hanno dimostrato che alcuni algoritmi raggiungono sensibilità e specificità comparabili, se non superiori, a quelle degli specialisti umani.
2. Efficienza operativa: l'analisi automatica delle immagini consente di processare un elevato numero di pazienti in tempi ridotti.
3. Accessibilità: l'utilizzo di dispositivi portatili e la possibilità di analisi remota permettono di estendere lo screening a popolazioni difficilmente raggiungibili.
4. Standardizzazione: l'IA garantisce una valutazione uniforme delle immagini, riducendo la variabilità inter-operatoria.
5. Supporto decisionale: gli algoritmi possono fornire indicazioni utili per la gestione clinica, facilitando il triage dei pazienti.

2. Svantaggi e limiti

Nonostante i numerosi vantaggi, l'utilizzo di algoritmi IA presenta anche alcune criticità:

1. Qualità delle immagini: la performance degli algoritmi dipende dalla qualità delle immagini acquisite; immagini sfocate o con artefatti possono compromettere l'accuratezza diagnostica.
2. Bias nei dataset di addestramento: se i dati utilizzati per l'addestramento non sono rappresentativi della popolazione target, l'algoritmo potrebbe non generalizzare bene.
3. Implicazioni medico-legali: l'affidamento a sistemi automatizzati solleva questioni legali in caso di errori diagnostici.
4. Accettazione da parte del personale sanitario: l'integrazione dell'IA nella pratica clinica richiede un cambiamento culturale e formazione adeguata.
5. Privacy e sicurezza dei dati: la gestione delle immagini e dei dati dei pazienti deve rispettare le normative sulla privacy e garantire la sicurezza delle informazioni.

<https://doi.org/10.1038/s41746-024-01197-3>

Autonomous artificial intelligence for diabetic eye disease increases access and health equity in underserved populations



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Diabetic eye disease (DED) is a leading cause of blindness in the world. Annual DED testing is recommended for adults with diabetes, but adherence to this guideline has historically been low. In 2020, Johns Hopkins Medicine (JHM) began deploying autonomous AI for DED testing. In this study, we aimed to determine whether autonomous AI implementation was associated with increased adherence to annual DED testing, and how this differed across patient populations. JHM primary care sites were categorized as “non-AI” (no autonomous AI deployment) or “AI-switched” (autonomous AI deployment by 2021). We conducted a propensity score weighting analysis to compare change in adherence rates from 2019 to 2021 between non-AI and AI-switched sites. Our study included all adult patients with diabetes (>17,000) managed within JHM and has three major findings. First, AI-switched sites experienced a 7.6 percentage point greater increase in DED testing than non-AI sites from 2019 to 2021 ($p < 0.001$). Second, the adherence rate for Black/African Americans increased by 12.2 percentage points within AI-switched sites but decreased by 0.6% points within non-AI sites ($p < 0.001$), suggesting that autonomous AI deployment improved access to retinal evaluation for historically disadvantaged populations. Third, autonomous AI is associated with improved health



Diagnosis by machine legal aspects

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Editorial

> [Radiol Med](#). 2020 Jun;125(6):517-521. doi: 10.1007/s11547-020-01135-9.

Epub 2020 Jan 31.

Artificial intelligence: Who is responsible for the diagnosis?

Emanuele Neri ¹, Francesca Coppola ², Vittorio Miele ³, Corrado Bibbolino ⁴, Roberto Grassi ⁵

Affiliations + expand

PMID: 32006241 DOI: [10.1007/s11547-020-01135-9](#)



Grazie

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