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Teleretinography into diabetes integrated care: an Italian experience

Roberto Perilli[1], Rosamaria Di Biagio[2], Renato Seller[3], Luigi Ruotolo[4], Carla Granchelli[5], Valeria Marisi[5], Stefania Melena[6] and Agostino Consoli[2]

[1]*UOSD Oftalmologia Sociale Territoriale, AUSL Pescara, Italy*
[2]*UOC Endocrinologia e Malattie del Metabolismo, Centro di Diabetologia, AUSL Pescara, Italy*
[3]*General Practitioner, Pescara, Italy*
[4]*opeNETica srl, Montesilvano, Pescara, Italy*
[5]*Dipartimento di Prevenzione, AUSL Pescara, Italy*
[6]*Servizio Prevenzione e Tutela Sanitaria, Assessorato Sanità, Regione Abruzzo, Pescara, Italy*

Abstract

Introduction. Integrated care, by allowing information exchange among health professionals, improves outcomes and favours a reduction in hospital admission in diabetes. Retinal complications can be sight-threatening, and diabetic patients often miss the suggested yearly clinical examination.

Methods. Teleretinography can be easily performed in patients attending Diabetes Clinics: images are sent to a remote ophthalmologist, grading and instructions are received and forwarded to General Practitioners by a dedicated software.

Results. We here report the results of teleretinography performed in our Diabetes Clinic in 362 patients missing the yearly fundus examination: 253 patients showed no diabetic retinopathy, 86 a mild form, and 23 needed referral to hospital settings.

Conclusions. Teleretinography is a user-friendly, time-saving and cost-effective technique, easily integrable into integrated care, allowing a better adherence to guidelines.

Key words

- integrated care
- teleretinography
- telemedicine
- ocular fundus examination
- diabetic retinopathy screening

INTRODUCTION

Population and financial factors drive public health's efforts toward a cost-effective "integrated care" (IC) model of chronic disease management; interaction between primary and secondary care structures prevents providing the patient with fragmented (if not conflicting) inputs from different health professionals, and decreases demand for hospital admissions [1, 2]. In diabetes, several studies have shown that IC is associated with an improvement in metabolic control indicators (HbA1C, blood pressure, serum lipids, body mass index) and a reduction in hospital admission [1, 3-5]. In Italy, the diabetes IC programme (IGEA, Integration, Management and Assistance to the Diabetic patient) started in 2009 [6].

Teleretinography (digital imaging of the ocular fundus) is a simple, cost-effective and rapidly spreading technique [7-10], and relevant international scientific societies recommend its use for diabetic retinopathy (DR) screening [11, 12], with several reports [13-17] showing its clinical- and cost-effectiveness. In the UK, all eligible diabetic patients are annually telescreened in the NHS Diabetic Eye Screening Programme (DESP) [18].

A national survey in Italy [19] showed that no more than 20% of diabetic patients undergo a yearly fundus examination, thus jeopardizing early identification of incipient DR.

Patients routinely attending our Diabetes Clinic (DC) in Pescara, Italy, have their fundus photographed with a digital fundus camera. Images are sent to a remote ophthalmologist ("store-and-forward" method), and grading and follow-up recommendations are forwarded to the General Practitioners (GPs). Cases needing referral are rapidly sent to the ophthalmology service.

Patients enrolled in IC have their clinical fundus examination replaced with teleretinography. We report the results of a 10-month experience of digital fundus imaging in patients who had missed routine controls in ophthalmic settings.

MATERIALS AND METHODS

An asp.net technology-based software was implemented (QUICKConnect, opeNETica, Montesilvano, Pescara, Italy), allowing a complete data exchange among the different data archiving softwares used by the GPs. GPs attended courses to manage the software and to share common guidelines on diabetes treatment, and were asked to send patients to the DC for fundus

Address for correspondence: Roberto Perilli, UOSD Oftalmologia Sociale Territoriale, AUSL Pescara, DSB Pescara Nord, Via Nazionale Adriatica Nord 140, 65123 Pescara, Italy. E-mail: roberto.perilli@ausl.pe.it.

examination, an alternative to retinal examination in an ophthalmic setting.

From January to October, 2014, 362 diabetic patients: 207 males (57.18%) and 155 females (42.82%); ages 21-82, median 63; 9 type I (2.48%) and 353 type II (97.52%), at their first admission in our DC and missing the yearly fundus examination, underwent retinography with a digital fundus camera (DRS, CenterVue, Fremont, CA, USA). All patients were dilated with Tropicamide 1% (Visumidriatic 1%, Visupharma, Italy). Median time from drop administration to exam was 20 minutes (10-35). Time for personal data recording and image taking, operated by non-medical personnel, ranged from 5 to 10 minutes. No additional cost beyond those of the instrument and drops was required.

A set of two 40x45 images was taken in each eye, one centered at the optic disc and the other at the fovea. On a "store-and-forward" basis, the records were sent to an ophthalmologist trained in DR, who examined both a color and a digitally filtered red-free image for every field, and graded diabetic retinopathy accordingly with the NHS-DESP classification *(Table 1)* [20, 21]. Grading and suggested follow-up were sent back to the DC in a week's time, downloaded by diabetologists into the patients' electronic records, and forwarded to GPs. Admission to hospital ophthalmic settings was immediately planned for cases needing referral.

The procedure was routinely performed with the patients' informed consent (both for pupil dilation and for image management), and data collected in compliance with the tenets of the Declaration of Helsinki. The present note is a report of routine clinical practice, and is not intended as an observational study.

Table 1
Diabetic retinopathy lesions classification

Level R0 – None

Level R1 – Background
- Microaneurysm(s)
- Retinal haemorrhage(s) ± any exudate

Level R2 – Pre-proliferative
- Venous beading
- Venous loop or reduplication
- Intraretinal microvascular abnormality (IRMA)
- Multiple deep, round or blot haemorrhages
- Cotton wool spots (CWS – careful search for above features)

Level R3 – Proliferative
- New vessels on disc (NVD)
- New vessels elsewhere (NVE)
- Pre-retinal or vitreous haemorrhage
- Pre-retinal fibrosis ± tractional retinal detachment

Maculopathy (M0 – nil present, M1 – maculopathy)
- Exudate within 1 disc diameter (DD) of the center of the fovea
- Circinate or group of exudates within the macula
- Retinal thickening within 1DD of the centre of the fovea (if stereo available)
- Any microaneurysm or haemorrhage within 1DD of the centre of the fovea only if associated with a best visual acuity of ≤ 6/12 (if no stereo)

Photocoagulation (P)
- Focal/grid to macula
- Peripheral scatter

Unclassifiable (U)
- Ungradable/unobtainable

RESULTS

The involvement of GPs in the IGEA project has been rapidly growing, with 156 out of 196 doctors (79.6%) participating since the beginning of the project in January 2014, becoming 176 out of 196 (89.8%) at October 2014. The amount of diabetes-related records exchanged (GPs to diabetologists and viceversa) grew from 349 in January to 1264 in October. After ten months, 89.8% of GPs had a total 73% of their diabetic patients enrolled in IC. Patient data *(Figure 1)* showed an increase in: number of HbA1C measurements; HbA1C values < 7.5% (< 58 mmol/mol); LDL-cholesterol < 130 mg/dl (< 3.3 mmol/L); blood pressure (BP) < 130/80 mmHg; number of creatinin measurements. A slightly lower result appeared in the number of body mass index and BP measurements, what immediately led to correct clinical routine.

All retinal images were clear enough to be graded. Among the 362 patients *(Table 2)*, 253 R0M0 (69.89%) and 86 R1M0 (23.75%) were invited to repeat retinography in a year's time; 10 R1M1 (2.76%), 8 R2M0 (2.21%) and 4 R2M1 (1.10%) were referred to ophthalmology within two weeks; one R3M1 (0.25%) with preretinal hemorrhage was immediately referred to ophthalmology for treatment. Comorbidities were identified, some of which needing referral to the hospital setting for further diagnosis and therapy: 151 patients with various stages of Age-Related Macular Degeneration (ARMD, ranging from isolated drusen to atrophy and neovascularization, 41.71%); 54 with hypertensive retinopathy (Keith-Wagener-Barker's stage II or more, 14.91%); 18 with suspect glaucomatous cupping of the optic disc (4.97%); 8 with vitreoretinal interface shrinking (2.20%).

DISCUSSION

A meta-analysis of 53 controlled trials [1] showed a statistically significant reduction (up to 19%) in the risk of hospitalization for diabetic patients enrolled in IC programs. A German experience in the region of Saxony [3], involving 75% of GPs, 100% of diabetologists and about 90% of the diabetic population, was aimed at HbA1c and blood pressure control. A narrowing of the regional differences in therapeutic management and outcome and an approximation to targets as defined by the guidelines were obtained. The authors highlighted the importance of both the timely referral of patients to the diabetologist by the GP and the improved competence in the disease treatment by the GP, trained in quality workshops provided by diabetologists, and stated that collective disease management data exchange and discussion was crucial for the success of the program, helping breaking down barriers between the two care levels. A Saudi-Arabian experience [4] led the Authors to state that "dynamic tailoring of the care components in response to patient's need may have contributed to improved glycemic control". In Ireland, a guideline on IC was produced [5] involving patients, GPs, practice nurses, diabetologists, clinical nurses specialist in diabetes, dieticians, ophthalmologists and podiatrists, with a facilitated access to endocrinology, vascular, cardiology, nephrology and psychology servic-

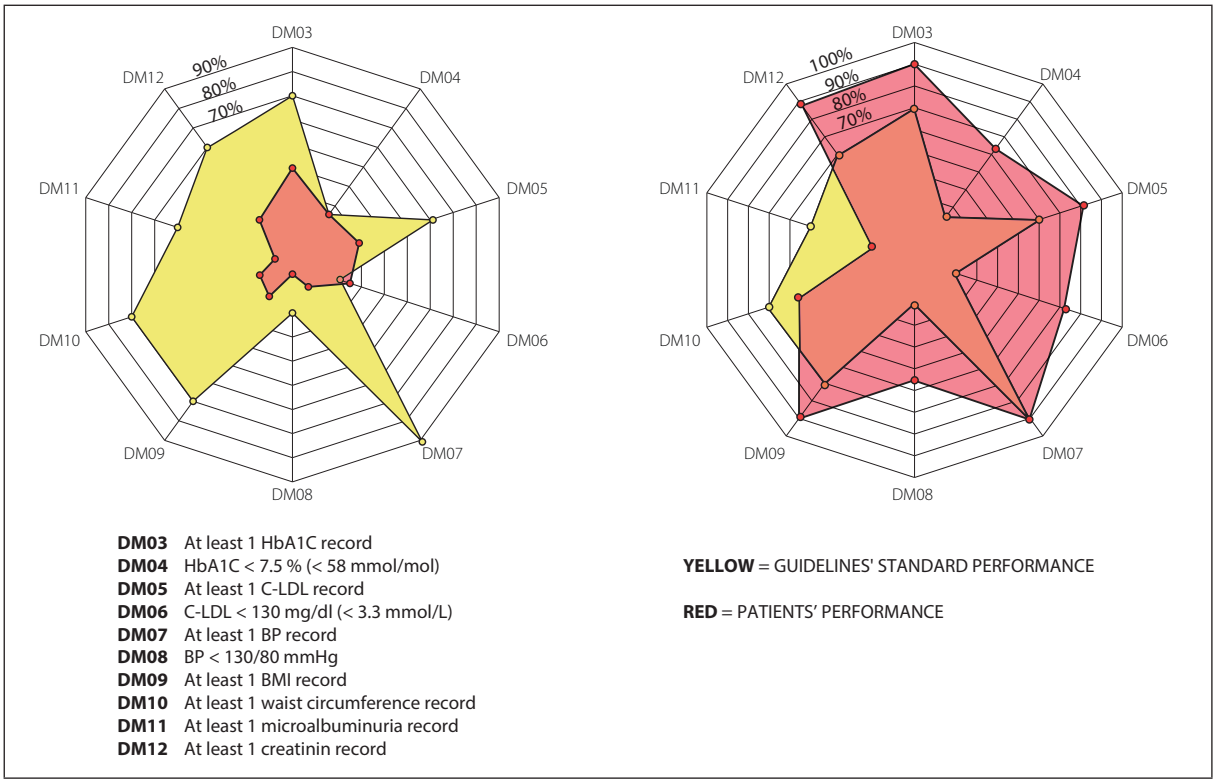

Figure 1
Patients' performance: not in integrated care (left) – in integrated care (right).

es as needed, stressing the fundamental importance of the "register-review-recall" paradigm.

A 2004 report [22] highlighted the fundamental importance of involving primary care clinicians in preventing vision loss from chronic eye disease.

In Italy, the IGEA project [6, 23], managed by the Ministry of Health and the Istituto Superiore di Sanità, was implemented in 2009 to improve the quality of care by: guaranteeing effective intervention for all persons with diabetes, measuring both processes and outcomes; promoting multi-disciplinary care teams involving primary and secondary care levels; aiming at the diffusion of the model to the entire Country accordingly with local organizations.

Table 2
Distribution of pathologies

Pathology	Patients	Percentage
Diabetic retinopathy, stage		
• R0M0	253	69.89
• R1M0	86	23.75
• R2M0	8	2.21
• R1M1	10	2.76
• R2M1	4	1.10
• R3M1	1	0.25
Age-related macular degeneration	151	41.71
Hypertensive retinopathy*	54	14.91
Glaucoma suspect	18	4.97
Vitreoretinal interface syndrome	8	2.20

*Keith, Wegener, Barker stage II or more.

Implementation of IGEA in our DC involving diabetologists, GPs and an ophthalmologist started in January, 2014.

The ACCORD study [24] showed that DR is related to cardiovascular events, thus acting as a marker of systemic disease. Allowing an *in vivo* visualization of small vessels, the retina is also a marker of microangiopathy, which is linked to serum lipids [25], blood pressure [26] and microalbuminuria [27]. Within the retina, a correlation has been shown [28] between microaneurysm turnover and development of clinically significant macular oedema, one of the main causes of blindness worldwide.

The strong value of retinography in identifying both ocular and systemic diseases is well known [29, 30].

In our DC, teleretinography has become part of IC, and images, grading and suggested follow-up are available online to both diabetologists and GPs in a few days. Our results confirm that poorly compliant patients can show referable stages of retinal microangiopathy and/or comorbidities. Teleretinography helped starting a proper care pathway and informing patients about the serious consequences of missing periodical examinations.

CONCLUSIONS

We consider retinal microangiopathy a clinical outcome in IC. Performing teleretinography in the DC overcomes the problem of limited access of patients to clinical fundus examination [19, 31, 32], allowing a better EBM-based follow-up of patients. The camera is operated by non-medical personnel, ophthalmologists' worktime for fundus examination (in Italy, scheduled

outpatient time is 15-20 minutes) is reduced, and images can be graded out of clinical routine.

Portable fundus cameras [33], with images conveyed to reading centres, can help extend the screening activity to the entire network of GP practices, to assure a standardized and capillary diffusion of early detection of retinal microangiopathy. We believe that the slight GPs' overwork in dilating the patients' pupils is worth the result of an increased diabetic population coverage.

Our ongoing experience in DR telecreening is aimed at paralleling the UK effort in covering the entire diabetic population, by taking fundus photographs in every patient attending the DCs and the GP practices, and calling the unattending ones.

In 2003 UK produced a complete HTA report on digital imaging in DR [34]; recently, it established a protocol [35] to define an HTA on the attendance to DR controls, reporting as an early indicator of the success of the NHS Diabetic Eye Screening Programme [18] the drop in the numbers of blindness certifications attributable to diabetic retinopathy in England and Wales in working age adults (16-64 years), from 17.7% in 1999 to 2000 to 14% in 2009-2010. In Italy, the incidence of blindness from diabetes is 2-3 cases/100 000/year under age 70, and 6-12 cases/100 000/year over age 70 [36]. Blindness from DR is avoidable in most cases, and the UK experience shows the effectiveness of early identification and treatment [37], thus fulfilling both the 1968 Wilson and Jungner's [38] and the 2008 World Health Organization's [39] criteria for screenings.

Conflict of interest statement

None.

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