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The Integration of Diabetic Eye Screening into Hemodialysis Units in Northern Ireland

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Key Points

- Previous literature shows people with type 2 diabetes and CKD are more likely to have sight-threatening retinopathy.
- Our study shows that many people attending for dialysis often fail to attend their annual diabetic eye screening appointments.
- High levels of sight-threatening diabetic retinopathy were found in people on dialysis, showing the importance of screening in these clinics.

Abstract

Background Diabetes is rising globally and is the most common cause of both end-stage renal disease and blindness. People on hemodialysis have to attend several dialysis appointments per week, which can affect their attendance at diabetic eye screening. In addition, previous literature suggests patients on hemodialysis are more likely to have sight-threatening diabetic eye disease. This study aims to determine attendance at the Diabetic Eye Screening Program in Northern Ireland, diabetic retinopathy severity, and use of handheld retinal imaging in people with diabetes attending hemodialysis units in Northern Ireland.

Methods All patients with diabetes attending hemodialysis clinics regionally were screened and graded by the Diabetic Eye Screening Program in Northern Ireland using a handheld and/or conventional nonmydriatic fundus camera.

Results All eligible people ($N=149$) were offered a Diabetic Eye Screening Program in Northern Ireland appointment, 132 attended, 34% of whom had not been seen in >3 years and 15% of whom had never attended the Diabetic Eye Screening Program in Northern Ireland despite multiple previous appointments. Altogether, 13% required urgent referral to hospital eye services, which is significantly higher than the national average of 0.4%.

Conclusions Those on hemodialysis are at high risk for sight-threatening diabetic retinopathy. Implementing the Diabetic Eye Screening Program in Northern Ireland in hemodialysis clinics enables timely diagnosis and referral.

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Introduction

Global prevalence of diabetes among adults has risen from 5% in 1980 to 9% in 2014 and is the most common cause of both end-stage kidney disease (ESKD) and blindness (1). Approximately 20%–30% of patients with type 1 and 2 diabetes mellitus suffer from chronic kidney disease (CKD) (2). In addition, a study of 28,344 patients with type 2 diabetes found those with CKD are more likely to present with sight-threatening diabetic retinopathy (STDR) (3). Some patients with CKD require hemodialysis up to three times a week, making it difficult to attend other appointments, including their annual Diabetic Eye Screening Program (DESP).

The most recent UK Renal Registry report (4) shows that 35%–38% of patients on renal replacement therapy (RRT) are on in-clinic hemodialysis (ICHD). As of 2019, there were 556 people on ICHD (29% of RRT patients). Their median age was 72.2 years (67.5 years in the United Kingdom), and 61% were men. The majority (98%) were White in comparison with the rest of the United Kingdom. It was suggested that approximately 28% of those on ICHD had an initial cause due to diabetes in the United Kingdom.

This study assesses the attendance at the DESP and diabetic retinopathy (DR) severity in patients with diabetes undergoing hemodialysis in Northern Ireland.

Materials and Methods

Between April and October 2021, all people with diabetes undergoing renal dialysis were offered their

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annual diabetic eye screening (DES) in their renal dialysis unit (RDU). Macula and disc-centered fundus images were taken of each eye by a qualified DESP photographer using a Canon CR-2 nonmydriatic tabletop camera and Optomed Aurora Handheld Fundus Camera. Anterior segment images were taken where media opacity was present. All patients were dilated using 1% tropicamide. Images were double graded by qualified DESP graders using the United Kingdom national grading definitions of no visible retinopathy (R0), background retinopathy (R1), preproliferative retinopathy (R2), active proliferative retinopathy (R3A), stable proliferative retinopathy (R3S), no maculopathy requiring referral (M0), and maculopathy requiring further evaluation (M1). Demographic information, DR grade, and date of last appointment were recorded.

Statistical analyses were conducted using IBM SPSS Statistics for Windows v26 (IBM Corp., Armonk, NY). Basic frequency analysis was conducted for demographics, DR grade, and DESP attendance.

This project was given audit Caldicott Guardian approval from the Quality and Audit department in the Belfast Health and Social Care Trust, audit ID 6039. Written consent was not required from participants because this project was undertaken as a service improvement and audit within the DESP. After explanation of what would happen during their DES appointment, consent was obtained and recorded on the system by the screener/graders.

Results

Between April and October 2021, 149 people were invited to the DESP in their respective RDU. Of the 149 patients, 132 attended. Seventeen did not attend their appointment due to medical emergencies or RDU nonattendance that day. Of the 132 attendees, 59% (n=88) were men, and the age range was 33–91 years. One was known to have had a central retinal vein occlusion, and two had no perception of light before screening.

The vast majority (96%) arrived at their RDU in wheelchairs, with only 20% able to transfer to the photography chair. Canon nonmydriatic imaging was possible in 92% (122), whereas handheld imaging was possible in all patients. Ten patients could only be imaged by handheld camera due to being on stretchers or large wheelchairs.

Of those screened in 2021, 28 (21%) had no DR (R0), 36 (27%) had background DR (R1), and 30 (23%) had STDR (R2, R3A, R3S) in their worst eye. Seventy-seven (58%) patients had no maculopathy (M0), whereas 14 (11%) did (M1). Thirty-five (27%) patients required slit lamp referral due to media opacities. Three (3%) were ungradable for maculopathy (Table 1). These results can be seen in Table 1.

Compared with previous DESP results, progression from no DR to background DR was seen in seven patients, whereas nine patients progressed from background to STDR. One person progressed from STDR to no perception of light. Of those who did not attend before, STDR was detected in seven, and three had background DR. The treated stable proliferative DR in three patients reactivated and required treatment. Stable DR was documented in 73 patients. The rest had no previous DR grades due to nonattendance or DNA, slit lamp, or referral to hospital eye services.

Only 36 patients had been screened in the previous 18 months, whereas 42 had an interval of >2 years, 21 had an interval of 3 years, and 26 had >4 years of nonattendance due to conflicting appointments. Twenty-one patients had never attended the DESP before, and three were too sick to attend at all.

Of the 52 patients imaged on the Optomed handheld fundus camera, 38 had gradable images on both the handheld and tabletop cameras. When handheld images were graded by an independent trained grader, 21 (55%) were in full agreement with grades from tabletop imaging, and 13 (34%) had grades within one level of background/no DR (R0/R1). Four grades were not in agreement, with two having had STDR on handheld missed. These patients lacked a disc-centered image.

In-built artificial intelligence on Optomed Aurora handheld camera was used on the images of a small cohort of 17 patients. Of these, 15 had a grade on the conventional camera and for ground truth. Artificial intelligence agreed with eight of the human graders' conventional camera image decision, whereas four did not. No STDR was missed. Three patients' images were ungradable.

Of those referred urgently, six patients have been seen and treated by hospital eye services, three failed to attend, and five are still awaiting suitable appointment. Three

Table 1. Diabetic retinopathy results from screening in hemodialysis units and progression results

Grade	Total from Screening in Renal Dialysis Unit, %	Progression from Previous Retinopathy	Total
Retinopathy grade (worst eye)		Stable retinopathy	73
No retinopathy (R0)	28 (21%)	No retinopathy→background retinopathy	7
Background retinopathy (R1)	36 (27%)	Background retinopathy→sight-threatening retinopathy	9
Sight-threatening retinopathy (R2, R3A, R3S)	30 (23%)	Sight-threatening retinopathy→no perception of light	1
Maculopathy grade			
No maculopathy (M0)	77 (58%)		
Maculopathy (M1)	14 (27%)		
Other			
Referred for slit lamp	35 (27%)		

patients had died since referral to the hospital. Of those referred routinely, two were invited to hospital eye services, with only one attending and one to be seen in 6 months.

Discussion

To our knowledge, this is the first study to integrate DESP into hemodialysis clinics across a whole region. Our results show that approximately 24% had STDR, with 17 (13%) requiring urgent and three (2%) requiring routine referral to hospital eye services. This is several times higher than indicated in 2016/2017 by the English National Screening Programme report, where 2% required routine and 0.4% required urgent referral (5). Although a relatively small number of people require hemodialysis, our study showed that the number of patients requiring DR referral is alarming. They represent a high-risk group for sight loss, and our data suggest that providing the DESP at the time of dialysis is vitally important for identifying those requiring treatment.

Although there is existing literature on reasons for nonattendance in the general population and other groups (6,7), there is a scarcity of evidence for this at-risk group. This patient group has important competing priorities because they must attend their hemodialysis units three times per week, rendering it difficult to attend other health-related appointments. In addition, these patients may have limited knowledge on other complications and might assume that they will be taken care of by the renal team for all aspects of their diabetes care. They might also struggle to find transportation to appointments, and some have significant ill health that renders them unable to attend elsewhere. Although this study has small numbers, it includes all people on hemodialysis with diabetes in Northern Ireland. A larger study across the United Kingdom or island of Ireland could give further insight into attendance at DES and severity of retinopathy in this cohort. The causes and dangers of the progression of retinopathy are difficult to establish. Previous literature shows that age, duration of diabetes, type of diabetes, and other comorbidities can affect the level of retinopathy (8,9); however, reports can be conflicting according to each population. Therefore, future research should also take into account diabetes control, duration of diabetes, and effect on quality of life.

In conclusion, those on hemodialysis represent a high-risk group requiring referral for STDR. Provision of eyecare at the time of hemodialysis is especially important for preserving quality of life because these patients rely on activities such as reading or watching television during the 3-hour-long hemodialysis appointments.

Disclosures

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Author Contributions

P. Blows, L.N. Cushley, T. Peto, and N.B. Quinn were responsible for conceptualization and for the investigation; P. Blows, L.N. Cushley, and N.B. Quinn were responsible for data curation; L.N. Cushley was responsible for formal analysis; L.N. Cushley and E. McKeever wrote the original draft of the manuscript; L.N. Cushley, T. Peto, and N.B. Quinn were responsible for methodology; T. Peto was responsible for supervision; and all authors reviewed and edited the manuscript.

Data Sharing Statement

Data cannot be deposited into a repository because it contains patient data under Caldicott guardian permission and is not a clinical trial. They are local data from the health care trusts in Northern Ireland. Should a person require the data, they can contact the corresponding author to discuss.

References

1. Sarwar N, Gao P, Seshasai SR, Gobin R, Kaptoge S, Di Angelantonio E, Ingelsson E, Lawlor DA, Selvin E, Stampfer M, Stehouwer CD, Lewington S, Pennells L, Thompson A, Sattar N, White IR, Ray KK, Danesh J; Emerging Risk Factors Collaboration: Diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease: A collaborative meta-analysis of 102 prospective studies [published correction appears in *Lancet* 376: 958, 2010 10.1016/S0140-6736(10)61452-3]. *Lancet* 375: 2215–2222, 2010 https://doi.org/10.1016/S0140-6736(10)60484-9
2. Shahbazian H, Rezaii I: Diabetic kidney disease; Review of the current knowledge. *J Renal Inj Prev* 2: 73–80, 2013
3. Lee WJ, Sobrin L, Kang MH, Seong M, Kim YJ, Yi JH, Miller JW, Cho HY: Ischemic diabetic retinopathy as a possible prognostic factor for chronic kidney disease progression. *Eye (Lond)* 28: 1119–1125, 2014 https://doi.org/10.1038/eye.2014.130
4. UK Renal Registry: UK Renal Registry 23rd annual report—Data to 31/12/2019. Bristol, United Kingdom: UK Renal Registry, 2021
5. Scanlon PH: The English National Screening Programme for diabetic retinopathy 2003–2016. *Acta Diabetol* 54: 515–525, 2017 https://doi.org/10.1007/s00592-017-0974-1
6. Cushley LN, Curran K, Quinn NB, Bell A, Muldrew A, Graham UM, McCance DR, Wen Q, Peto T: Diabetic retinopathy screening programme: Attendance, barriers and enablers amongst young people with diabetes mellitus aged 12–26 years. *Int J Transl Med* 1: 154–162, 2021 https://doi.org/10.3390/ijtm1030011
7. Piyasena MMPN, Murthy GVS, Yip JLY, Gilbert C, Zuurmond M, Peto T, Gordon I, Hewage S, Kamalakannan S: Systematic review on barriers and enablers for access to diabetic retinopathy screening services in different income settings. *PLoS One* 14: e0198979, 2019 https://doi.org/10.1371/journal.pone.0198979
8. Marshall G, Garg SK, Jackson WE, Holmes DL, Chase HP: Factors influencing the onset and progression of diabetic retinopathy in subjects with insulin-dependent diabetes mellitus. *Ophthalmology* 100: 1133–1139, 1993 https://doi.org/10.1016/S0161-6420(13)31517-6
9. Rasoulinejad SA, Hajian-Tilaki K, Mehdipour E: Associated factors of diabetic retinopathy in patients that referred to teaching hospitals in Babol. *Caspian J Intern Med* 6: 224–228, 2015

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See related editorial, "Seeing the Light: Improving Diabetic Retinopathy Outcomes by Bringing Screening to the Dialysis Clinic," on pages 1474–1476.