

Impact of Socioeconomic Disadvantage and Diabetic Retinopathy Severity on Poor Ophthalmic Follow-Up in a Rural Vermont and New York Population

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Objective: To investigate the impact of socioeconomic disadvantage and diabetic retinopathy severity on follow-up for vision care among people with diabetes mellitus (DM) residing in rural Vermont and northern New York State.

Methods: A retrospective chart review of people with DM who visited our academic eye clinic at least once between October 1, 2015, and March 31, 2016, was done. Of 1,466 unique patient visits, 500 were chosen for full chart review by simple random sampling. DM follow-up within 1 year was recommended for 331 adults. Data about prescribed and actual follow-up intervals were extracted. Regression models were used to identify factors associated with poor attendance at follow-up appointments.

Results: Sixty-eight [20.5%] patients had poor follow-up, defined as no ophthalmology visit within double the prescribed interval. Of these, 57 were not seen in follow-up by the end of study observation. Poor follow-up was greatest among socioeconomically disadvantaged patients, as defined by Medicaid enrollment (odds ratio [OR], 1.95; 95% CI, 1.07–3.56) in comparison to non-disadvantaged patients. Follow-up was better among those with moderate or worse diabetic retinopathy (OR, 0.38 95% CI, 0.20–0.70), and those with macular edema (OR, 0.19; 95% CI, 0.057–0.62).

Conclusion: Medicaid insurance and better diabetic retinopathy status were associated with worse follow-up among our predominantly rural population of patients. Patients who did not follow-up within double the recommended interval were unlikely to follow-up at all. Interventions are needed to target those at highest risk for poor follow-up.

Keywords: diabetes mellitus, socioeconomic disadvantage, rural medicine, follow-up attendance

Introduction

Diabetic retinopathy (DR) is the leading cause of blindness among working-aged adults in the United States, affecting approximately 4.2 million Americans¹ and 93 million people worldwide.^{2,3} Although strict guidelines have been adopted by the International Council of Ophthalmology, the American Academy of Ophthalmology, and many other professional organizations, screening rates have historically been quite poor, ranging from 35% to 65%.^{4–7} The reasons for poor screening are multifactorial, and complicated by the fact that diabetes itself is a known risk factor for appointment non-attendance in the general medical setting.^{8,9}

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While changes in systemic management have improved outcomes for many with diabetes mellitus (DM), and certain innovations like remote screening via ocular telehealth may improve screening rates, prevention of vision loss continues to require ongoing attendance at in-person ophthalmic follow-up.^{10,11}

To address these concerns, we identified factors associated with poor attendance at diabetic eye care appointments in a predominantly rural population through a retrospective chart review. The baseline established in this study may be used for developing tools that identify and assist patients at high risk.

Methods and Materials

Data Extraction

The approval of the University of Vermont Institutional Review Board (IRB) was obtained before conducting this study. The study was performed in accordance with the Health Insurance Portability and Accountability Act of 1996 and the tenets of the Declaration of Helsinki. This study was deemed minimal risk and given IRB waiver of consent. A retrospective chart review identified people older than 18 years of age with DM with or without DR seen in the offices of the University of Vermont Medical Center Ophthalmology Division at least once between October 1, 2015, and March 31, 2016. To identify people with DM, the following codes were selected from the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Clinical Modification (ICD-10CM): diabetes type I, no ocular complications (E10.9), diabetes type II, no ocular complications (E11.9), diabetes with unspecified diabetic retinopathy with macular edema (E10.311, E11.311), diabetes with unspecified diabetic retinopathy without macular edema (E10.319, E11.319), mild non-proliferative diabetic retinopathy (E10.321, E10.329, E11.321, E11.329), moderate non-proliferative diabetic retinopathy (E10.331, E10.339, E11.331, E11.339), severe non-proliferative diabetic retinopathy (E10.341, E10.349, E11.341, E11.349), and proliferative diabetic retinopathy (E10.351, E10.359, E11.351, E11.359). The date range was chosen as it coincided with the roll out of ICD-10 coding in the electronic health record at our institution and allowed for 24 months of follow-up before the conclusion of the study period on March 31, 2018.

The random number generator function in Microsoft Excel was used to (pseudorandomly) order the patient

records and the first 500 were selected from this list for manual chart review. The sample size for this exploratory study was selected to exploit our available resources and provide data for formal sample size calculations for future studies. Patients were included in the study group if they were prescribed a diabetes-related ophthalmology follow-up of any interval one year or less from the index visit. Patients with other ocular comorbidities were not excluded from the study. Follow-up was only considered completed if there was a dilated fundus examination recorded. It was only possible to assess patients for eligibility after a full chart review. Patients were excluded if they were less than 18 years old (n=1), self-pay (n=2), or had a recommended follow-up interval greater than 1 year (n=7). Demographic factors, insurance status, stage of DR, and diabetic macular edema (DME) diagnosis were extracted, as was the follow-up interval prescribed by the examining physician, and the achieved follow-up interval.

Statistical Analysis

Eligible patient charts were examined for follow-up attendance. Non-attendance or “poor follow-up” was defined as absence of follow-up in the medical record within an interval less than or equal to twice the prescribed duration.¹² Patients with Medicaid or Medicare with Medicaid insurance status were defined as “socioeconomically disadvantaged.” Demographic factors, including disadvantaged status, DR stage, and DME status were explored for association with poor follow-up in univariable and multivariable logistic regression models. Receiver-operating characteristic (ROC) curves were assessed for identifying individuals unlikely to follow-up using regression models with all available co-variables as well as automated models using forward and backward stepwise estimation for this exploratory analysis. Analyses were conducted using Stata 15 (StataCorp, College Station, Texas).

Results

Study Population and Nonattendance Rates

Upon an initial electronic health record (EHR) search, 1,466 unique ophthalmology visits by patients with diabetes were identified (Figure 1). Five hundred visits were randomly selected for further chart review. Of these, 331 patients (66.2%) who were recommended returning for DM-specific follow-up and met inclusion criteria were

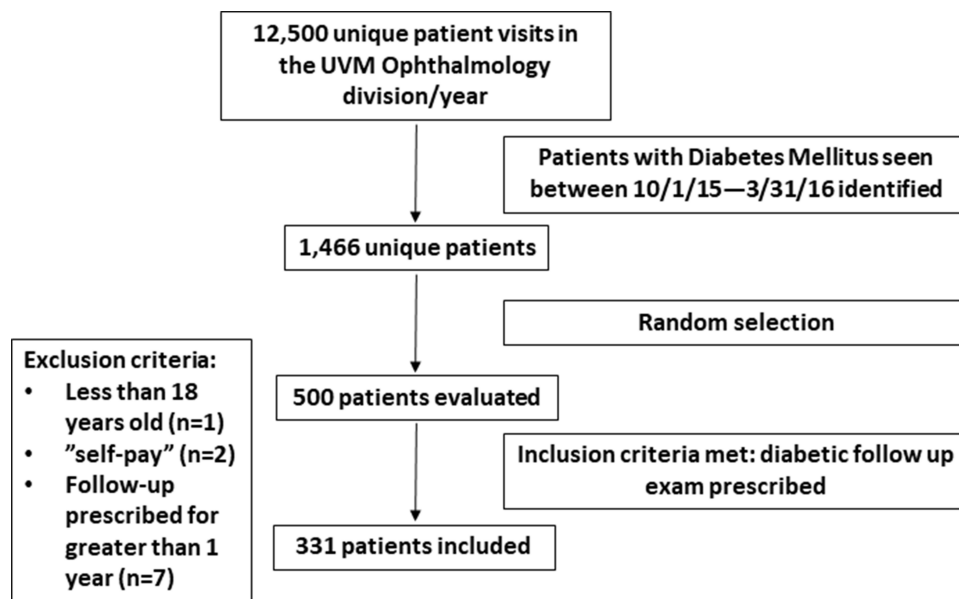


Figure 1 Study flowchart.

included in this analysis (Table 1). Sixty-eight (20.5%) patients qualified as poor follow-up and 57 (83.8%) of these had no ophthalmology follow-up visit at all as of the conclusion of the IRB-approved study window on March 31, 2018. The median prescribed follow-up was 365 days overall (interquartile range (IQR): 275) in both the poor follow-up (IQR: 305) and good follow-up (IQR: 185) groups (Supplemental Figure 1). Median patient age was 65 years (IQR: 16). One hundred forty-eight (44.7%) patients were females, and almost all patients (93.4%) were white. Seventy (21.4%) were categorized as disadvantaged as determined by Medicaid (n=24) or Medicare with Medicaid insurance status (n=46). DR severity ranged between none (n=178, 53.8%), mild (n=25, 7.6%), moderate (n=61, 18.4%), severe (n=8, 2.4%), and proliferative (n=59, 17.8%). Fifty-five (16.6%) patients were diagnosed with DME.

Risk Factors for Poor Follow-Up

Patients with disadvantaged status had 1.95 times greater odds of poor follow-up than non-disadvantaged patients in univariable regression (95% CI, 1.07–3.56; $P=0.03$). People with disadvantages were on average 5 years younger and had milder DR (Table 3). People with moderate or more severe DR had 0.38-fold lower odds of poor follow-up than those with mild or no DR (95% CI, 0.20–0.70; $P=0.002$, Table 2). Each step increase in DR severity conveyed 0.74-fold lower odds of poor follow-up (95% CI, 0.60–0.91; $P=0.004$) (steps defined as: “No DR,” “Mild Non-

proliferative diabetic retinopathy (NPDR),” “Moderate NPDR,” “Severe NPDR,” and “Proliferative DR”). The effect of moderate or worse DR severity persisted in a multivariable regression model adjusting for age, disadvantaged status, and follow-up interval length (OR 0.34 95% CI, 0.14–0.80, $P=0.013$). Patients with DME had 0.19-fold lower odds of poor follow-up (95% CI, 0.057–0.62; $P=0.006$) than those without. Older patients were more likely to attend follow-up for each increased decade of life, yet this data was not statistically significant (OR, 0.83; 95% CI, 0.67–1.03; $P=0.09$). Longer prescribed follow-up interval was also associated with poor follow-up, with 6 months or longer interval having 2.0-fold higher odds of poor follow-up than shorter intervals (95% CI, 1.07–3.74; $P=0.03$). Neither gender nor race was significantly associated with follow-up attendance. A multivariable logistic regression model incorporating all co-variables was used to generate a (ROC) curve (Supplement Figure 2) with an area-under-the-curve (AUROC) of 0.669. Forward and backward-selection stepwise estimation were used to generate logistic regression models, which identified disadvantaged status, DR severity and DME status as significant covariates. This model did not improve the AUROC (data not shown).

Discussion

Poor follow-up, as defined by the absence of attending a recommended ophthalmology appointment within double the prescribed follow-up interval, occurred in more

Table 1 Demographic Characteristics

	Poor Follow-Up (n=68)[95% CI] ^{a,b}
Overall (n=331)	20.5% [16.5–25.3]
Gender	
Female (n=148)	20.9% [15.0–26.7]
Male (n=183)	20.2% [15.1–28.3]
Race	
White (n=309)	20.1% [16.0–24.9]
Non-white (n=20)	30.0% [14.1–52.8]
Disadvantaged Status^c	
Yes (n=70)	30.0% [20.4–41.7]
No (n=261)	18.0% [13.8–23.1]
Age (Mean 63.7 ± 12.5) Quartiles	
<57 (n=83)	26.5% [18.1–37.0]
57–65 (n=94)	18.1% [11.5–27.2]
66–72 (n=72)	20.1% [12.9–31.8]
>72 (n=82)	17.1% [10.3–26.8]
Diabetic Retinopathy Severity	
1. None (n=178)	27.0% [20.9–34.0]
2. Mild (n=25)	20.0% [8.5–40.1]
3. Moderate (n=61)	11.5% [5.6–22.2]
4. Severe (n=8)	12.5% [1.7–53.9]
5. Proliferative (n=59)	11.9% [5.7–22.9]
Diabetic Macular Edema	
Yes (n=55)	5.5% [18.9–28.9]
No (n=276)	23.5% [18.8–28.9]

Notes: ^aPoor Follow-up defined as no visit within double the recommended follow-up interval. ^bOf 68 People with poor follow-up, 57 did not follow-up at all within the study window. ^cDisadvantaged = Medicaid, Medicare/Medicaid.

than one-fifth of patients in this study. Fewer than one in six of those who failed to attend in this time frame ever followed up within the 2-year observation window. This complete loss to follow-up (LTFU) is worrisome, as it is not clear if or when these individuals will return for

Table 3 Comparison of Patients by Disadvantaged Status

	Disadvantaged Status ^b (n=70)	Not Disadvantaged Status (n=261)
Poor Follow-Up ^a	30.0%	18.0%
Median Age (Interquartile Range)	59 (17)	66 (15)
Diabetic Retinopathy Severity (Mean) ^c	1.0	1.3
Macular Edema Present?	15.7%	16.9%

Notes: ^aPoor Follow-up defined as no visit within double the recommended follow-up interval. ^bDisadvantaged = Medicaid, Medicare/Medicaid. ^cSeverity on 5-point scale (see Table 1).

additional eye care. Because DR can be asymptomatic until rather advanced stages, it is probable that some of these individuals will lose vision owing to their failure to adhere to follow-up recommendations. The relatively high rates of poor follow-up and clinical LTFU parallel earlier studies in general diabetic populations,^{3,13–15} macular degeneration populations,¹⁶ glaucoma populations,¹⁷ and populations of DR patients undergoing laser treatments and/or intravitreal injections.¹⁸ Poor rates of follow-up attendance have also been reported following telemedicine screening for DR in both urban and rural settings.^{19,20}

We defined socioeconomically disadvantaged patients as those using Medicaid insurance with or without Medicare. In univariable analysis, these patients had a 1.95-fold increased likelihood of poor follow-up compared to those with commercial insurance or Medicare without Medicaid. In a model adjusting for age, DME status, and follow-up interval ordered, the effect of disadvantage was minimally blunted (OR: 1.83, 95% CI: 0.99–3.43, $p=0.055$). This finding is consistent with other studies which have found dual eligibility (Medicare with Medicaid) status to be a risk factor for poor follow-up in general medical settings.^{21–25} As is shown in Table 3, the

Table 2 Predictors of Poor Follow-Up

	Overall (n=331)	Good Follow-Up ^b (n=263)	Poor Follow-Up (n=68)	Odds Ratio (95% CI)	Univariable P-value
Disadvantaged ^a	21.1%	18.6%	30.9%	1.95 (1.07–3.56)	0.03
Median Age (Interquartile Range)	65 (16)	65 (16)	60.5 (18.5)	0.83 (0.67–1.03) ^c	0.09
Gender (% female)	44.7%	44.5%	45.6%	1.04 (0.61–1.79)	0.87
Race (% white)	93.9%	94.6%	91.2%	0.59 (0.22–1.59)	0.29
Diabetic Retinopathy Severity (Mean ^d)	1.2 (mild)	1.4 (>mild)	0.7 (<mild)	0.38 (0.20–0.70) ^e	0.002
Macular Edema Present	16.6%	19.8%	4.4%	0.19 (0.057–0.62)	0.006
Prescribed Follow-up in Days (Mean±SD)	236 (±144)	228 (±147)	267 (±126)	1.06 (1.00–1.13) ^f	0.046

Notes: ^aDisadvantaged = Medicaid, Medicare/Medicaid. ^bGood follow-up defined as completed visit within less than double recommended follow-up interval. ^cPer decade of age. ^dDiabetic retinopathy severity on 5-point scale (see Table 1). ^eModerate or more severe retinopathy as compared to mild or no retinopathy. ^fPer 30 days.

disadvantaged and non-disadvantaged groups were not balanced with respect to age and diabetes status, which limits our ability to adjust for all confounders given our sample size.

Conversely, worse diabetic retinopathy, the presence of diabetic macular edema, and shorter recommended follow-up were each associated with better follow-up in univariable models. Since these are interrelated concepts in the clinical context of diabetic retinopathy, it was not obvious a priori which covariate(s) would be independently associated with poor follow-up. In a multivariable model, DME status ultimately remained significantly associated with poor follow-up, perhaps because DME is likely to be under active treatment, whereas other DR states may be active or inactive. In particular, the correlation between DR status and follow-up interval may not be as perfect as we initially suspected (for example., a person with stable PDR without DME might be prescribed a 3–4-month follow-up, whereas a person with an active traction retinal detachment might require much more proximate follow-up, but both would be classified as the same severity of DR in our models). Previous psychological and behavioral studies have shown that diabetic patients who believe the severity of illness to be greater have better compliance rates and tend to be older,^{26,27} possibly supporting the need for more DR education and awareness in younger and less severely affected individuals.

The strengths of our approach include manual full-text review of the medical record to ascertain inclusion/exclusion criteria, DR diagnosis and follow-up interval. We feel this allowed for more robust data than a review of billing/claims data. Likewise, we included the full range of diabetic retinopathy states from diabetes without retinopathy to proliferative diabetic retinopathy. Finally, we had a sufficiently long observation window to follow all included patients for double their prescribed follow-up interval.

Our sample, while reflective of the general population of Vermont (94.5% white)²⁸ and perhaps other rural regions of the United States, is constrained by racial homogeneity that may limit generalizability to other populations. Our finding that white patients had 0.59-fold lower odds of poor follow-up when compared to non-whites was not statistically significant and was likewise unable to be further characterized for confounding due to very few participants of other races. Nevertheless, our results do compliment other studies conducted in more urban environments. Most notably are the findings from an urban study regarding follow-up after pan-

retinal photocoagulation or intravitreal anti-VEGF therapy for patients with proliferative diabetic retinopathy, which found 25.4% were lost to follow-up within 4 years of their procedure.¹⁸ The investigators identified an association between older age and higher income with improved follow-up. They also reported decreased rates of follow-up among African American, Hispanic, Native American, and Pacific Islanders as compared with Asian and white patients. Since the study included only patients with PDR, the authors were unable to comment on disease severity and loss to follow-up.

A second limitation of our study was our inability to determine if care was received elsewhere by our patients. It is possible that some patients we classified as not following up did indeed find care elsewhere, though the use of an electronic medical record did allow for confidence that all patient visits at our institution were able to be included. Another facet of patients classified as LTFU is that they may have followed up shortly outside our IRB-approved study window and not been captured.

Although our results do not consider all risk factors for poor follow-up, and several of our covariates are intimately linked such as retinopathy status, macular edema status, and prescribed follow-up interval, these data are important in the clinical setting for understanding the scope of the poor follow-up and for establishing interventions designed to improve outcomes among predominantly rural populations. While ROC analyses of our predictive models were not currently adequate for clinical use (AUROC: 0.669), they are encouraging about the potential for further work to develop predictive algorithms to alert clinicians through the EHR that a particular patient might be prone to poor follow-up. Such a system could be more robust than common recall systems. In the current system, people requiring follow-up within the University of Vermont Medical Center receive a letter three months in advance of their prescribed appointment time with instructions to call and schedule. Several studies have shown promise in creating personalized follow-up and education for ophthalmology patients.^{29–33} Future investigation ought to expand upon this research in other, diverse populations while considering additional risk factors such as occupation, education, and marital status.

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Disclosure

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