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Evaluation and Optimization of Diabetic Retinopathy Screenings for Uninsured Latinx Patients in a Resource-Limited Student-Run Free Clinic

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Abstract

Background: Diabetic retinopathy (DR) is a sight-threatening condition that causes progressive retina damage. Student-run free clinics represent a valuable opportunity to provide DR screenings to high-risk populations. We characterized the patient population, evaluated the performance, and conducted a needs assessment of DR screenings at the University of California, San Diego Student-Run Ophthalmology Free Clinic, which provides care to predominantly uninsured, Latino patients.
Methods: Retrospective chart review was conducted of all patients seen at the free clinic since 2019 with a diagnosis of type II diabetes. Date and outcome of all DR-related screenings or visits from 2015 onward, demographics information, and DR risk factors such as A1c and insulin dependence were recorded. Predictors of diabetic retinopathy and frequency of DR screenings for each patient were analyzed using multiple logistic regression, t-test for equality of means, and Pearson's correlation.
Results: Of 179 uninsured diabetic patients receiving care at the free clinic, 71% were female and average age was 59. 83% had hypertension, 93% had hyperlipidemia, and 79% had metabolic syndrome. Prevalence of non-proliferative DR was 34% and that of proliferative DR was 15% in diabetic patients. The free clinic capacity in recent years plateaued at just under 50% of patients seen for DR screening or visit per year, though average wait time was over 2 years between visits. Patients with higher no-show rates had less frequent DR screenings. Chronic kidney disease and poor glycemic control were the strongest predictors of DR.
Conclusion: The student-run free ophthalmology clinic has been effective in providing screening and follow-up care for DR patients. Creation of a protocol to identify which patients are at highest risk of DR and should be seen more urgently, addressing no-shows, and implementation of a tele-retina program are potential avenues for improving clinic efficiency in a resource-limited setting for vulnerable populations.

Introduction

Diabetic retinopathy (DR) is a sight-threatening complication of diabetes mellitus that causes insidious and progressive damage to the retina. Global prevalence of vision-threatening DR among individuals with diabetes has been estimated at 22.27%, and the burden is only expected to increase as the prevalence of diabetes increases.[1] DR is also estimated to account for 2.6% of all blindness worldwide.[2] Regular ophthalmic screenings to identify cases of DR that require timely management are essential.[3] DR represents a major healthcare challenge, particularly in low-income populations where individuals may lack access to eye care.[4] For example, the Los

Angeles Latino Eye Study found that Latinos developed visual impairment and blindness at the highest rate of any ethnic group in the country. The authors primarily attributed this to environmental factors such as access to care and socioeconomic background, and also found that lower family income was correlated with higher rates of DR and less disease awareness.[5] Another study found that DR causes 17% of visual loss in African Americans as compared to 8% in non-Hispanic Caucasians.[6]

Much research attention has been dedicated to disparities in DR screening and treatment for racial and ethnic minorities, who often present with more advanced stages at initial diagnosis.[7,8] According to a study examining self-reported barriers to regular eye exams, the most common reasons included too many other medical appointments, not being able to afford exam or copayment, being asymptomatic, not understanding the importance of regular screening, and transportation issues.[9] Low income, young age, immigration status, and mental health illness have additionally been identified as risk factors for being unscreened for DR.[10] Maximizing efficiency of DR screening and care is critical in primary care and resource-limited settings.

The focus of this study is the DR screening program of the University of California, San Diego (UCSD) Student-Run Free Clinic Project (SRFCP). The UCSD SRFCP, previously described by Beck in 2005,[11] provides free healthcare to predominantly uninsured, Spanish-speaking communities in San Diego. Patients receive primary care, from which they then receive referrals to specialty clinics ranging from dentistry to ophthalmology. The monthly ophthalmology specialty clinic is run by medical student leaders, supervised by volunteering ophthalmologists, and offers a limited number of DR screening and follow-up visits. The number of DR-related referrals from primary care exceeds clinic capacity. Therefore, scheduling DR visits for this clinic is determined by student leaders based on information included in the referral, including most recent A1c and due date for next DR visit. The clinic currently does not have a defined protocol for selection of patients from the referral waitlist.

The SRFCP offers a powerful opportunity to analyze and optimize DR screenings and care in a resource-limited setting that does not have the capacity to provide annual appointments to all eligible patients, and further represents a unique cohort of underinsured patients that would otherwise not be captured by billing or claims data. Student-run ophthalmology clinics have been broadly described in the context of medical education,[12-14] but the literature on the potential and performance of a student-run clinic for DR screenings, follow-ups and outcomes is sparse. In a study previously published by our group, we found that the coronavirus disease 2019 (COVID-19) pandemic significantly impacted DR screenings, with only 11.4% of eligible patients seen in 2020 compared to 46.1% of patients seen in 2021.[15] The purpose of this study was to characterize, evaluate and identify avenues to improve DR screening and care in a resource-limited setting. We start by describing the cohort of patients requiring DR screening and care at the UCSD SRFCP, including the prevalence of risk factors and DR in this population. We then analyze clinic performance by investigating potential gaps in care such as no-show rates and whether patients are being triaged effectively and scheduled for visits proportionally to their risk of DR. This formative study provides a needs assessment of an important public health intervention for a vulnerable population to understand past performance and to inform future improvements.

Methods

This study was approved by the UCSD Institutional Review Board as a quality improvement project and adhered to the tenets of the Declaration of Helsinki. A list of all patients seen at the UCSD SRFCP since 2019 with a diagnosis of type II diabetes was extracted from the institutional electronic medical record (EMR) Epic (2022, Epic Systems Corporation, Verona, WI) using International Classification of Disease (ICD) codes related to diabetes on the EMR problem list. Additional data including each patient's medications, medical diagnoses, demographics, and labs were extracted from the EMR data warehouse using standardized queries that excluded patients who had previously declined sharing their data ("mandatory research exclusion" per institutional policies).

From this list of patients, a retrospective chart review was conducted. Patients were excluded from the study if they were found to not have been regular patients of the UCSD SRFCP for more than a year from January 2015 to March 2022 or if they did not receive ophthalmologic care at the UCSD SRFCP because they were being cared for elsewhere. The year 2015 was chosen as the start of the study period because the period of time from 2013 to 2014 marked the clinic's transition and adjustment period to the new Epic EMR system. We define regular patients as being established and receiving routine care with a primary care provider at the clinic. This means, at bare minimum, seeing a primary care provider for an annual exam, although as the SRFCP specifically seeks to provide care for patients in medical need, most patients are followed by their primary care provider more closely.

The date and outcome of all DR screenings or follow-ups from January 2015 to March 2022 were recorded for each patient. The number of visits were totaled and tracked longitudinally throughout the study period in yearlong increments. Outcomes were classified as one of the following: no DR, mild non-proliferative DR (NPDR), moderate NPDR, severe NPDR, or proliferative DR (PDR). Other data recorded include whether the patient had a history of PDR or NPDR, whether the patient was receiving treatment for hypertension, whether the patient was insulin-dependent, average A1c each year from 2015 to 2022, approximate length of diabetes diagnosis (1 to <3 years, 3 to <6 years, 6 to 10 years, over 10 years), presence of diabetes related complications including chronic kidney disease (CKD) and cerebrovascular accident, body mass index (BMI), and no-show rate. No-show rate was obtained using a no-show predictive model based on random forest machine learning developed by the Epic Corporation.

The primary metric for DR visit frequency, years between visits, was computed by dividing the number of years that the patient was a regular patient at the UCSD SRFCP by the total number of DR-related visits or screenings that a patient received during that time. In a patient with diabetes and no prior DR diagnosis referred for annual screening, the optimum frequency would be 1 year between visits; and in a patient being followed closely after DR diagnosis, the optimum frequency would be higher with less than one year between visits.

Table 1. Comorbidities, complications of diabetes, and other risk factors for diabetic retinopathy in the UCSD SRFCP clinic population (N=179)

Characteristic	Diabetes patients (N=179), n (%)
Comorbidity	
Hypertension	148 (82.6)
On medication	143 (79.9)
Hyperlipidemia	166 (92.7)
Insulin dependence	106 (59.2)
Metabolic syndrome	141 (78.8)
With insulin dependence	89 (49.7)
Complications of diabetes	
Chronic kidney disease	
Stage II-III	13 (7.3)
Stage IV-V	12 (6.7)
Peripheral neuropathy	71 (39.7)
Limb amputation	2 (1.1)
Cerebrovascular accident	9 (5.0)
Other risk factors	
Duration of diabetes	
1 to <3 years	7 (3.9)
3 to <6 years	15 (8.4)
6 to <10 years	33 (18.4)
Over 10 years	124 (69.3)
BMI	
18.5 to 24.9 (normal weight)	9 (5.0)
25.0 to 29.9 (overweight)	58 (32.4)
30.0 to 34.0 (class I obesity)	48 (26.8)
35.0 to 39.9 (class II obesity)	32 (17.9)
>40.0 (class III obesity)	28 (15.6)
Unknown	4 (2.2)

UCSD SRFCP: University of California, San Diego Student-Run Free Clinic Project; BMI: body mass index.

Each patient's risk for sight-threatening DR was estimated using the QDiabetes risk calculator, a validated algorithm that takes into account factors such as age, A1c and length of diagnosis to determine a 10-year risk of blindness as a complication of diabetes.[16,17] From this, patients were grouped into low, medium, and high risk (based on tertile from calculated risk) for further analysis.

Table 2. Outcome of logistic regression analysis for risk factors predicting DR in the UCSD SRFCP population.

Variable	OR	Estimate	SE	p-value
Hypertension	1.35	0.30	2.00	0.5700
Hyperlipidemia	0.25	-1.37	0.53	0.1100
Insulin dependence	1.56	0.44	0.86	0.3800
Diabetes duration				
4 to 6 years	0.18	-1.72	-1.41	0.1600
7 to 10 years	0.49	-0.72	-1.25	0.2100
Chronic kidney disease				
Stages II-III	4.04	1.40	2.10	0.0360*
Stages IV-V	3.60	3.58	3.21	0.0013†
Amputation	1.62	0.48	0.29	0.7800
Male gender	0.78	-0.25	-0.58	0.5600
Age	0.98	-0.02	-0.96	0.3400
Glycemic control (average A1c)	1.32	0.28	1.99	0.0470*

**p<0.05; †p<0.005.*
DR: diabetic retinopathy; UCSD SRFCP: University of California, San Diego Student-Run Free Clinic Project; OR: odds ratio; SE: standard error.

Statistical Analyses

Multiple logistic regression analysis was performed with any kind of diabetic retinopathy diagnosis as the binary outcome variable and the following as predictors: gender, age, hypertension, hyperlipidemia, insulin dependence, duration of diabetes, CKD, history of amputation, and glycemic control (average A1c over years). Two-sample t-tests for difference of means were used to evaluate whether there were significant differences in mean years between visits for patients with PDR vs. those without PDR, and patients with NPDR vs. those without any diabetic retinopathy. We also calculated Pearson's correlation coefficients to examine relationships between no-show rates, glycemic control, and frequency of DR screenings. Significance was defined as $p<0.05$. All analyses were performed using either R software (v3.6.3, R Development Core Team, Vienna, Austria) or Microsoft Excel (v16.80, Microsoft Corporation, Redmond, WA).

Results

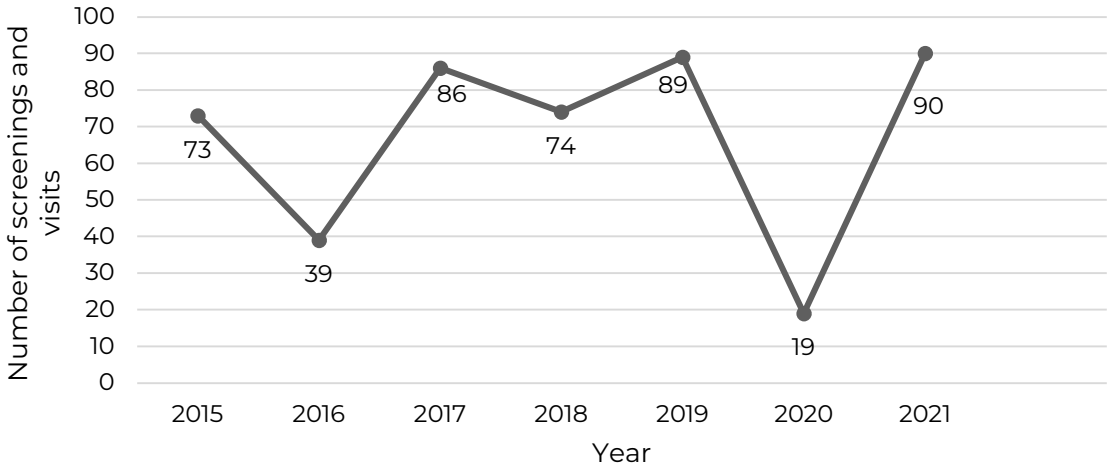
Initial electronic extraction generated a list of 199 patients who were diabetic and were seen at least once at UCSD SRFCP since 2019. Twenty patients were excluded based on eligibility criteria (e.g. not at SRFCP for at least a year or had received ophthalmic care elsewhere), leaving 179 patients.

Descriptive Analysis and Risk Factors of Clinic Population

Of these 179 patients, 127 (71%) were female and average age was 59 years. Table 1 lists descriptive characteristics of the clinic population in terms of well-established risk factors for DR.[18-20] Of the diabetic patients, 148 (82.6%) had hypertension, 141 (78.8%) had metabolic syndrome, 124 (69.3%) had diabetes for more than 10 years, and 166 (92.7%) of patients were overweight or obese based on BMI (Table 1).

Sixty patients out of 179 (33.5%) were found to have had NPDR, either identified during routine screening at UCSD SRFCP or recorded in their past medical history. This number includes the patients who went on to develop PDR. Twenty-seven patients out of 179 (15.1%) were found to have had PDR, either on screening at UCSD SRFCP or in their past medical history. In the logistic regression model (Table 2), advanced CKD (stages IV and V) emerged as the strongest predictor of DR, and glycemic control and early CKD (stages II and III) also emerged as significant predictors. Of note, in the definition of CKD stage V of GFR <15 (or dialysis) used for this analysis established by Levey et al.,[21] end-stage renal

Figure 1. Diabetic retinopathy screenings and visits by year at the UCSD SRFCP



UCSD SRFCP: University of California, San Diego Student-Run Free Clinic Project.

disease (ESRD) was included in CKD stage V.

Clinic Capacity and Performance

The number of patients seen for DR screening or follow-up annually at the UCSD SRFCP ophthalmology clinic is shown in Figure 1. Given that the maximum number of visits per year was achieved in 2021 with 90 visits out of 179 patients with diabetes eligible for annual exam, clinic capacity plateaus at just under 50% of patients screened per year. Low clinical volume in 2020 (n=19) reflects mandatory COVID-19 clinic closures.

Histograms showing the distribution of DR visit frequency for low risk, medium risk, and high risk patients (with risk defined by the QDiabetes risk calculator and grouped into tertiles) are depicted in Figure 2. On average, low risk patients were seen every 3.3 years with a standard deviation (SD) of 1.9 years, medium risk patients were seen every 2.8 years (SD 1.6 years), and high risk patients were seen every 2.9 years (SD 1.9 years). It should be noted that 26 out of 60 patients in the high-risk group for DR had an average gap of more than two years between visits for DR.

On average, patients with PDR were seen significantly more frequently than patients without PDR (1.3 years vs. 3.1 years between visits, $p<0.0005$), and patients with NPDR were seen significantly more frequently than patients without any diabetic retinopathy (1.9 years vs. 3.3 years between visits, $p<0.0005$).

Relationship between No-Show Rates and Diabetic Retinopathy

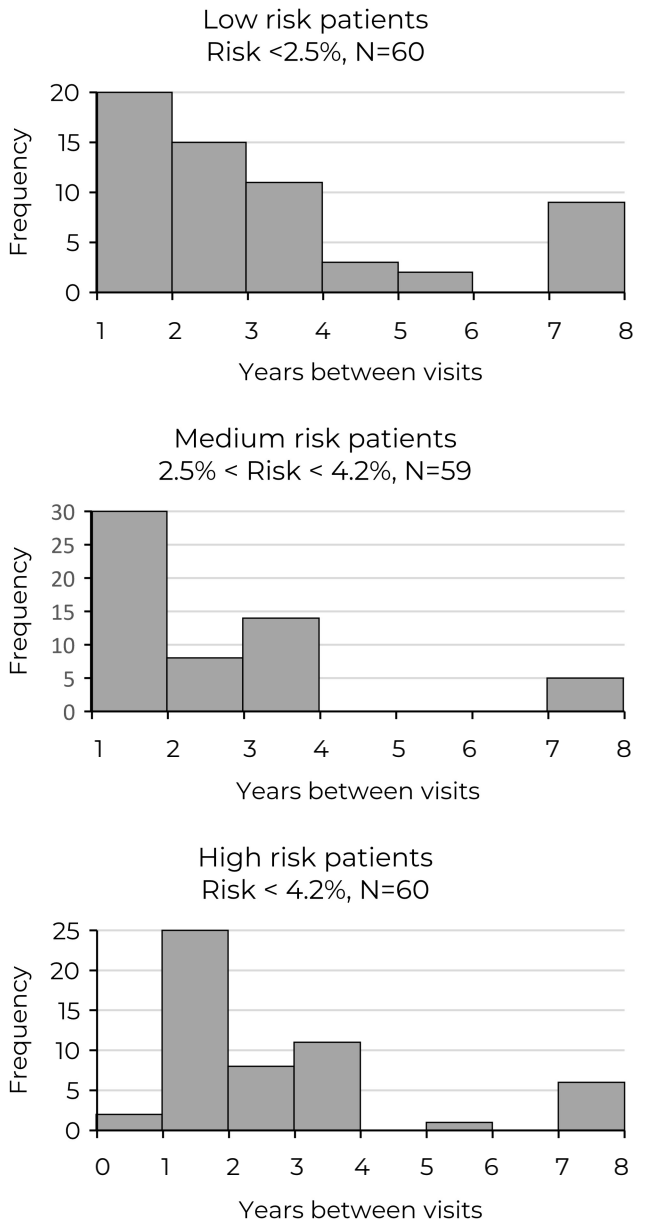
No-show rates were significantly correlated with poorer glycemic control as measured by A1c average across the study period (Figure 3; $r=0.41$, $p<0.0005$). Furthermore, patients with higher no-show rates had less frequent DR screenings ($r=-0.26$, $p<0.005$). Patients who had been diagnosed with any type of diabetic retinopathy had significantly higher no-show rates than patients who had not (17% vs. 13%, $p<0.05$).

Discussion

Student-run free ophthalmology clinics offer medical students early and hands-on exposure to ophthalmology[22] while providing specialized care to underinsured minority communities. Our findings demonstrate that the monthly ophthalmology free clinic at UCSD is currently able to provide screening and follow-up care for DR for up to nearly 50% of patients who receive referrals. However, several challenges remain, particularly with our findings that even some high-risk patients had several years between visits.

This project originated from a group of student leaders who faced challenges at the UCSD SRFCP determining how to schedule patients from long referral waitlists for ophthalmology clinics with limited capacity and sought to both optimize this process and identify avenues for future

Figure 2. Diabetic retinopathy visit frequency calculated as average number of years between visits per patient

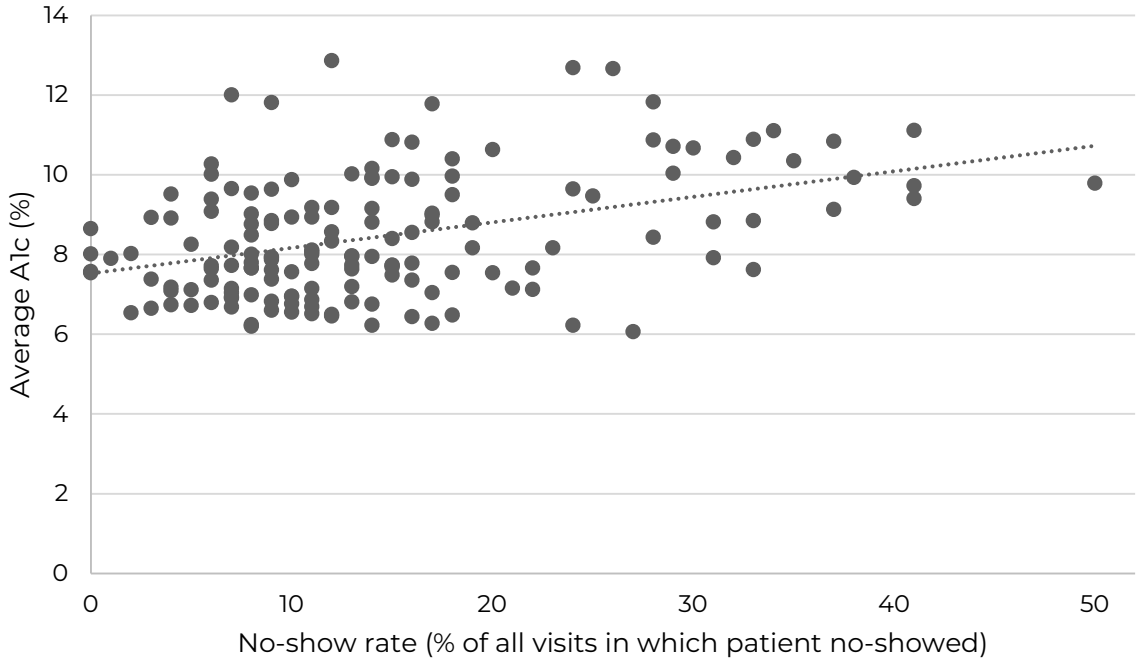


improvement. One way to improve the efficiency of the clinic is to identify which patients might be at highest risk for DR. Herein, we found that the UCSD SRFCP treats a uniquely high-risk population for DR, consistent with studies showing racial and ethnic disparities for diabetes and related comorbidities and complications.[8,23] Nearly 80% of UCSD SRFCP patients with diabetes had concurrent hypertension or metabolic syndrome, nearly 70% of patients had longstanding diabetes for greater than 11 years, and 92.7% met BMI criteria for overweight or obesity. This exceeds what has been previously reported in general populations; in a large retrospective cohort examining comorbidities with diabetes, overweight/obesity was estimated at 78.2%, and metabolic syndrome was estimated at only 67.5%.[24] The question then becomes how to identify patients who need to be seen most urgently in an already high-risk population. Our logistic regression model demonstrated that in the presence of many different risk factors, advanced stage CKD was the most powerful predictor of DR, followed by glycemic control. This is supported by a body of literature on the link between DR and CKD,[25-27] and could guide future management at free clinics serving a high-risk minority population by prioritizing patients with co-morbid CKD, particularly advanced stages.

These findings are relevant because the histograms in our study demonstrated that there were many high-risk patients who had over 2 years between appointments on average, while many low-risk patients were seen annually. The reasons for such need to be explored: it is possible that high-risk patients are also more likely to no-show or experience greater socioeconomic barriers to care. The 2022 American Diabetes Association (ADA) guidelines state that screening every 1 to 2 years may be considered in a patient without DR and well-controlled diabetes,[28] and the same interval has been proposed in low-resource settings.[29] This all points to risk triage as one promising area of improvement in the ophthalmology free clinic to alleviate high patient burden. If student leaders are educated on ADA guidelines and how to determine risk levels when scheduling patients, then the goal could be for high-risk patients to be seen annually while patients with adequate glycemic control can be safely followed up every two years.

No-show rates have been previously shown to correlate with poorer glycemic control,[30,31] however the relationship between no-show rates and diabetic retinopathy has been less explored. One study showed that consecutive number of missed appointments was associated with higher proportion of patients showing referable retinopathy at next visit,[32] and another study has shown that patients with DR often experience

Figure 3. Relationship between no-show rate and glycemic control



significant financial barriers leading them to avoid or delay care.[33] In our study, patients with any diagnosis of DR had higher no-show rates and higher no-show rates were also correlated with fewer DR screenings. This has clinical implications because at UCSD SRFCP, patients with high rates of no-show are often flagged on the waitlist and less likely to be scheduled. This is reflective of ongoing discussion over electronic no-show predictive models suggesting that characterizing certain patients or groups as a higher no-show risk may further widen healthcare disparities if these patients are consistently overlooked or scheduled into overbooked slots.[34] The opposite is needed and more attention—such as phone calls or increased education and outreach interventions—should be dedicated to reaching these patients who may be at higher risk of sight-threatening disease. Corroborating this, a recent 2023 study in a diverse primary care clinic found that telephone outreach and standardized automated reminders significantly reduced in-person no-show rates, and specifically reduced no-show disparities by improving access for minority patients.[35] In the UCSD SRFCP, volunteers typically call patients for appointment reminders, but the impact of this on patient no-show rates, and whether additional reach-out could benefit certain patients, has yet to be explored.

There were several limitations to this study. First, many longitudinal metrics such as A1c, BMI, and years between visits were averaged across time for analysis; however, this may not allow for nuanced analysis of change across those years. High-risk patients who were not seen for years at UCSD SRFCP in many cases had been diagnosed through our screening with severe DR requiring procedural treatment and referred through an organization called Project Access for outside retina care; every effort was made in this study to account for this by excluding time periods of documented outside ophthalmologic care from calculations. Furthermore, though QDiabetes was initially developed from a British population and the UCSD SRFCP sees a unique population demographic, the tool accounts for ethnicity and has been validated through multiple primary care databases, externally validated in a South Asian population as well international populations, and evaluated in systematic reviews.[17,36-40]

In light of our needs assessment, we acknowledge that while optimizing care through risk triage is important for clinics with limited capacity, the ideal and long-term goal is to increase

screening capacity. Autonomous artificial intelligence and tele-retinal screening has shown great potential for substantially increasing screening capacity in resource-limited settings.[41-43] The UCSD SRFCP is currently exploring this possibility through a retinal imaging device, with the goal of taking retinal photos for patients—possibly even during primary care visits—that could be subsequently screened, either by artificial intelligence or by a volunteer ophthalmologist, for diabetic retinopathy. The implementation of such is a promising direction for future study.

Utilizing tele-retina in a primary care setting, educating student leaders on ADA guidelines for diabetic retinopathy screening, and proper risk triage of patients could significantly improve clinic capacity and better address the preventative care needs of all patients referred for diabetic retinopathy screening. Here, we provide insight on the potential of a student-run clinic to provide in-person diabetic retinopathy screening and care. This study evaluated current performance of a student-run ophthalmology free clinic, characterizing the unique patient population as well as identifying multiple avenues for quality improvement that may be broadly applicable to other student-run free clinics serving high-risk populations.

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Disclosures

The authors have no conflicts of interest to disclose.

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