



# An Initiative to Improve Follow-up of Patients with Glaucoma

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**Purpose:** This study describes the implementation of an electronic medical record (EMR)-based initiative aimed at reducing the number of patients with glaucoma-related diagnoses lost to follow-up (LTF) and reviews its short-term outcomes.

**Design:** Retrospective, comparative case series.

**Participants:** Patients with glaucoma-related diagnoses seen 1 year prior at the Lahey Medical Center and who had not returned within the 6-month period between January 1, 2020, and June 30, 2020, which spanned the outbreak of the Coronavirus Disease 2019 (COVID-19) pandemic in the United States.

**Methods:** An EMR-based tool was designed to identify patients suspected of being LTF with glaucoma-related diagnoses. Providers were enlisted to review the EMR for each of these patients and re-engage them, as appropriate. One month later, the initiative was evaluated by means of a retrospective chart review. Binary logistic regression analysis was used to identify demographic, clinical, and sociomedical factors associated with being LTF.

**Main Outcome Measures:** Patients who completed a telemedicine or in-person appointment, or had a future scheduled or ordered return appointment, were considered re-engaged.

**Results:** Of the 3551 patients seen during the study period, 384 patients were identified as LTF (11%), with 60 identifying COVID-19 as the reason for canceling their visit (16%). Patients who lived farther from the eye clinic ( $P < 0.001$ ) or who had a history of canceling or missing an appointment ( $P < 0.001$ ) were more likely to be LTF. Patients with open-angle glaucoma ( $P = 0.042$ ) or who had completed a visual field ( $P < 0.001$ ) or ophthalmic imaging ( $P < 0.001$ ) within the past year were less likely to be LTF. One month after the re-engagement initiative, 124 LTF patients (32%) had been re-engaged (40% through telemedicine), 238 patients (62%) had future scheduling orders in place, and 22 patients (6%) had no active plan for future follow-up.

**Conclusions:** An EMR-based tool is an effective method for identifying patients at risk of being LTF and provides an opportunity for providers to recall and re-engage patients. Use of telemedicine to recontact LTF patients shows promise of improving the management of glaucoma, enhancing clinical productivity, and documenting treatment plans, thereby potentially reducing medicolegal liability. *Ophthalmology Science* 2021;1:100059 © 2021 by the American Academy of Ophthalmology. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Adherence to recommended follow-up for glaucoma has historically been poor, especially among asymptomatic patients or those with mild disease, with rates of “lost to follow-up” (LTF) as high as 46%.<sup>1-4</sup> The Coronavirus Disease 2019 (COVID-19) pandemic has increased the likelihood that patients with glaucoma will become LTF. In the first 6 weeks after the announcement of a statewide stay-at-home order in Massachusetts in response to the outbreak of COVID-19, total ophthalmology volume at our academic, multispecialty group practice decreased 86% and glaucoma visits, in particular, decreased 94%.<sup>5</sup>

This study presents a quality improvement (QI) initiative aimed at reducing LTF among patients with glaucoma-related diagnoses at an academic medical center. We used an electronic medical record (EMR)-based reporting tool to identify patients who were at risk of being LTF by virtue of not returning for follow-up care. We then enlisted providers to review the EMR for each of their patients and

re-engage them, as appropriate, through a combination of telehealth and office-based recall orders. We evaluated the efficiency and effectiveness of such an EMR-based program, and examined several readily obtainable EMR data elements and sociomedical factors with the aim of understanding which factors might be exacerbating LTF. It is our hope that this EMR-based strategy will be adopted to improve patient retention and ultimately enhance glaucoma care and outcomes.

## Methods

The research followed the tenets of the Declaration of Helsinki and was approved as a QI initiative by the Institutional Review Board of the Lahey Hospital & Medical Center, Burlington, Massachusetts. Information was gathered and secured in compliance with the Health Insurance Portability and Accountability Act. The

requirement for informed consent was waived because of the retrospective nature of the study.

Patients with glaucoma-related diagnoses seen 1 year prior at the Lahey Hospital & Medical Center and who had not returned within the 6-month period between January 1, 2020, and June 30, 2020, were identified from the Lahey Hospital & Medical Center EMR on the basis of billing records and were flagged for provider review. This period coincided with the outbreak of the COVID-19 pandemic in the United States. Deceased patients and those with future scheduled appointments were excluded. Patient demographics (age, gender, race/ethnicity, and primary language spoken), clinical characteristics (visual acuity [VA], intraocular pressure [IOP], central corneal thickness, cup-to-disc ratio [CDR], and type of glaucoma), and ophthalmology appointment data (completed, canceled, and no-show appointments in the preceding year, medication refill requests, and history of visual field testing or imaging of the retinal nerve fiber layer [RNFL]) were extracted from the EMR for each patient by means of a custom reporting tool. Patients with glaucoma were defined broadly by International Classification of Diseases 10th Revision, Clinical Modification codes and divided into 4 groups: glaucoma suspects (H40.0) including OHT (H40.05); open-angle glaucoma (H40.1), including primary open-angle glaucoma (POAG) (H40.10 and H40.11), low-tension glaucoma (H40.12), pigmentary glaucoma (H40.13), and pseudoexfoliation glaucoma (H40.14); primary angle-closure glaucoma (H40.2); and secondary forms of glaucoma including unspecified (H40.9). Distance to the nearest Lahey Hospital & Medical Center eye clinic was computed by using an Excel VBA program to access Microsoft Maps (Microsoft Corp.) that calculated the distance between each patient's home ZIP code and clinic ZIP code.

### Quality Improvement Initiative

Providers received a list of their patients designated as potentially LTF based on the results of the EMR report and were asked to review the charts and re-engage patients, as appropriate, by means of telemedicine or scheduling orders for future recall in the EMR. Because the definition of potentially LTF was 6 months without being seen, providers were made aware that some of the patients identified in the report might not actually be due for return visits. Providers were not informed that the results of this initiative would be reviewed 1 month later to determine the efficacy and efficiency of this strategy.

### Review of Quality Improvement Initiative

One month after this QI initiative, an EMR audit was performed by manually reviewing the charts of all patients sent to providers to ascertain their LTF status and to determine if the LTF status had changed as a result of the program. Patients who had scheduling orders that were not yet due (or due within the next 30 days relative to the start of the program) or had documented transfer of care to an outside provider were considered not to be LTF. Engagement by the program was divided into the following categories: patients who had completed (or scheduled) a telemedicine visit or in-person visit, those who declined follow-up when contacted, and those for whom a new scheduling order had been submitted during the period of the program. A review of existing scheduling orders in the EMR was also performed to determine if patients who remained LTF had an active, but overdue, scheduling order, an expired order (or an order that had been marked as completed in error), or no scheduling order placed at the time of their last follow-up. For patients who were LTF and had canceled or did not attend

their most recent scheduled appointment, the reason for the missed appointment was noted, when known. Medication refill requests during the study period were also tabulated.

### Statistical Analysis

SPSS Statistics version 27.0 (IBM Corp) was used to analyze data. Categorical variables are presented as percentages and compared using the 2-sided chi-square test with significance judged at the 5% level ( $P < 0.05$ ). Data for continuous variables are recorded as mean  $\pm$  standard deviation and compared using the 2-sided Student *t* test with significance judged at the 5% level ( $P < 0.05$ ). Binary logistic regression analysis was used to identify demographic, clinical, and sociomedical factors associated with being LTF. For the logistic regression of multiple variables, we used a generalized linear model to determine the association between the variables included in the model and LTF status. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for each variable with significance of the obtained results judged at the 5% level ( $P < 0.05$ ).

## Results

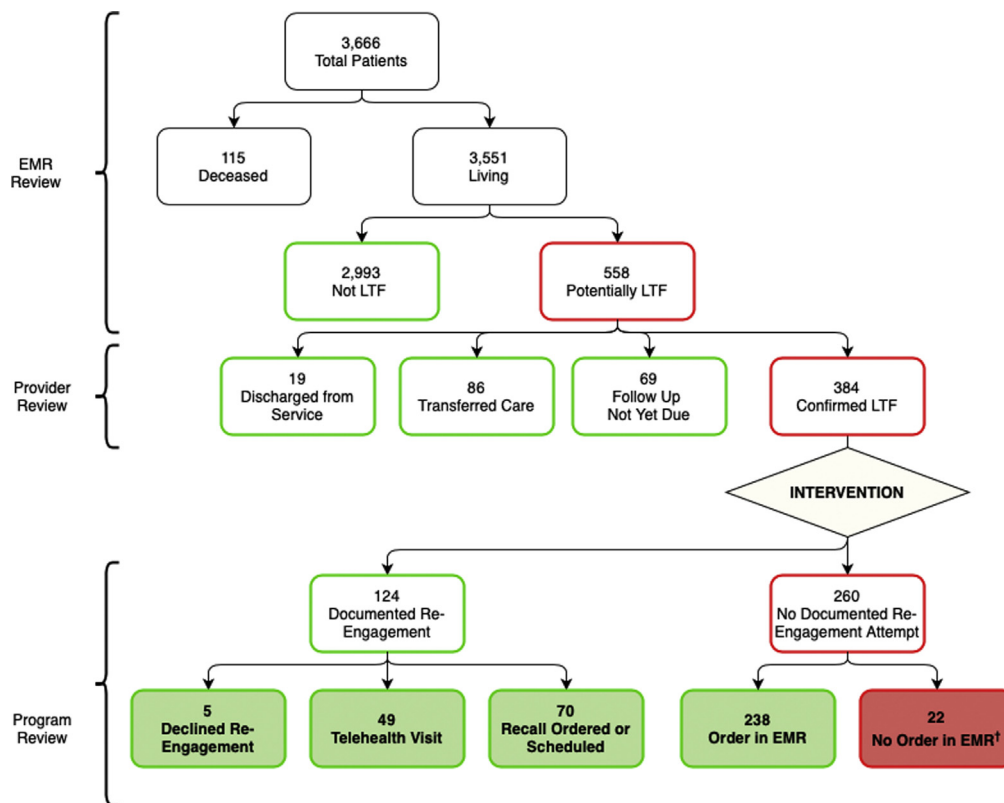
### Demographics

From a total pool of 39 372 unique patients seen in ophthalmology between January 1, 2019, and June 30, 2019, 3666 patients (9.3%) with glaucoma-related diagnoses were identified (Fig 1). Of these, 558 patients were classified as potentially LTF (15%), having not been seen within the last 6 months, and were brought to the attention of their providers for further review. Providers were also notified of the 115 patients (3%) who were deceased.

A review of those patients forwarded on to providers confirmed that 384 patients were LTF (11%). Mean age of the LTF group was  $76.0 \pm 11.4$  years, compared with  $75.8 \pm 11.1$  years ( $P = 0.121$ ) for the non-LTF group. The age distribution was not normally distributed and was skewed toward older ages in both groups (Shapiro–Wilk test,  $P < 0.001$ ). Some 57% of the LTF patients were female, compared with 54% of the non-LTF group (chi-square = 1.68,  $P = 0.195$ ). A majority of patients in the LTF and non-LTF groups self-identified as White, non-Hispanic (91% and 89%, respectively, chi-square = 1.254,  $P = 0.263$ ). Additional clinical and demographic features are shown in Table 1.

### Factors that Predict LTF

Several biometric and sociodemographic factors were found to be associated with the failure to follow-up among patients with glaucoma-related diagnoses. Patients LTF had similar CDRs and CDR asymmetry compared with those who were non-LTF ( $0.52 \pm 0.21$  vs.  $0.52 \pm 0.24$ ,  $P = 0.589$ , and  $0.13 \pm 0.16$  vs.  $0.15 \pm 0.19$ ,  $P = 0.123$ , respectively). Specifically, patients who were LTF were less likely to have open-angle glaucoma (43% vs. 48%, chi-square = 4.127,  $P = 0.042$ ) and even less likely to be LTF if they had POAG as a subtype of glaucoma (22% vs. 30%, chi-square = 10.506,  $P = 0.001$ ). No significant difference was found for the rate of other glaucoma subtypes (data not shown). Finally, patients who had completed a visual field



**Figure 1.** Process for patient identification and re-engagement strategy. An electronic medical record (EMR)-based strategy identified 558 potentially lost to follow-up (LTF) patients, of whom 384 patients were identified as LTF, comprising approximately 11% of all patients in the study period. One month after implementation of the quality improvement (QI) initiative, 124 of these LTF patients (32%) had been re-engaged: 40% through telemedicine, 57% with recall ordered or scheduled, and 4% declined follow-up when contacted. An additional 238 LTF patients (62%) had existing scheduling orders in the EMR; only 22 LTF patients (6%) had no active plan for future follow-up care.

or imaging of the RNFL within the past year were less likely to be LTF, compared with those who did not have a history of such testing (66% vs. 37%, chi-square = 97.410,  $P < 0.001$ , and 53% vs. 24%, chi-square = 114.042,  $P < 0.001$ , respectively). Age, gender, race/ethnicity, primary language spoken, VA, and IOP all had no association with LTF status.

Ophthalmology appointment metrics were also evaluated for association with LTF status. Patients LTF completed fewer total ophthalmology appointments in the prior year than those who were not LTF ( $2.4 \pm 1.8$  vs.  $3.9 \pm 3.4$ ,  $P < 0.001$ ). Some 20% of patients LTF had canceled an appointment in the prior year, whereas only 10% of non-LTF patients had canceled (chi-square = 6.64,  $P = 0.010$ ). Likewise, although 15% of patients who were LTF had not shown up for a scheduled appointment in the last year, the rate was only 8% for patients who were not LTF (chi-square = 19.00,  $P < 0.001$ ).

Finally, distance to the clinic was directly related to the likelihood of being LTF. Patients who were LTF lived, on average, 50% farther from the nearest Lahey Hospital & Medical Center eye clinic compared with those whose follow-up was up-to-date ( $23 \pm 58$  miles vs.  $15 \pm 33$  miles,  $P < 0.001$ ).

### Multiple Regression Analysis for Key Factors Associated with LTF

Stepwise multiple regression was used to assess variables that might influence LTF among patients with glaucoma-related diagnoses (Table 2). Variables selected for the final model included the number of ophthalmology appointments completed, canceled, and missed within the prior year, as well as a history of visual field testing or RNFL imaging within the prior year. The number of ophthalmology appointments completed within the prior year was inversely related to the risk of being LTF (OR, 0.75; 95% CI, 0.67–0.81,  $P < 0.001$ ). The number of canceled or missed scheduled appointments increased the risk of being LTF (OR, 1.15; 95% CI, 1.11–1.25,  $P < 0.001$  and OR, 1.75; 95% CI, 1.4–2.18,  $P < 0.001$ , respectively). Completing a visual field test or an RNFL image in the prior year was the strongest factor associated with a reduced risk of being LTF (OR, 0.43; 95% CI, 0.33–0.56,  $P < 0.001$ , and OR, 0.35; 95% CI, 0.27–0.46,  $P < 0.001$ , respectively). Age, sex, race/ethnicity, primary language, VA, IOP, CDR, type of glaucoma, and distance to the nearest eye clinic were all excluded because of a lack of significant unique predictive ability in the stepwise regression.

Table 1. Demographics and Clinical Characteristics and their Association with Loss to Follow-up

Characteristic	Patients (n = 3551)	Group		P Value <sup>†</sup>
		LTF (n = 384)	Not LTF (n = 3167)	
Continuous variables				
Age (yrs)				
Mean (SD)	74.2 (11.2)	76.0 (11.4)	74.1 (11.1)	0.121
Median	76	77	76	
Range	18–101	38–98	18–101	
CCT (SD)	553.2 (41.2)	556.1 (39.4)	552.9 (41.4)	0.426
IOP (SD)	16.1 (3.6)	16.1 (3.6)	16.2 (3.4)	0.706
CDR (SD)	0.52 (0.23)	0.52 (0.21)	0.52 (0.24)	0.589
CDR asymmetry (SD)	0.15 (0.19)	0.13 (0.16)	0.15 (0.19)	0.123
Distance in miles to nearest eye clinic (SD)	16 (33)	23 (58)	15 (33)	<b>&lt;0.001</b>
Categorical variables				
Race (%)				
White	89.3	91.4	89.0	0.263
Gender (%)				
Female	54.2	57.4	53.8	0.195
Type of glaucoma (%)				
Glaucoma suspects	26	30	25	0.075
Open-angle glaucoma	48	43	48	<b>0.042</b>
Narrow-angle glaucoma	8	10	8	0.154
Other*	18	17	18	0.702
Visual field in last year (%)	63	37	66	<b>&lt;0.001</b>
RNFL Imaging in Last Year (%)	50	24	53	<b>&lt;0.001</b>

CCT = central corneal thickness; CDR = cup-to-disc ratio; IOP = intraocular pressure; LTF = lost to follow-up; RNFL = retinal nerve fiber layer; SD = standard deviation.

\*Including unspecified forms of glaucoma.

<sup>†</sup>Comparison between the LTF and not LTF groups. Significance is marked in bold ( $P < 0.05$ ).

## Review of Patient Re-engagement Initiative

Of the 558 potentially LTF patients identified by the EMR reporting tool, 384 patients were confirmed LTF (69%) after the provider review. One month after the QI initiative, 124 of these LTF patients (32%) had been re-engaged (40% through telemedicine), 238 LTF patients (62%) had future scheduling orders in place, and only 22 LTF patients (6%) had no active plan for future follow-up.

The most recent encounter was a no-show or cancellation for 322 LTF patients (84%), 317 of whom still had an active scheduling order accessible in the EMR (98%). Only 11 patients (3%) never had an order for follow-up care placed by the provider despite documented plan for follow-up.

Overdue but active scheduling orders were in place for 24 patients (6%). Finally, 27 patients (7%) had scheduling orders marked as completed without a corresponding appointment scheduled. In total, 340 patients (88%) identified as LTF had active scheduling orders in the EMR.

For the 294 patients in the LTF group who had an appointment scheduled but not completed, the no-show rate was 24% (69 patients). The remainder canceled appointments, either by phone or electronic reminder system; 28% did so because of a conflict in schedule (63 patients), 27% because of a concern over COVID-19 exposure (60 patients), and 45% for no documented reason (102 patients).

An examination of the characteristics of the 174 patients who were determined not to be LTF despite identification by

Table 2. Logistic Regression of Multiple Variables Demonstrating Odds of a Patient Being Lost to Follow-up

	$\beta$	Standard Error	Wald Chi-square	P Value*	Adjusted OR	95% CI,	
						Lower-Bound	Upper-Bound
Completed ophthalmology appointments in last year	-0.292	0.036	67.102	<b>&lt;0.001</b>	0.747	0.697	0.801
Canceled ophthalmology appointments in last year	0.161	0.039	16.713	<b>&lt;0.001</b>	1.175	1.088	1.270
No Show Ophthalmology Appointments in last year	0.553	0.111	24.979	<b>&lt;0.001</b>	1.739	1.400	2.161
Visual field completed in last year	-0.722	0.133	31.409	<b>&lt;0.001</b>	0.486	0.377	0.625
RNFL Imaging in Last year	-1.059	0.133	63.353	<b>&lt;0.001</b>	0.347	0.267	0.450

CDR = cup-to-disc ratio; CI = confidence interval; RNFL = retinal nerve fiber layer.

\*Significance is marked in bold ( $P < 0.05$ ).

our EMR-based strategy (<5% of the total study population) revealed that 86 patients (49%) had transferred care or were otherwise documented to be followed by an eye care provider outside of the practice; 69 patients (40%) were found to have orders that were not yet due; and 19 patients (11%) did not require glaucoma follow-up, either due to low disease severity or resolution with treatment, such as an episode of ocular hypertension within a postoperative period. Therefore, the overall false-positive rate of our EMR-based strategy was 31%.

### Medication Refills while LTF

Seventy of the 384 LTF patients (18%) had documented medication refills in the period after their last clinic visit. The average order was for a  $205 \pm 130$ -day supply. Only 13 patients (19%) received less than a 90-day supply, and 28 patients (40%) received a 1-year supply.

### Results of Re-engagement Effort

Of 384 patients who were LTF, 124 (32%) were re-engaged by the time of the 1-month review (Fig 1). A total of 49 patients (40%) were re-engaged through telemedicine, 35 patients (28%) had a new order for follow-up placed, 35 patients (28%) were scheduled for a future in-person appointment, and 5 patients (4%) declined follow-up care when contacted. The likelihood to be re-engaged was not associated with age, sex, race/ethnicity, primary language, VA, central corneal thickness, IOP, CDR, type of glaucoma, or distance to the nearest eye clinic.

## Discussion

Our study found that being LTF is a significant problem among patients with glaucoma-related diagnoses. In just 1 month after the initiation of a provider-based recall initiative to improve the delivery of care to these patients, approximately one-third of those identified as LTF were directly re-engaged, and the majority of the remainder were accounted for with provider-ordered recall or scheduled appointments. Literature from similar programs aimed at re-engagement of patients LTF in other medical specialties shows a variable record. A urology program re-engaged 56% of patients who had exceeded 90 days after ureteral stent placement,<sup>6</sup> whereas a Veterans' Affairs mental health re-engagement program successfully reached only 7% of patients.<sup>7</sup>

Glaucoma care historically has had poor compliance with follow-up. In one study, glaucoma care was provided to patients at no cost, with flexible clinic hours and transportation, but the follow-up rate after a positive glaucoma screen was only 41%.<sup>8</sup> Our overall LTF rate (11%) is comparable to other studies of patients followed for glaucoma and related diagnoses (Table 3).<sup>1-4</sup> Notably, studies with lower rates of LTF tend to be carried out in settings of universal healthcare, such as the United Kingdom and South Korea.<sup>3,4</sup> Differences in definition of LTF may also partially explain the difference in the rate of LTF between these studies. Kim et al<sup>3</sup> defined LTF as greater than 12 months after proposed follow-up. Our study captured patients with as small a gap as 6 months after the last clinic contact. If we had adopted a 12-month cutoff for LTF, our rate would have fallen to 2.6%, which is significantly lower than Kim et al<sup>3</sup> (chi-square = 7.66,  $P = 0.006$ ). However, our rate would still be greater than Davis et al,<sup>4</sup> who defined LTF as "no documented outcome" after chart review by a senior clinician (chi-square = 47.80,  $P < 0.001$ ). We believe that a narrower definition of LTF is beneficial because it provides an opportunity to re-engage patients before irreversible vision loss has occurred. When patients with glaucoma and related conditions are left untreated, they are at significantly higher risk of ocular morbidity, compared with patients cared for by other ophthalmic subspecialties.<sup>4</sup> For example, patients with suspicion for normal-tension glaucoma convert to glaucoma at a rate of 2.6% per year while LTF.<sup>9</sup>

Previous studies have identified several risk factors for LTF among patients with glaucoma, including older age, male gender, lower baseline IOP, distance from the place of care, frequency of visits, and unknown family history of glaucoma.<sup>3,10,11</sup> Our study did not find age or gender to be predictive of LTF status, but we did find that the distance from the eye clinic and the number of appointments in the prior year were important factors. We also found a direct relationship between number of cancellations and missed appointments and the risk of LTF. We are unable to assess the specific impact of baseline IOP or family history of glaucoma in our study as a result of the limitations imposed by the use of an EMR tool to extract data elements, rather than performing a manual chart review. However, our study did identify several disease features that correlated with lower LTF, including having a history of open-angle glaucoma or POAG, and a history of glaucoma-related testing. These findings are reassuring in

Table 3. Comparison of Loss to Follow-up in Studies of Patients with Glaucoma

Study	LTF (n)	Total (n)	LTF (%)	Chi-square	P Value*
Ngan et al, 2007 <sup>1</sup>	83	181	46%	202.4	<0.001
Batra et al, 2017 <sup>2</sup>	24	98	24%	19.4	<0.001
<b>Lahey Hospital &amp; Medical Center</b>	<b>384</b>	<b>3551</b>	<b>11%</b>		
Kim et al, 2017 <sup>3</sup>	247	6848	3.6%	199.6	<0.001
Davis et al, 2017 <sup>4</sup>	5251	410 060	1.3%	2310.3	<0.001

LTF = lost to follow-up.

\*Significance is marked in bold ( $P < 0.05$ ).

that they indicate that patients who have potentially more severe disease are less likely to be LTF.

The most common barriers cited by patients to follow-up in glaucoma clinics are long clinic waiting times, scheduling difficulties, comorbid conditions, and linguistic barriers.<sup>12</sup> These barriers disproportionately affect minority populations, including Asian-Pacific Islanders,<sup>12,13</sup> Black Americans,<sup>14-16</sup> and Hispanic and Latino populations.<sup>12,13</sup> We did not find any impact of race/ethnicity or primary language on LTF status in the present study, but careful attention to these sociomedical factors is warranted.

Another important contributor to our higher-than-expected LTF rate was the COVID-19 pandemic.<sup>5,17-22</sup> Indeed, the rate of LTF in our study is higher than several other reports,<sup>3,4</sup> and the outbreak of COVID-19 at least partially accounts for this higher rate. The rate of no-show and canceled appointments increased by more than 33% between March and May 2020 compared with the same period 1 year earlier, and directly resulted in at least 60 patients canceling their visits (16% of all LTF patients). Patients who failed to appear for appointments or canceled through the automated appointment booking system may also have done so because of COVID-related concerns. Coronavirus Disease 2019 may also have contributed to other reasons given for canceling appointments, such as transportation issues.

A large proportion of LTF patients miss scheduled appointments and fail to reschedule, even though prompted by staff to do so. Approximately 90% of LTF patients had an active, overdue scheduling order in the EMR. There are several suspected causes of this outcome, including lack of documentation of an unsuccessful scheduling attempt, patients deferring scheduling when contacted, or an insufficient number of schedulers to reach out repeatedly to patients. This represents an important area for future practice improvement efforts.

Refill requests are a well-known, but poorly leveraged opportunity to recover patients.<sup>23,24</sup> In our study, we found that the majority of medication refills for patients who were LTF were for greater than a 90-day supply. Although refilling medications for long periods without in-person examination and testing is clearly not optimal care, it is also possible that greater harm is done by limiting refills without a system in place for re-engaging patients. Patient- or pharmacy-initiated refills also provide an opportunity for providers and staff to review the treatment plan. A more detailed analysis of where refill requests came from, and which providers filled the requests, may reveal system-level processes that can be altered to reduce LTF.

One way to reduce LTF and improve patient re-engagement is tele-glaucoma. Tele-glaucoma has been shown to be a highly effective tool but requires patients to be seen by skilled technicians to obtain funduscopy and tonometry.<sup>25-28</sup> Patient attitudes toward telemedicine are also an important consideration, with one survey of patients aged more than 60 years finding that more than 70% had at least neutral views toward telemedicine. The same study determined that patients were more likely to report a positive view of telemedicine if they were aged less than 70 years, had an education beyond high school, were of

European descent, and had traveled a longer distance in the past 3 days.<sup>29</sup> Our program resulted in 49 telehealth visits in just 1 month, which accounted for approximately 2% of total telehealth visits in ophthalmology during this period. A similar program directed at other eye conditions, such as diabetic retinopathy or macular degeneration, could have an even greater impact on clinical productivity.

Although our EMR-based strategy successfully identified patients at risk of being LTF, thereby providing an opportunity for providers to re-engage patients, approximately one-third of the patients whom providers reviewed in the program were not overdue for care. The specificity of reporting methods to identify patients LTF depends on parameters chosen, especially the interval used to define LTF. Notably, 90% of the potentially LTF patients in our study already had an active, but overdue, scheduling order. The training of support staff to review those orders would have reduced the average number of charts to fewer than 5 per provider in our cooperative group practice with 16 ophthalmologists and 8 optometrists. After the program was implemented, only 22 patients (6% of LTF patients, but <1% of patients overall) had not been contacted or had an active scheduling order. Those patients were re-engaged after this review. Continued use and refinement of this report are likely to improve its specificity and reveal the optimum interval for running this process.

### Study Limitations

The limitations of the present study include its retrospective nature and small sample size derived from a single-center, outpatient clinic that serves as a glaucoma referral center. This may impact the prevalence of glaucoma-related diagnoses in our study population. Our study also defined glaucoma broadly, which means that the patients included in our study varied widely in their risk of disease and frequency of required follow-up, both of which were not directly assessed in our study. We also did not control for other comorbid eye diseases that could influence the frequency of patient follow-up. Although we examined the length of medication refills, we were unable to assess the specific impact of prior use of glaucoma medications, laser, or surgery on LTF status. All of these are factors that should be explored in future research. In our program, the actions taken by providers were left to individual clinical judgment, rather than based on a standardized set of recall guidelines. Future studies should also stratify data by provider type or experience to assess if this impacts the risk of a patient becoming LTF. Although we controlled for clinical events that could be expected to affect LTF, including the COVID-19 pandemic, other factors, such as time of year or turnover in clinical staff, may have affected our LTF rate. Finally, the short-term nature of our evaluation of outcomes limits our ability to draw conclusions about how our program will affect subsequent risk of LTF. Future directions for this research should include a longer study period and assess glaucoma-related outcomes.

In conclusion, an EMR-based QI initiative successfully identified patients with glaucoma-related diagnoses who

were at risk of being LTF and used a provider-based strategy to selectively re-engage patients through a combination of telehealth and office-based recall orders. Such efforts not only promote optimal care of patients by potentially reducing the undesirable outcome of vision loss from inadequately managed glaucoma, but also serve to maintain clinical productivity, document treatment plans, and potentially reduce medicolegal liability arising from gaps in glaucoma care.<sup>30</sup> Our study also identified several readily obtainable EMR data elements that are associated with LTF, including distance to the nearest eye clinic,

ophthalmic appointment history, and prior ophthalmic testing history, that may alert clinicians to patients posing a relatively greater risk of LTF. This allows the opportunity to develop protocols for ensuring that higher-risk patients return for care.

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Abbreviations and Acronyms:

**CDR** = cup-to-disc ratio; **CI** = confidence interval; **COVID-19** = Coronavirus Disease 2019; **EMR** = electronic medical record; **IOP** = intraocular pressure; **LTF** = lost to follow-up; **OR** = odds ratio; **POAG** = primary open-angle glaucoma; **QI** = quality improvement; **RNFL** = retinal nerve fiber layer; **VA** = visual acuity.

Keywords:

Adherence, Electronic Health Record, Glaucoma, Medical informatics, Open-Angle Glaucoma, Quality Improvement, Taxonomy.

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