




The Impact of Workflow Modifications in an Electronic Medical Record on Tertiary Service Referrals for Patients with Visual Impairment in New York City

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Purpose: Low vision services are beneficial for many patients with visual impairment. To facilitate referrals from Montefiore Medical Center in the Bronx to specialists at Lighthouse Guild (LHG), a New York City-based non-profit offering low vision services, an integrated referral system and best practice advisory (BPA), a pop-up tool used to guide clinicians toward recommended actions based on patient data, were implemented within the electronic medical record (EMR; Epic Systems). This was later expanded to nearby medical centers. The primary objectives of this retrospective study are to describe these EMR modifications and analyze how they impacted referrals to LHG low vision services. The secondary objective is to understand barriers to evaluation through an analysis of scheduling rates on an index year (2023).

Patients and Methods: We analyzed referrals to LHG from Montefiore's Department of Ophthalmology along with other local institutions between 2015 (baseline year) to 2023. Patient demographic data were extracted from Montefiore Epic. Referral volumes were obtained from LHG and trended over time to determine the impact of sequential workflow modifications and regional expansions. Descriptive statistics and a chi-square analysis were performed to compare patients successfully scheduled for LHG services in 2023 with those who were referred but not scheduled.

Results: Referrals to LHG increased by 220% from 2016–2017 (N=45 to 144). A flag indicating a patient's visual status resulted in a 65% year-to-year increase in 2019 (N=207 to 341). The BPA and expansion to nearby institutions increased total referrals by 90% (N=573 to 1,090). Older individuals referred to LHG were less likely to schedule appointments than younger individuals (67 vs 60 years old) (p=0.0090).

Conclusion: An EMR-based system designed to alert clinicians of visual deficits and enable real-time referrals dramatically improved access to low vision services. Further integration of services and coordination of care should focus on vulnerable patients such as the elderly.

Keywords: low vision, electronic health record, clinical decision support systems, age

Introduction

The spectrum of functional limitations observed in individuals with visual impairment is heterogeneous, reflective of the underlying pathology and severity of visual loss. Devices, rehabilitation, and other services can address the diverse needs of patients with visual impairment.^{1,2} In particular, low vision rehabilitation services can address psychological, physical, social, and functional factors that may increase patients' independence and quality of life.³ However, studies indicate that many patients who are eligible may not be referred for low vision services.⁴ Internationally, Wittich et al suggest that

availability varies widely due to challenges including the spectrum of government and privately funded healthcare, rural and urban dynamics, and overall financial resources.⁵ In the United States, low vision services may be available through academic medical centers, non-profits, the Department of Veterans Affairs, or private agencies, but barriers to care exist. Coker et al showed that these include lack of knowledge about low vision services, inefficient referral systems, long distances to low vision services, and cost.⁶

In New York State, individuals who are visually impaired are eligible for services at Lighthouse Guild (LHG). Based in Manhattan, LHG is a non-profit organization that provides a range of services to help visually impaired individuals both personally and professionally, from job training to healthcare and support services. Many visually impaired patients are eligible for services at LHG but generally require a referral for services to initiate formal evaluation. Montefiore Medical Center, located in the Bronx, has referred low vision patients to LHG for many years.

Prior to 2016, patients were referred to LHG through paper-based forms and facsimile. This manual process introduced inefficiencies and placed a considerable burden on clinical staff. The absence of systematic tracking and auditing capabilities inherent in this workflow likely impeded efficient patient referrals, ultimately limiting access to specialized low vision care.

Studies indicate benefits to digitizing referrals within ophthalmology, particularly in connecting patients from primary care providers or optometrists to ophthalmologists.⁷⁻⁹ Khan et al developed an electronic referral system between optometrists and ophthalmologists, which resulted in significantly reduced wait times and improved subspecialty triaging.⁹ Outside of ophthalmology and optometry, Kwon et al found that an electronic medical record- (EMR) based interspecialty referral system resulted in higher physician satisfaction with referrals and improved visibility.⁸ To date, there is limited published literature on quality improvement initiatives that systemically analyze the impact of implementing EMR-based referral systems, and universally accepted best practices remain undefined.

Given the critical need to enhance patient access to and utilization of low vision services due to the detrimental effects of visual impairment on patients' functional abilities and overall quality of life, this gap in the literature warrants attention. The primary objectives of this quality improvement study were twofold: to implement stepwise workflow modifications and enhancements in the EMR to improve referrals between Montefiore and LHG and to conduct a retrospective analysis to understand the impact on referrals between 2016 and 2023. The secondary objective was to evaluate patient barriers to low vision evaluation through an analysis of scheduling rates during the index year 2023.

Methods

Inclusion Criteria

All referrals to LHG from Montefiore between January 1, 2015 and December 31, 2023 were included in this analysis. Referrals were made by Montefiore ophthalmologists based upon clinical need and best corrected visual acuity of 20/50 or worse in their better-seeing eye. At this time, only best corrected visual acuity is used to determine eligibility and severity of functional deficit. Visual field data assessing the severity of functional constriction (eg <20 degrees) are not consistently available.

Initial Conversion to an Electronic System (2016 to 2018)

The first step toward designing an electronic referral workflow utilized software to create current and future state implementation flowcharts. This enabled the conversion from a paper to an automated electronic facsimile referral process that featured autopopulation of demographic and ophthalmologic data from the chart using native Epic tools.

Patient Flags (2019)

To improve identification of patients with visual impairment within the EMR and to better visualize eligible individuals, we implemented a targeted intervention with patient flags, as shown in [Figure 1](#). As part of this effort, we employed Epic rule logic to automatically flag patients within the standard Epic patient scheduling dashboard. Specifically, patients with visual acuity of 20/50 or worse in their better-seeing eye are labeled "Impaired", while those with 20/200 or worse vision in their better-seeing eye are designated "Legally Blind." This system assists clinicians by enhancing the visibility of

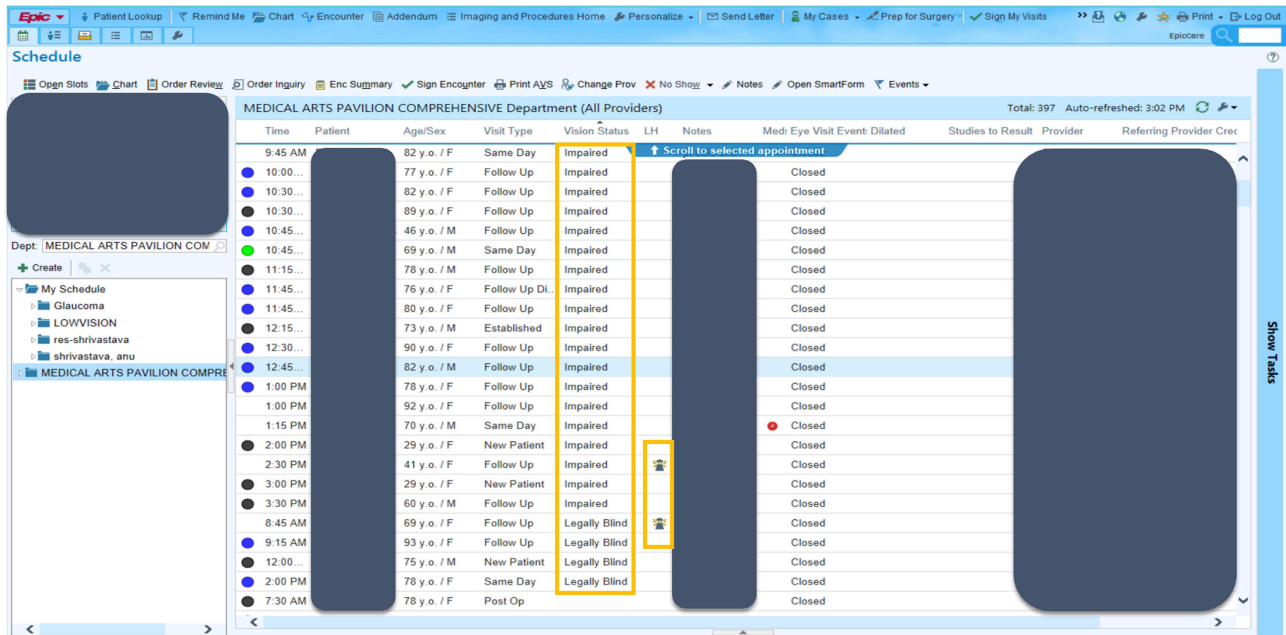


Figure 1 Schedule with Patient Flags. Epic Schedule tab with new “Vision Status” column indicating whether a patient is “Impaired” or “Legally Blind” (left box) and new “LH” column (right box) showing whether a patient has an active referral order to LHG by the visual indicator.

patients who could benefit from low vision services in a centralized manner that leverages an existing workflow. This patient flag began appearing in a newly created “Vision Status” column in the Multi-Provider Schedule tab as well as within a patient’s chart on the StoryBoard in order to alert providers to patients eligible for LHG referral. Additional logic was configured to display a visual indicator on the Multi-Provider Schedule in the EMR for all patients who had a signed referral order to LHG.

Best Practice Advisory and Expansion (2021)

Next, we implemented a best practice advisory (BPA) for all ophthalmology clinic patients meeting the above definition of “Impaired” or “Legally Blind”, which is shown in Figure 2. This BPA presents ophthalmologists with a pop-up modal offering the option to place an order for an LHG referral. If the provider declines to order the referral, they must specify the reason before closing the patient’s EMR visit. To ensure periodic review, the BPA is designed to reappear every two years for each eligible patient timed to the cadence when authorizations frequently require renewal.

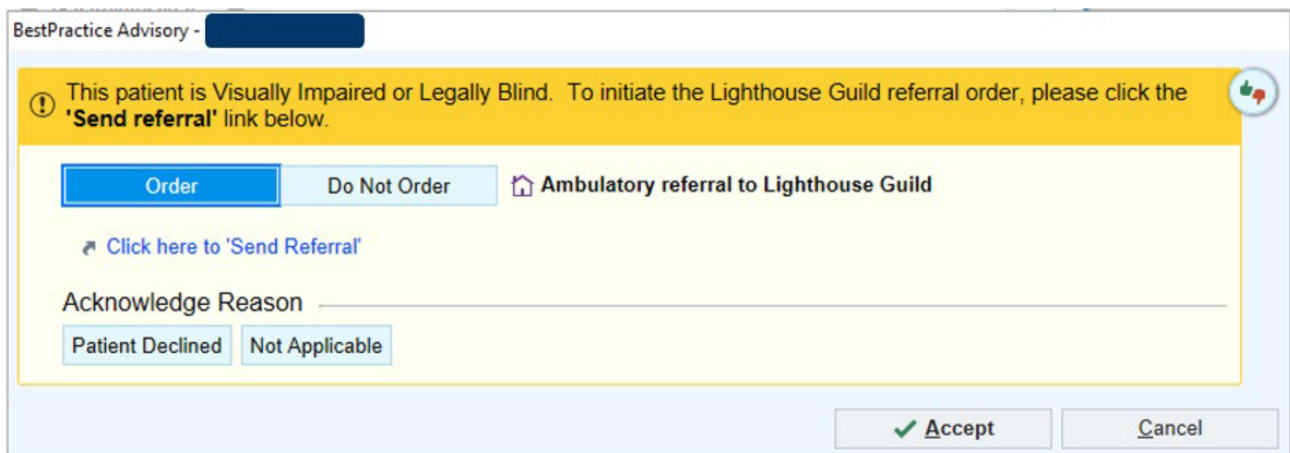


Figure 2 Best Practice Advisory for LHG Referral. Pop-up modal that appears in eligible patients’ charts to facilitate referrals.

Based on the initial success of the early phases of the intervention, the electronic referral system was introduced and subsequently adopted by nearby health systems to optimize patient access to low vision services beyond the catchment area of Montefiore in the Bronx, NY. This included other academic medical centers and sites within New York City (NYC)'s five boroughs as well as within the country's largest municipal health system, NYC Health and Hospitals.

Analysis of Patient Scheduling Barriers (2023)

We obtained data from LHG to determine total referral volume for each year during the study period. We included 2015 as a baseline year to show typical referral counts prior to the EMR modifications. We built a customized reporting tool in Epic to aggregate demographic data for patients referred to LHG from Montefiore in 2023. All patients referred to LHG during 2023 were included in this secondary analysis. Montefiore Epic data were matched with LHG visit data to determine which patients were able to be scheduled for LHG services.

Statistical Analysis

We used descriptive statistics to analyze the demographics of patients referred to LHG from Montefiore in 2023. A *t*-test or chi-square test, as appropriate, was used to evaluate differences between patients who were scheduled for services compared to those who were not based on demographic data. This study met the criteria for a quality improvement initiative at our institution and was therefore determined to be exempt from institutional board review.

Results

A total of 8,841 referrals were placed to LHG between January 2016 and December 2023, including 2,030 from Montefiore and 6,802 from all other sites included in the expansion. The changes in referral patterns over time are shown in Figure 3. The initial conversion to the electronic system started in 2016 increased referrals by 220% in the first year (N = 45 to 144). In 2019, the introduction of Epic flags to alert physicians of a patient's visual status resulted in

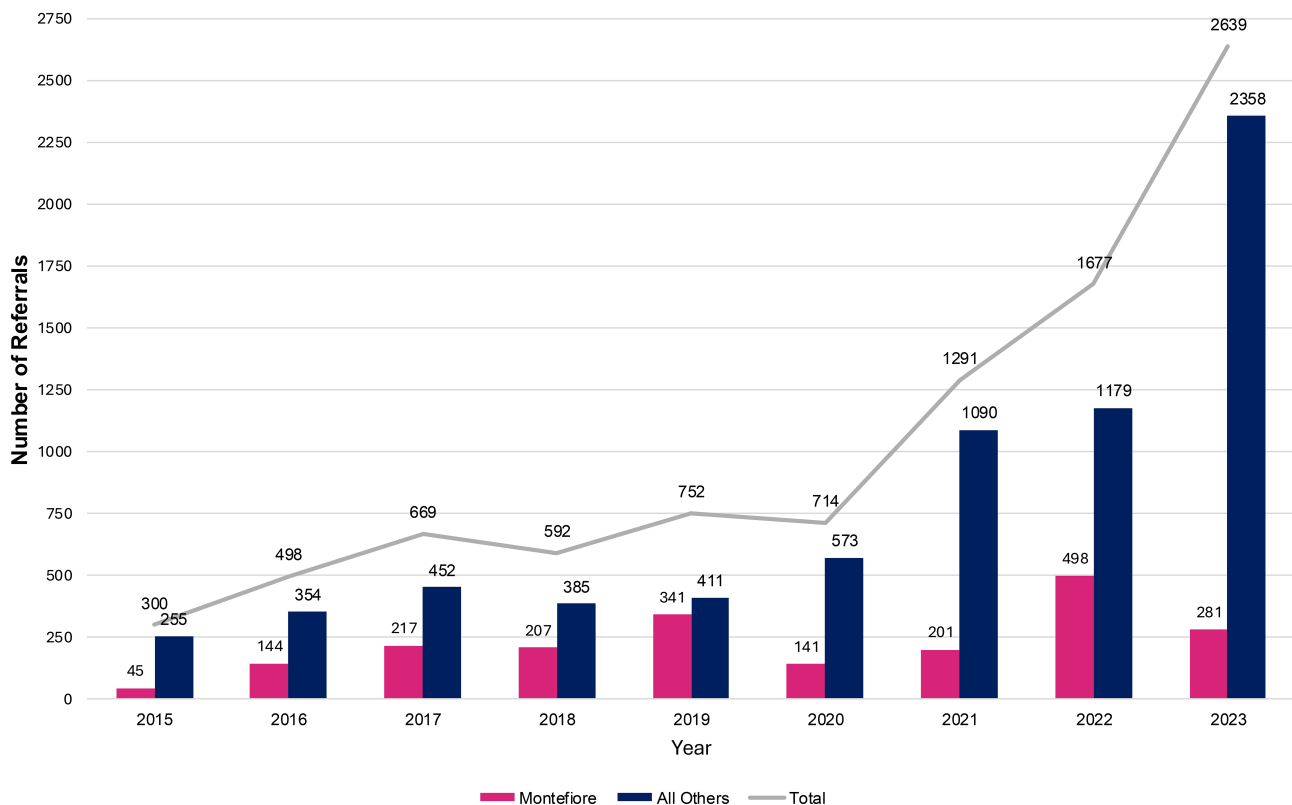


Figure 3 Annual Referrals to LHG 2015–2023. Annual referrals to LHG from Montefiore (left), all other sites (right), and total (top line).

a 65% year-to-year increase in referrals (N = 207 to 341). In 2021, the addition of a BPA along with expansion to neighboring institutions increased total referrals by 90% (N = 573 to 1,090). **Figure 4** shows the overall trend in referrals at Montefiore alone (**Figure 4a**) and Montefiore combined with expansion sites (**Figure 4b**).

In 2023, 281 patients were referred from Montefiore to LHG, and 144 (51%) were successfully scheduled for LHG services. Their characteristics are shown in **Table 1**. Of the 137 (49%) patients not scheduled, the most common reason was inability to contact the patient for 51%, followed by 18% declining services, 9% with insurance issues, 7% lost to follow-up, and 15% for unknown reasons. There was a significant difference in age between the two cohorts, with patients who were scheduled having a mean age of 60 years and patients who were not scheduled having a mean age of 67 years ($P = 0.0090$). There were no significant differences between patients who were scheduled and not scheduled regarding race. The overall cohort identified as 11% White, 34% Black or African American, 5% Asian, 43% Other, and

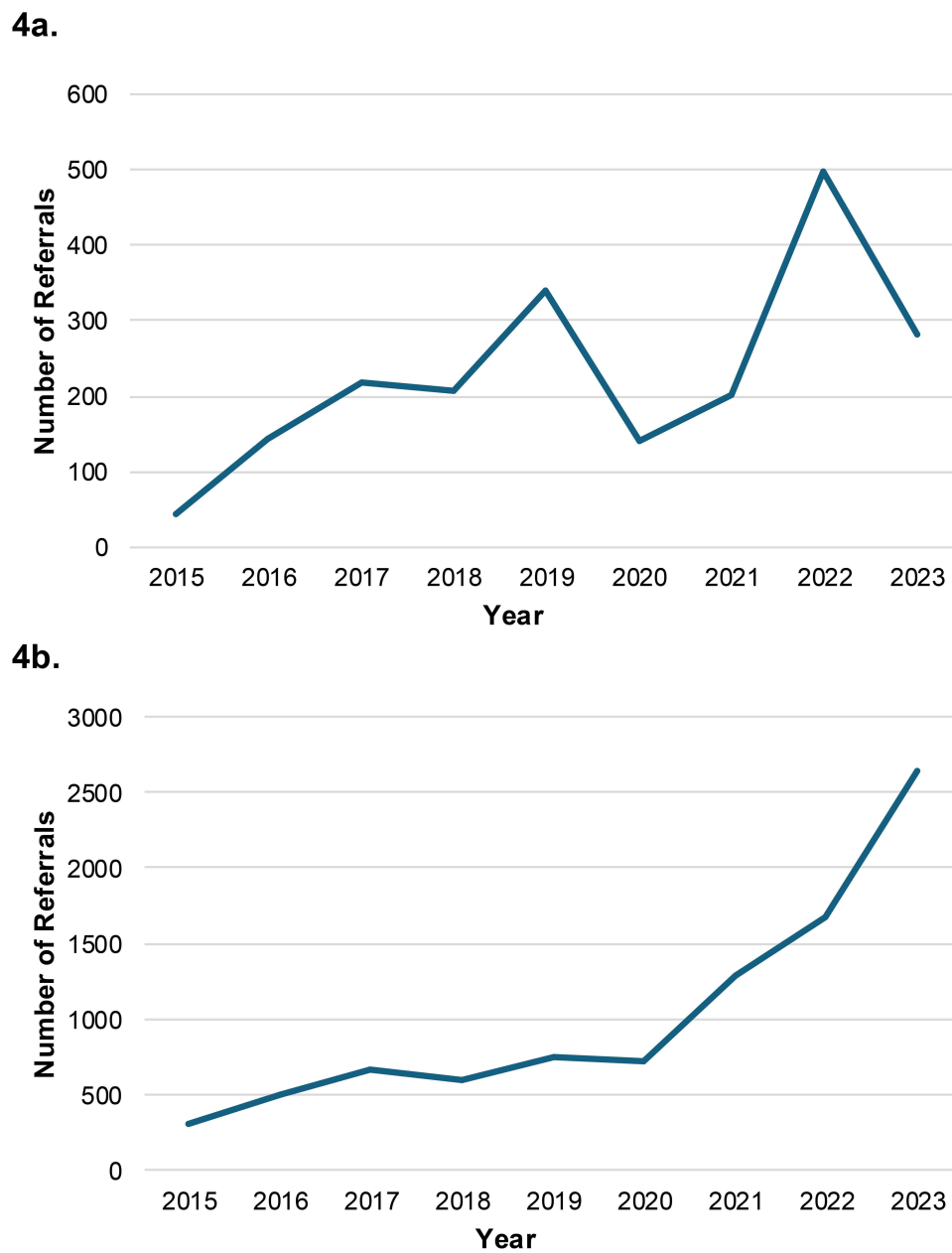


Figure 4 Annual Referrals to LHG 2015–2023 by Site. (a) Annual referrals to LHG from Montefiore only. (b) Annual referrals to LHG from Montefiore plus nearby medical centers included in the expansion.

Table 1 Characteristics of Patients Referred from Montefiore to LHG

Characteristics	Patients Scheduled for LHG Services (N=144)	Patients Not Scheduled for LHG Services (N=137)	All Patients Referred to LHG (N=281)	P Value
Age, mean (SD), years	60 (24)	67 (19)	63	0.0090
Sex, no. (%)				0.32
Male	63 (44)	68 (50)	131 (47)	
Female	81 (56)	69 (50)	150 (53)	
Race, no. (%)				0.74
White	15 (10)	15 (11)	30 (11)	
Black or African American	45 (31)	50 (36)	95 (34)	
Asian	6 (4)	8 (6)	14 (5)	
Other	68 (47)	54 (39)	122 (43)	
Unknown	10 (7)	10 (7)	20 (7)	
Ethnicity, no. (%)				0.47
Hispanic/Latino	61 (42)	54 (39)	115 (41)	
Not Hispanic/Latino	69 (48)	74 (54)	143 (51)	
Unknown	14 (10)	9 (7)	23 (8)	
Primary insurance at time of referral				0.64
Medicare	79 (55)	85 (62)	164 (58)	
Medicaid	49 (34)	36 (26)	85 (30)	
Private insurance	7 (5)	9 (7)	16 (6)	
Other	5 (3)	4 (3)	9 (3)	
Unknown	4 (3)	3 (2)	7 (2)	
Best documented visual acuity at referral visit				0.24
≥20/40	25 (17)	19 (14)	44 (16)	
<20/40, ≥20/60	21 (15)	33 (24)	54 (19)	
<20/60, >20/200	36 (25)	32 (23)	68 (24)	
≤20/200	62 (43)	53 (39)	115 (41)	
Subspecialty of referring ophthalmologist, no. (%)				0.32
Glaucoma	55 (38)	50 (36)	105 (37)	
Retina	46 (32)	51 (37)	97 (35)	
Cornea	12 (8)	13 (9)	25 (9)	
Neuro-Ophthalmology	11 (8)	12 (8)	23 (8)	
Pediatrics	12 (8)	3 (2)	15 (5)	

(Continued)

Table 1 (Continued).

Characteristics	Patients Scheduled for LHG Services (N=144)	Patients Not Scheduled for LHG Services (N=137)	All Patients Referred to LHG (N=281)	P Value
Uveitis	7 (5)	6 (4)	13 (5)	
Reason for incomplete referral, no. (%)				
Unable to contact patient		70 (51)		
Patient declined		25 (18)		
Insurance issue		13 (9)		
Lost to follow-up		9 (7)		
Unknown		20 (15)		

Notes: Demographic data of patients who were referred from Montefiore to LHG and scheduled for LHG services, patients who were referred from Montefiore to LHG and not scheduled for LHG services, and all patients who were referred from Montefiore to LHG.

7% Unknown ($P = 0.74$). 41% of patients overall identified as Hispanic or Latino with no significant differences between the two groups ($P = 0.47$). Most patients had Medicare insurance (58%) across both cohorts followed by Medicaid (30%), with no significant differences between the groups overall ($P = 0.64$).

In the cohort, 41% of patients were legally blind in their better seeing eye, with no significant differences in best documented visual acuity between patients who were scheduled and not scheduled ($P = 0.24$). Referrals most commonly came from retina specialists (37%), followed by glaucoma (35%), cornea (9%), neuro-ophthalmology (8%), and pediatrics and uveitis (5% each) ($P = 0.32$).

Discussion

In this study, we evaluated the impact of stepwise workflow modifications in the EMR on referral patterns from academic medical centers to specialty low vision services at LHG between 2015 and 2023. There was an overall increase in referrals across this period, with the greatest proportional increase occurring after the introduction of a BPA and expanding these EMR-based workflow changes to local institutions. Among patients referred from Montefiore to LHG in 2023, patients who were not scheduled for LHG services were significantly older compared to those who were scheduled. However, there were no significant differences in race, ethnicity, sex, best corrected visual acuity, or referring ophthalmologist subspecialty. These data support the use of an EMR-based system to increase referrals to specialty services and guide further interventions to continue to improve access to specialty low vision care.

Clinical Decision Support Systems and BPAs

A key finding in our study is the importance of a BPA in increasing referrals. While initial steps in our study involved digitizing referrals, which is similar to other studies,^{7,8,10,11} we believe the BPA allowed us to further simplify the referral process to more easily visualize eligible patients. This essentially eliminated the need to separately initiate a referral order process.¹² In addition, BPAs allow for a more standardized referral process that may even decrease implicit physician biases while reinforcing clinical guidelines on a regular basis.¹³ It is crucial to be mindful of the clinician perspective when creating a clinical decision-making support system to avoid alert fatigue, which may cause these systems to become burdensome and unsustainable. For example, a study evaluating a BPA saw an initial 95% spike in referrals followed by BPA fatigue and lack of engagement, and its complexity led to its eventual removal from use.¹⁴ In order to create a sustainable BPA in the long term, we created a pop-up modal requiring very simple responses. Building on previous workflow modifications that auto-populated almost the entire LHG referral form, this time-efficient design integrates seamlessly within existing clinical workflows and likely played a critical role in reducing barriers to adoption.

Patient Flags

To our knowledge, few, if any, published works in ophthalmology have yet described or examined the clinical impact of the use of patient icons and labels within the schedule. Our labels for a patient's visual status (ie impaired or legally blind) and visual indicator showing that an LHG referral order has been placed for a patient have been extremely valuable resources in the referral process. These icons serve as important reminders for clinicians and provide an opportunity for easy follow-up. Clinicians do not automatically receive information regarding the scheduling of patients referred for low vision services. Therefore, the visual indicator of the lighthouse becomes a critical means to monitor and discuss these services with patients—functioning almost as a secondary referral but without the burden of additional documentation or system interactions.

Barriers to Scheduling

Our study also provides insight into potential barriers to accessing low vision services in our patient population, as we found that patients who were not scheduled for low vision services were 12% older. This is a finding that is consistent with other studies.^{15,16} The potential for mobility issues and other comorbidities in older patients, coupled with the fact that LHG is located in a different NYC borough, may explain the age discrepancy observed between our two groups. This contrasts with another study by Guo et al, which included numerous on-site low vision services, thereby removing the barrier of travel and the need for extensive care coordination.¹³ Another possibility is that older patients may have lived with visual impairment longer and thus adapted without low vision services. Along with potential attitude-related factors, this adaptation could present further barriers beyond logistics.^{17,18} Older patients may need more counseling, follow up, and involvement of their support network to ultimately be scheduled for LHG services.

System-Wide Trends and COVID-19

There are several factors contributing to the observed peaks, troughs, and plateaus in referrals throughout our study timeline. NYC was an epicenter of the COVID-19 pandemic, and decreased ophthalmology clinic visits and LHG service availability inevitably led to decreased referrals.¹⁹ We observed that the combination of our workflow modifications along with increased clinical volume resulted in steep increases in referral volume as pandemic related restrictions eased. The plateau in referrals observed at Montefiore and across expansion sites between 2017 and 2018 reflects the impact of the initial electronic LHG referral form conversion. With many patients referred using this new method in the first two years, and referrals having a two-year duration, a stabilization in referrals around this timeframe would be expected. This ceiling effect is observed in other studies, such as a study testing a new screening tool that causes an initial increase in screening rates followed by a plateau until a new cohort becomes eligible for screening or an additional intervention is introduced.²⁰ Thus it follows that our sharpest increases in referrals occurred after we introduced each subsequent EMR modification, including the initial electronic conversion. The decrease in referrals at Montefiore in 2023 may be similar to these earlier plateaus, as a new modification had not recently been introduced. In contrast, the BPA started at Montefiore in 2021 has been introduced into the EMRs of expanding local institutions individually over the past few years, contributing to the continued sharp rise in referrals since its introduction in 2021.

Strengths and Limitations

This study's primary strengths include its analysis of longitudinal data that capture changes in provider behavior with a clear patient impact in a large health system serving a diverse, urban patient population. The initiative's scalability is demonstrated by its use in the nearly ubiquitous Epic EMR, and its ease of adoption is reflected in the significant growth in referrals immediately after implementation. This study was also interdisciplinary, with input for workflow modifications generated from ophthalmologists as well as low vision experts and non-profit leadership. Ultimately, this study is one of the few in the literature to explore and show that targeted EMR workflow modifications can lower referral barriers, leading to tangible improvements in patient access to specialty care.

Significant challenges persist in integrating low vision evaluation reports into the official EMR due to disparate medical record systems that currently lack efficient interoperability. A manual integration to monitor outcomes and improve service offerings is in development to better understand patient and provider needs. However, most LHG providers send reports to ophthalmologists that are incorporated into the EMR, each referral lasts only two years before needing renewal, and patient flags serve as reminders for ophthalmologists to discuss patients' experience with the referral at follow-up office visits. Referral criteria for the BPA were limited by EMR capabilities and based solely on Snellen visual acuity and are unable to incorporate other factors, including visual fields or contrast sensitivity. These factors may be included in the BPA to encompass more patients with vision loss if clinical documentation allows incorporation in the future.

Conclusion

The introduction and expansion of an EMR-based system designed to alert clinicians of visual impairment and enable seamless, real-time referrals has increased the number of patients being referred for low vision services. We identified age as a remaining barrier for scheduling patients for LHG services. The implementation of an efficient BPA is one of the most significant components of our study, as it significantly streamlined referrals without compromising clinician workflow. This model of balancing clinical efficiency with patient impact represents a broadly applicable strategy with potential for implementation across specialties beyond ophthalmology, particularly as such EMR alerts become more integrated into clinical practice. While the intervention was highly successful, future work will focus on deeper EMR integration to optimize care coordination and on systemically addressing the residual barriers that impede patient access to low vision services.

Acknowledgments

Montefiore Ophthalmology/ IT/Clinical Trials - Zara Mian, Mina Mikhael, Jonathan Balingcongan. Lighthouse Guild - Janet Weinstein, Margaret Walters.

Disclosure

Dr. Anurag Shrivastava is a member of the board of trustees at the Rochester Museum and Science Center and a member of the Lighthouse Guild Advisory Board Committee. All remaining authors report no conflicts of interest in this work.

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