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Socioeconomic Disparities in Patients Receiving Intravitreal Injections for Age-Related Macular Degeneration Amid the COVID-19 Pandemic

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Abstract

Purpose: To determine the effects of socioeconomic factors on visit adherence and the resultant visual outcomes for patients receiving intravitreal injections for neovascular age-related macular degeneration during the COVID-19 pandemic. **Methods:** In this retrospective case-control study, medical records were reviewed to collect appointment attendance, age, sex, self-reported race/ethnicity, primary language, marital status, insurance, distance from clinic, and Area Deprivation Index (ADI), a measure of socioeconomic disadvantage. Multivariate regression models were created to determine differences in socioeconomic factors between individuals who attended (show group) and those who did not attend (no-show group) appointments. **Results:** The study enrolled 126 patients in the show group and 115 in the no-show group. On univariate analysis, nonadherence was significantly higher in non-White patients than in White patients ($P = .04$), urban sites than in suburban sites ($P = 1.7 \times 10^{-4}$), and non-English-speaking patients than in English-speaking patients ($P = 4.0 \times 10^{-3}$). The associations remained significant in multivariate analysis for non-English-speaking patients ($P = .03$) and urban-site patients ($P = .01$) after adjusting for age, sex, self-reported race/ethnicity, primary language, marital status, insurance, distance from clinic, site of visit, and ADI. At 6 months and 1 year, a 1-, 2-, and 3-line vision loss was significantly higher in the no-show group than in the show group on univariate and multivariate analysis after adjusting for age, sex, race, lens status, and presence of glaucoma and diabetic retinopathy. **Conclusions:** Non-English-speaking patients and urban-based patients were less likely to present for intravitreal injection appointments during the initial peak of the COVID-19 pandemic. This disparity translated to worse vision outcomes at 6 months and 1 year.

Keywords

age-related macular degeneration, health disparity, intravitreal injection, COVID-19, demographics, socioeconomics

Introduction

Patients with neovascular age-related macular degeneration (nAMD) require regular monitoring and treatment with intravitreal injections to maintain vision. Lapses in treatment can lead to the formation of disciform scars or catastrophic subretinal hemorrhage with irreversible vision loss. During the onset of the COVID-19 pandemic, multiple United States–based studies showed that nAMD patients who missed their injection visits had a decline in visual acuity (VA) over less than 6 months in short-term studies and over longer than 1 year in long-term studies.[1–9]

Although there has been extensive research on the impact of the pandemic on visit adherence and visual outcomes in nAMD patients receiving intravitreal injections, less is known about the effect of nonophthalmic factors, such as demographics and socioeconomic status. Research on health disparities has widely recognized that racial and ethnic minorities and those with lower income have worse health outcomes than White patients and those with a higher income.[10,11] Examples include pregnancy-related morbidity and mortality and the prevalence of chronic conditions, such as heart failure.[10,12–14] To our knowledge, only 1 study has studied the effect of nonophthalmic factors (ie, race/ethnicity and systemic comorbidities) on adherence to intravitreal injection appointments during the pandemic.[15] This study found that compared with 2019, there was a drop in

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visit adherence in all racial and ethnic groups except patients identifying as Hispanic/Latino at a Veterans Affairs Hospital in Los Angeles County.[15]

In our study, we investigated the effects of nonophthalmic factors on visit adherence for patients with nAMD having intravitreal injections. We retrospectively reviewed the medical charts of all patients scheduled to have an injection appointment during the initial wave of the COVID-19 pandemic at Boston Medical Center, the largest urban safety-net hospital in New England, or its 2 affiliated suburban eye clinics. We evaluated the effects of age, sex, self-reported race/ethnicity, primary language, marital status, insurance status, distance from the clinic, appointment location, and socioeconomic status and correlated these variables with short-term (6-month) and long-term (1-year) vision loss.

Methods

Study Design, Setting, and Sample

This retrospective single-center case-control study comprised patients with bilateral nAMD who had injection appointments scheduled from March 11, 2020, to May 26, 2020, at Boston Medical Center and its 2 affiliate suburban eye clinics. An injection appointment was defined as any appointment at which an intravitreal injection was given to the patient. This included procedure-only visits with a planned injection or possible injection visits with an examination and/or assessment before the decision to inject. Excluded were patients who had not received an injection within the 6 months before their scheduled appointment, did not have at least 1 year of follow-up, did not have bilateral nAMD, or lived outside Massachusetts. Institutional review board approval was obtained, and the study was conducted following the regulations set forth by the US Health Insurance Portability and Accountability Act of 1996 and adhered to the tenets of the Declaration of Helsinki.

The 2020 study window coincided with the Massachusetts mandate authorizing only emergent medical appointments during the initial surge of COVID-19.[16] The patients were categorized into 2 groups: the show group and the no-show group. The show group was defined as patients who attended their originally scheduled appointment or an appointment within 2 weeks of the original appointment. All other patients were placed in the no-show group. Patients were also categorized by appointment location: (1) urban if their appointment was scheduled at Boston Medical Center or (2) suburban if their appointment was at an affiliate suburban eye clinic.

For each patient, the following data were also collected: age, sex, self-reported race/ethnicity, self-reported primary language, marital status, primary insurance, address of primary residence, and location of appointment (urban vs suburban). The better-seeing eye was selected as the study eye because patients tend to rely on the better-seeing eye for everyday activities. If a patient had the same VA at baseline, 1 eye was randomly selected using a random-number generator. The lens status, presence of concurrent ocular comorbidities, and VA were recorded for the study eye.

VA was recorded at 4 timepoints; that is, at the 2 visits immediately before the study window, at the 6-month visit, and at the 1-year visit. The 6-month and 1-year visits were defined as within 2 months of the date that corresponded to exactly 6 months or 1 year after the scheduled appointment date in the study window. For patients in the show group and no-show group, the baseline VA was calculated by averaging the VAs recorded at the 2 visits before the study window within a 6-month period. The recorded Snellen VA was transformed to logMAR notation using the following equation: $\text{logMAR} = -\log_{10}(\text{Snellen VA})$. The change in VA was calculated via the following equation: logMAR VA at 6 months or 1 year minus the baseline logMAR VA. Then, for each patient the change in VA was evaluated for whether there was a loss of 1 line, 2 lines, or 3 or more lines.

The Area Deprivation Index (ADI) at the state level was used as a proxy for socioeconomic status. The ADI ranks neighborhoods by socioeconomic disadvantage in a region of interest by factoring in income, education, employment, and housing quality.[17–19] The ADI was obtained via the University of Wisconsin School of Medicine's Neighborhood Atlas website.[20] Patients' full addresses were used to obtain their ADI. The ADI at the state level was given as a decile (1 to 10), with a higher number indicating a more disadvantaged group. In the current study, socioeconomic disadvantage was defined as follows: 1–3 = low; 4–7 = average; 8–10 = high.

Last, patients who had an appointment scheduled in the parallel 2019 study window (from March 11, 2019, to May 26, 2019) were also recorded as a control to compare visit adherence before and during the pandemic. Other visual outcomes data were not compared because of insufficient data availability.

Outcomes

The primary outcome was visit adherence. The secondary outcome was the percentage of patients with vision loss of 1 line, 2 lines, or 3 or more lines at 6 months and 1 year.

Statistical Analysis

The covariates were compared between patient cohorts in the show group and the no-show group. Categorical variables were compared using the chi-square test, and continuous variables were compared using the *t* test. Univariate and multivariate logistic regressions were used to examine the association between the show rate and no-show rate and vision loss of more than 1 line, 2 lines, or 3 lines during the pandemic and before the pandemic. Missing VA, race/ethnicity, marital status, ADI, and primary language data were imputed by Markov chain Monte Carlo multiple imputations.

The multivariate regression models for visit adherence were controlled for age, sex, race/ethnicity, primary language, marital status, primary insurance type, distance from the clinic,

Table 1. Patient Demographics During First Surge of COVID-19 Pandemic (2020 Study Cohort).

Variable	Show Group[a]		No-Show Group[b]		*P* Value[c]
	n	Value	n	Value	
Mean age (y) ± SD	126	80.8 ± 8.34	115	81.09 ± 9.00	.80
Male sex (%)	126	28.3	115	26.5	.33
Race/ethnicity (%)	122		103		.04[d]
White		86.7		76.5	
Black		5.7		11.8	
Hispanic		3.8		8.8	
Asian		3.8		2.9	
Primary language English (%)	123	90.5	112	76.5	.004[d]
Married (%)	62	81.1	65	64.7	.08
Insurance (%)	126		115		.42
Medicare		64.1		58.8	
Private		35.9		35.3	
Medicaid		0		5.9	
Mean distance from clinic (miles) ± SD	126	10.4 ± 8.85	115	10.19 ±11.81	.87
Urban (%)	126	26.4	115	52.9	.0017[d]
ADI (%)	125		115		.16
Low		15.1		23.6	
Average		43.4		38.2	
High		41.5		38.2	

Abbreviations: ADI = Area Deprivation Index; n = sample size.
[a]Patients who showed up within 2 weeks of scheduled appointment in 2020.
[b]Patients who did not show up within 2 weeks of scheduled appointment in 2020.
[c]Univariate analysis.
[d]Statistically significant ($P < .05$).

appointment location, and state-level ADI. The covariates for the multivariate regression models for vision loss of 1 line, 2 lines, or 3 or more lines at 6 months and 1 year were controlled for age, sex, race/ethnicity, lens status, presence of glaucoma, and presence of diabetic retinopathy (DR). The presence of cataracts, glaucoma, and DR was included in the multivariate analysis because they were the most common ocular comorbidities that affected VA in our study population; other ocular comorbidities were rare. The analyses also examined the no-show rate and rate of vision loss of more than 1 line, 2 lines, or 3 or more lines for patients with a follow-up before and during the pandemic using the McNemar test.

All analyses were performed using Stata/IC software (version 12.1, StataCorp LLC). For the univariate and multivariate analyses, a *P* value less than 0.05 was considered statistically significant. Mean values are ± SD.

Results

Effect of the Pandemic on Visit Adherence

One hundred forty-nine patients had injection appointments scheduled in both the 2019 and 2020 study windows. Significantly more patients came to at least 1 scheduled appointment in 2019 (48%) than 2020 (10%) ($P < .0001$), indicating that the pandemic affected the overall visit adherence for nAMD patients receiving intravitreal injections by almost 5-fold.

Demographic Factors Affecting Visit Adherence During the COVID-19 Pandemic

The 2020 study cohort consisted of 241 patients, with 126 in the show group and 115 in the no-show group. The mean age of the 175 women (72.6%) and 66 men (27.4%) was 80.9 ± 8.5 years, with no significant difference between the 2 groups ($P = .80$).

Table 1 shows the univariate analysis of the 2020 patient demographics by visit adherence status. Race/ethnicity ($P = .04$), primary language ($P = .004$), and appointment location (urban vs suburban) ($P = .0017$) were significantly different between the show group and the no-show group. After adjusting for age, sex, race/ethnicity, primary language, marital status, insurance, distance from the clinic, appointment location, and ADI, only the primary language and appointment location were significantly different in multivariate analyses. Non-English-speaking patients were less likely to come to their visits than English speakers (logistic regression coefficient [Coef], −1.13; 95% CI, −2.20 to −0.06; $P = .03$). Urban patients were less likely to present for their injection visits (Coef, −1.16; 95% CI, −2.11 to −2.18; $P = .01$). Non-White patients did not have worse visit adherence than their White

Table 2. Percentage With Short-Term and Long-Term Vision Loss by Visit Adherence (Univariate Analysis).

	Percentage		
Vision Loss	Show Group[a]	No-Show Group[b]	*P* Value[c]
Short term (6 mo)			
1 line	20.7	32.3	< .0001[d]
2 lines	9.4	17.6	< .0001[d]
3 lines	5.6	14.7	< .0001[d]
Long term (1 y)			
1 line	32	38.2	.006[d]
2 lines	18.9	20.6	.008[d]
3 lines	13.2	17.6	.002[d]

[a]Patients who showed up within 2 weeks of scheduled appointment in 2020.
[b]Patients who did not show up within 2 weeks of scheduled appointment in 2020.
[c]Univariate analysis.
[d]Statistically significant ($P < .05$).

Table 3. Vision Loss in Show Group and No-Show Group During First Surge of COVID-19 Pandemic (Logistic Regression).[a]

	Univariate		Multivariate[b]	
Vision Loss	Coef (95 % CI)	*P* Value	Coef (95 % CI)	*P* Value
Short term (6 mo)				
1 line	1.19 (0.65-1.74)	<.0001[c]	1.24 (0.67-1.81)	<.0001[c]
2 lines	1.24 (0.63-1.86)	<.0001[c]	1.32 (0.67-1.98)	<.0001[c]
3 lines	1.52 (0.85-2.19)	<.0001[c]	1.64 (0.92-2.37)	<.0001[c]
Long term (1 y)				
1 line	0.71 (0.20-1.22)	.006[c]	0.69 (0.16-1.23)	.01[c]
2 lines	0.72 (0.19-1.25)	.008[c]	0.76 (0.19-1.32)	.008[c]
3 lines	0.86 (0.31-1.42)	.002[c]	0.87 (0.29-1.45)	.003[c]

Abbreviation: Coef = logistic regression coefficient.
[a]Change in vision was calculated by visual acuity (VA) at timepoint (6-month or 12 month visit) minus average baseline VA and categorizing VA changes based on lines of vision loss.
[b]Adjusted for age, sex, race, lens status at 6 months or 12 months, presence of glaucoma, and presence of diabetic retinopathy.
[c]Statistically significant ($P < .05$).

counterparts (Coef, 0.14; 95% CI, −0.19 to 0.48; $P = .41$). All other variables remained nonsignificant on multivariate analyses.

Effects of Visit Adherence on Vision Loss

Table 2 shows the impact of nonadherence on VA at 6 months and 1 year for the 2020 study cohort. Fewer patients in show group than in the no-show group had vision loss over the short term and long term. In the show group, which began with 126 patients, 122 patients had a follow-up appointment at 6 months and 110 had a follow-up appointment at 1 year. In the no-show group, which began with 115 patients, 86 patients had a follow-up appointment at 6 months and 80 patients had a follow-up appointment at 1 year. After adjusting for age, sex, race/ethnicity, lens status, presence of glaucoma, and presence of DR, the no-show group still had a significantly greater percentage of patients than in the show group with a 1-line, 2-line, or 3-line vision loss at 6 months and 1 year, as shown in Table 3.

Conclusions

To date, there are limited data on the impact of nonophthalmic factors on visit adherence by patients with nAMD receiving intravitreal injections during the COVID-19 pandemic. Ours is among the first few case-control studies to examine whether demographic factors, such as age, sex, race/ethnicity, primary language, marital status, insurance status, distance from appointment, appointment location, and socioeconomic health, affect visit adherence and long-term VA. We found that the initial surge of the pandemic negatively affected visit adherence by almost 5-fold over the previous year and that patients who were non-English speakers and sought care at our urban, hospital-based clinic were more likely to not to show for their injection visit than patients who were English speakers or attended our affiliated suburban eye clinics. There was no significant difference in visit adherence in all other demographic factors studied. In addition, a significantly greater percentage of patients in the no-show group than in the show group experienced vision

loss at the 6-month and 1-year follow-ups, indicating the negative long-term consequences of visit nonadherence.

To our knowledge, only 1 other study, by Ashrafzadeh et al,[15] examined the effect of nonophthalmic factors on injection appointment adherence during the COVID-19 pandemic. The results in our study differed from those of Ashrafzadeh et al in terms of race/ethnicity outcomes. Although they found that the visit adherence of Hispanic/Latino patients remained consistent, we noted a drop in univariate analysis for non-White patients but no differences on multivariate analysis. This can be explained by the higher percentage of Hispanic/Latino patients in our urban hospital-based clinic than in our suburban clinics and the lower visit adherence overall in the urban clinic on univariate and multivariate analyses. One possible explanation for why race/ethnicity was significant in our univariate analysis but not our multivariate analysis is that race/ethnicity, defined as shared physical traits or cultures, does not inherently affect visit adherence but rather that the social determinants of health and barriers to care disproportionately affect non-White individuals. Our multivariate analysis suggests that barriers to care, such as not speaking English and residing in an urban area, may be causes for visit nonadherence.

Transportation and fear of COVID-19 might have disproportionately affected our urban patients because many rely on public transportation to travel to their appointments, resulting in lower adherence with the urban appointments for injections. Public transportation was a riskier mode of transportation during the initial surge of the pandemic and a known barrier to healthcare use in other marginalized communities.[21] In general, suburban patients are less reliant on public transportation. Moreover, patients might have felt that a suburban clinic that provided only eyecare posed a lower COVID-19 risk than a large urban-based hospital serving multiple specialties with a higher census of COVID patients. These findings are supported by previous studies, which also found an exacerbation of preexisting barriers, resulting in loss to follow-up.[22–25]

Our study also emphasized the impact of visit nonadherence on short-term (6-month) and long-term (1-year) VA. Although some studies found some resolution of OCT findings, improvement in central macular thickness, and a nonsignificant improvement in VA after reinitiation of treatment, other studies support our findings of long-term vision loss resulting from visit nonadherence.[1–3,9] Stattin et al[9] reported that VA decreased by 1.9 Early Treatment Diabetic Retinopathy Study letters 1 year after injection appointments were missed during the pandemic. In a study by Soares et al,[3] there was a drop in VA of 3 to 4 lines over a 1-year gap in care. The greatest proportion of patients in our no-show group had 1 line of vision loss. This indicates that missing an injection, even for a short period, can cause permanent damage and might be a predictor for worse long-term VA.

This study was limited by the retrospective design and inclusion of patients who had a follow-up visit. In focusing on patients who had at least some follow-up data at 6 months and 1 year to assess the impact on VA, we excluded all patients who continually did not show at these timepoints. This could reflect a particularly vulnerable population who would benefit from further investigations. In addition, the impact of race/ethnicity, although significant on univariate analysis, was likely not adequately powered to show significance on multivariate analysis, probably because of the smaller samples of nAMD patients in those subgroups. Further studies are warranted to address this as a risk factor. Finally, it is unclear whether our typical reminder and rescheduling protocol was consistently functioning throughout the pandemic given the chaotic nature of the healthcare system, with staffing limitations and constant shifting of priorities. This could have been a potential confounder.

In summary, the initial surge of the Covid-19 pandemic significantly affected visit adherence for patients with nAMD receiving intravitreal therapy. Non-English-speaking and urban hospital–based patient populations had a lower injection appointment attendance rate, which was a predictor for long-term visual consequences. This highlights disparities in healthcare that disproportionately affect marginalized populations and is a starting point for understanding and developing interventions to reduce visual harm to vulnerable populations.

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Ethical Approval

This study was approved by the Boston University Institutional Review Board, conducted by regulations set forth by the US Health Insurance Portability and Accountability Act of 1996, and adhered to the tenets of the Declaration of Helsinki.

Statement of Informed Consent

Informed consent was not required for this retrospective chart review study given the impracticality of consenting the large, initial number of patients' charts reviewed.

Declaration of Conflicting Interests

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