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Review

CURRENT CONCEPTS AND MODALITIES FOR MONITORING THE FELLOW EYE IN NEOVASCULAR AGE-RELATED MACULAR DEGENERATION

An Expert Panel Consensus

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Purpose: The presence of neovascular age-related macular degeneration (nAMD) in one eye is a major risk factor for the development of disease in the fellow eye. Several methods exist to help physicians monitor the fellow eye, with new technologies becoming increasingly available.

Methods: We provide an overview of modalities for nAMD monitoring, including advances in home-based options, and review their utility for fellow-eye monitoring, based on a review of the literature and a consensus of retinal experts.

Results: Studies demonstrate the importance of early detection of nAMD in the fellow eye so that interventions can be made before significant vision loss occurs. A series of techniques exist for the early detection of nAMD including chart-based methods and imaging devices. The increased availability of home-based methods has presented an opportunity for patients to monitor their vision at home.

Conclusion: Frequent monitoring of the fellow eye in patients with unilateral nAMD is of critical importance to prevent vision loss and maintain quality of life. Patients should be examined every 3 to 4 months from the time of choroidal neovascularization diagnosis and encouraged to monitor their vision at home using home-based technologies where available, to provide the best opportunity for early detection.

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Despite a significant decrease in age-related macular degeneration (AMD)-related blindness in the past decade, largely due to the introduction of effective treatment with anti–vascular endothelial growth factor therapy,[1–3] age-related macular degeneration remains a major cause of central vision loss, affecting 10% of people aged ≥65 years.[4]

Age-related macular degeneration is considered a bilateral disease, affecting both eyes over its natural course. However, the development of neovascular AMD (nAMD) typically manifests in one eye. The presence of nAMD in one eye is a major risk factor for the development of nAMD in the fellow eye.[4–6] The incidence of nAMD in the fellow eye has been reported in up to 26.8% of untreated patients after 4 years,[7] with some reports suggesting that the annual incidence of choroidal neovascularization (CNV) in the fellow eye is approximately 10%.[8]

Early detection of nAMD in the fellow eye of patients with unilateral disease is necessary for preventing progression to bilateral vision loss and thereby preserving patient functioning and quality of life.[9] However, many patients with unilateral nAMD may have already experienced a decrease in visual

acuity by the time CNV lesions are detected in the fellow eye, despite the availability of imaging techniques such as optical coherence tomography (OCT), and more recently, OCT angiography (OCT-A), which could potentially detect asymptomatic CNV.[5,10,11] It is therefore important that patients with unilateral nAMD undergo regular monitoring of both eyes so that prompt initiation of treatment can occur to preserve visual function.[12–14]

A range of clinic- and home-based methods for the early detection of nAMD is available and can be used to monitor the fellow eye in patients with existing nAMD[9,15,16]; however, these methods have not previously been systematically compared. In this review, we discuss the rationale and importance of fellow-eye monitoring in at-risk patients with unilateral nAMD. We also provide an overview of the advantages and limitations of current clinic- and home-based detection methods for fellow-eye monitoring and provide clinical recommendations for monitoring in these patients.

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Methods

This article was based on a review of the literature and a consensus among retinal experts who are members of the Vision Academy, an international group of retinal physicians who work together to share existing skills and knowledge and provide collective recommendations on clinical challenges in areas where there is a lack of conclusive evidence in the literature (www.visionacademy.org). For this review, selected members of the Vision Academy volunteered to participate and met in October 2017 to review and discuss the current literature on fellow-eye monitoring and early detection of nAMD. A literature search and subsequent discussions led to a consensus among the members to provide guidance and promote best practice for monitoring of the fellow eye in cases where unilateral disease has been detected.

The Importance of Early Detection of Choroidal Neovascularization in the Fellow Eye

Natural history of neovascular age-related macular degeneration and risk to the fellow eye. Neovascular age-related macular degeneration is a progressive disease, and CNV lesion growth is typically associated with vision loss.[9] A meta-analysis by Wong et al[7] of over 4,000 patients with untreated nAMD revealed that 21.3% of patients developed severe vision loss at 6 months compared with baseline, increasing to 41.9% by 3 years. At 3 years, 75% of patients were legally blind.

Unilateral nAMD also frequently progresses to bilateral disease (Table 1). A pooled analysis of three prospective population-based studies by Joachim et al[17] showed that by 5 years, 20% to 25% of unilateral AMD cases had progressed to bilateral disease and up to 50% of late-stage unilateral cases progressed to fellow-eye involvement. Similarly, a retrospective analysis of clinical trials by Barbazetto et al[18] showed that CNV developed in the fellow eye in 23.8% to 38.8% of patients by 2 years. In addition, the meta-analysis by Wong et al[7] showed that by 12 months, 12.2% of patients with untreated nAMD had developed nAMD in the fellow eye, increasing to 26.8% at 4 years.

The burden of neovascular age-related macular degeneration in the fellow eye. Development of nAMD in the fellow eye has been associated with

Table 1. Studies Demonstrating Evidence of Choroidal Neovascularization in the Fellow Eye

Publication	Design	Patients (N)	Key Findings
Cachulo L et al[44]	Single-center, prospective, observational, longitudinal 2-year study of patients with nAMD in one eye and early ARM in the fellow eye	62	32.7% of patients developed nAMD in the fellow eye after 2 years
Joachim N et al[17]	A pooled analysis of 5-year progression in patients from three prospective population-based cohorts	1,490	In any 5-year duration, 19%–28% of unilateral AMD cases became bilateral 27%–68% of late-stage unilateral AMD cases became bilateral after 5 years
Silva R et al[45]	Single-center, prospective, observational, longitudinal 2-year plus 1-year extension study of patients with nAMD in one eye and early ARM in the fellow eye	52	In patients with nAMD in one eye, 46% had confirmed CNV in the fellow eye after 3 years
Ueta T et al[46]	Retrospective, observational, consecutive case series of patients diagnosed with exudative AMD	216	The cumulative incidence of fellow-eye involvement was 3.4% after 1 year, 9.3% after 3 years, and 11.3% after 5 years
Yanagi Y et al[47]	Prospective, observational study of patients with nAMD	76	Neovascularization was present in 18% of fellow eyes of patients with unilateral AMD PPE was a risk factor associated with neovascularization
Yanagi Y et al[48]	Prospective, observational cohort study of patients with nAMD	95	Estimated annual incidence of fellow-eye involvement was 18.1% (95% CI, 8.5%–40.4%) and 2.0% (95% CI, 0.44%–8.40%) for eyes with and without nonexudative neovascularization, respectively The probability of developing exudation within 6 months was significantly higher in eyes with baseline nonexudative neovascularization than those without (P = 0.008)

ARM, age-related maculopathy; CI, confidence interval; PPE, pachychoroid pigment epitheliopathy.

significantly lower vision-related quality of life, with significant worsening in social functioning, role difficulties, dependency, and driving.[19] Progressive loss of visual acuity in the fellow, better-seeing eye also causes a concomitant decline in quality of life.[10] Bilateral nAMD also places a burden on caregivers and family members, with up to 30% of patients requiring assistance with activities of daily living, as compared with just over 6% of elderly non-AMD patients. In addition, the rate of falls is twice as high (16% vs. 8%) in patients with bilateral nAMD versus non-AMD patients.[20,21]

Preserving vision in patients with neovascular age-related macular degeneration. Current treatments for nAMD are based on anti–vascular endothelial growth factor pharmacotherapies. These treatments limit the underlying pathophysiological process of the disease, restoring retinal morphology and subsequently increasing or maintaining visual function.[9,16,22] A substantial body of evidence from both randomized clinical trials and real-world studies suggests that better outcomes are achieved with these therapies if treatment is started early, before the CNV lesion advances and loss of visual acuity occurs.[12,13,23]

In Phase III trials of ranibizumab or bevacizumab, higher visual acuity scores and a smaller CNV lesion at baseline were associated with higher visual acuity scores after 1 year of treatment. Although treatment in patients with lower baseline visual acuity scores did lead to significant improvements, the post-treatment scores were generally not as good as in those with higher baseline scores.[12] In Talks et al's[14] retrospective analysis of electronic medical records data in

patients receiving aflibercept, a higher baseline visual acuity score was also associated with better visual acuity after 1 year, and an observational study by Lövestam-Adrian et al[24] demonstrated that good baseline visual acuity was important for best prognosis. Similar trends have been observed in longer-term studies of up to 5 years.[23,25]

This has also been demonstrated in the treatment of fellow eyes. Analyses of ranibizumab treatment by Chew et al[5] and Zarranz-Ventura et al[26] show that fellow eyes with good baseline visual acuity, in which CNV was detected during treatment of the first eye, have higher rates of visual stability and maintain better levels of visual acuity versus first-treated eyes. A post hoc analysis of data from two clinical trials in 2,412 patients demonstrated that >85% of fellow eyes had signs of AMD at baseline (i.e., drusen and pigment), with one-third of the fellow eyes displaying evidence of CNV at baseline.[6]

Collectively, these findings underscore the importance of early detection of CNV before the lesion progresses and severe vision loss occurs, based on current evidence indicating that prompt treatment leads to better visual outcomes. This is especially critical in patients with existing nAMD because avoiding loss of vision in the fellow, better-seeing eye will maintain function and avoid a decline in quality of life.

Factors contributing to delayed detection of neovascular age-related macular degeneration. Diagnosis of nAMD is currently based on patient history and clinical examination at the initial presentation, with fluorescein angiography and OCT used to confirm the diagnosis.[22,27] However, there are often delays between the initial formation of CNV and its detection, with lesions frequently identified only after considerable vision loss has occurred.[9,22] A meta-analysis of untreated control eyes from clinical trials of nAMD treatment estimated that even in the patients enrolled earliest into the studies, CNV had been present for 7.7 months before trial enrollment.[16,28]

There are several reasons for this potential delay. Patients may remain asymptomatic during the early stages of disease,[9] during which time CNV lesions grow more rapidly.[28] Patients may also not notice visual changes during the early stages of disease due to compensatory brain mechanisms, especially in cases where the lesion is outside the fovea.[9,29] A study by Chew et al[5] of clinical outcomes in fellow eyes in patients receiving ranibizumab treatment demonstrated that 53% of patients with OCT-detectable CNV in the fellow eye were asymptomatic, with 75% of these patients not showing a reduction in visual acuity versus their previous visit. For these reasons, a reliance on measuring change in visual acuity and the occurrence of symptoms may delay the diagnosis of nAMD until after the CNV lesion is established and advanced.[5]

There is also a need to increase familiarity with the symptoms of nAMD among those most at risk in the general population, such as older patients, and to raise awareness of the risk of progression to fellow-eye involvement among patients with unilateral nAMD.[9,16,22] Although many patients with visual changes promptly seek medical assistance, a multinational survey of over 900 patients with nAMD, conducted by Varano et al,[30] indicated that more than a quarter (27%) waited longer than 1 month before visiting a health care provider, primarily due to beliefs that symptoms would resolve on their own or that they were just part of the aging process. One of the main obstacles to treatment cited during the survey was the inability of caregivers to take patients to appointments; it is possible that patients may delay care out of fear of being a burden to others.[30] This highlights the importance of disease awareness among both patients and their caregivers, which is critical for early diagnosis and effective disease management.

Finally, discussion of the prognosis of nAMD with patients should include an explanation of the expected disease course in both eyes.[10] It is important to determine the status of the fellow eye at the time of nAMD diagnosis, to emphasize the need for patients to maintain regular monitoring, and to inform patients that early detection of CNV in the fellow eye may lead to improvements in long-term visual outcomes.

Risk Factors for Development of Choroidal Neovascularization in the Fellow Eye

Previous studies have identified several classic risk factors for the development of AMD, and many of these risk factors are also linked to the risk of developing nAMD in the fellow eye (Table 2), including the presence of AMD in the first eye, the large presence of drusen, or retinal pigmentary abnormalities.[17] In addition, the characteristics of lesions in the fellow eye are frequently similar to the characteristics of lesions in the first eye, including large fibrosis, hemorrhagic tendency, and the presence of retinal angiomatous proliferation.[31–33]

Modalities for Early Detection and Monitoring of Neovascular Age-Related Macular Degeneration

A series of techniques exist for the early detection of nAMD, ranging from chart-based methods such as Amsler grids and visual acuity testing through to specific software and devices such as noise field perimetry, OCT, and OCT-A. An overview of these

Table 2. Risk Factors for the Development of Age-Related Macular Degeneration and Bilateral Age-Related Macular Degeneration

Development of AMD	Development of Bilateral AMD
Age[49]	Age[17]
Cigarette smoking[49,50]	Cigarette smoking[17]
Genetic variants[51]	Genetic variants[17]
CFH	*CFH*
ARMS2	*ARMS2*
IL-8	
TIMP3	
SLC16A8	
RAD51B	
VEGF-A	
COL8A1	
White ethnicity[49]	Presence of unilateral AMD[17,50]
	Large number of drusen or retinal pigmentary abnormalities[17,44]
	PPE[47]
	Subclinical nonexudative neovascularization (subclinical macular neovascularization) detectable by OCT-A[42,52,53]

ARMS2, age-related maculopathy susceptibility 2; *CFH*, complement factor H; *COL8A1*, collagen alpha-1 (VIII) chain; *IL-8*, interleukin-8; PPE, pachychoroid pigment epitheliopathy; *RAD51B*, DNA repair protein RAD51 homolog 2; *SLC16A8*, solute carrier family 16 member 8/monocarboxylate transporter 3; *TIMP3*, metalloproteinase inhibitor 3; *VEGF-A*, vascular endothelial growth factor A.

techniques is provided in Table 3, along with comments on their utility for monitoring of the fellow eye in patients with nAMD.

Advances have also been made in the home-based detection and monitoring of nAMD, with the availability of devices that make use of preferential hyperacuity perimetry and shape discrimination hyperacuity. Both of these technologies assess the ability to perceive small differences in the relative spatial localization of two or more objects (Table 4).[9,16] Importantly, hyperacuity thresholds do not seem to vary with age and are not affected by ocular media opacity.[34,35]

The widespread utilization of smartphones and other personal devices such as tablets has also presented opportunities for home-based monitoring applications. Smartphone-based fundus imaging utilizes the stock camera and an external lens to capture retinal images, although the correct positioning to acquire such images does require a certain level of skill.[36,37] Smartphone-based visual acuity testing allows patients to utilize an application to self-test their acuity using a familiar test of the letter "E" in various orientations. Smartphone settings should also be taken into consideration, as contrast and brightness can affect testing outcomes.[38,39] However, in both cases, patients can utilize their personal smartphones for monitoring, providing increased convenience and access. Additional applications are available for use on other personal devices such as tablets. These include an application in development for measuring contrast sensitivity, which can identify slow changes in vision.[40] The PsyPad application measures sensitivity to luminance increment on a portable device and has demonstrated results consistent with microperimetry; however, as mentioned with other applications in Table 4, a learning curve in terms of ambient lighting and viewing distance may be necessary in order for consistent results to be obtained.[41] Additional details of these technologies and their role in monitoring of the fellow eye are presented in Table 4.

Recommendations for Monitoring the Fellow Eye in Patients With Neovascular Age-Related Macular Degeneration

Based on the current evidence, we have developed four key recommendations for the monitoring of the fellow eye in patients with nAMD:

1. Monitoring of the fellow eye should be considered standard of care in most patients with CNV due to nAMD. Patients should be carefully educated on the symptoms associated with disease progression in the fellow eye, as well as the importance of early access to diagnosis and proper care.
2. Examination of the fellow eye should be performed every 3 to 4 months from the time of CNV diagnosis in the first eye.
3. In the clinic, patients should be monitored by visual acuity examination, appropriate imaging (OCT and OCT-A), and, if indicated, fluorescein angiography.
    a. Treatment decisions based on positive OCT-A results alone are a matter of discussion.[42]
4. Patients should monitor their vision at home through monocular reading tests and typically should use home-based technologies where available, including preferential hyperacuity perimetry and shape discrimination hyperacuity, as appropriate for the patient.

Early detection of CNV before the development of advanced CNV lesions is essential for preventing vision loss and maintaining quality of life. Monitoring of the fellow eye should be considered standard of care in all patients with unilateral nAMD. It is important to determine the status of both eyes at the time of unilateral CNV diagnosis and to continue to monitor the fellow eye throughout disease management,[6] particularly due to the fast growth rate of early CNV lesions.[28]

Table 3. Methods of Fellow-Eye Monitoring in Neovascular Age-Related Macular Degeneration

Name	Description	In-Clinic or Home-Based?	Pros	Cons
Amsler grid	Patient reports distortions, blurriness, or missing lines in a 10 × 10-cm grid of 400 squares while vision is fixed on a central point[9]	Both	Suitable for early-stage detection of macular disease[9,54] Widely used and easily accessible[9,16] Available as a Smartphone app[9,16]	Variable sensitivity[9,54] Patients may require supervision and instruction to detect visual field defects[54] Compensation mechanisms may limit detection of visual field defects until they progress beyond a certain size[16] Not suitable for monitoring of progression, as it does not provide precise and quantifiable information[9]
Near visual acuity	Assessed with ETDRS and Snellen charts[55]	Both	Good predictor of reading rate[56] Suitable for monitoring of disease progression, which results in reductions in near visual acuity and reading rate[56] Charts are easily accessible and suitable for home use[9]	Efficacy for early detection of AMD not yet thoroughly assessed[9]
CS	Measures ability to recognize small differences in luminance or distinguish low-contrast differences between an object and the background[55,57–59]	In-clinic	CS represents an important component of functional vision important for activities of daily living[57,58] CS is decreased at all stages of AMD[58] Provides a useful supporting measure to visual acuity testing as it can identify additional aspects of functional impairment[55]	Chart-based CS tests may not be widely available[56] Requires clinic attendance[56] Reliability may be affected by the subjective nature of the tests and environmental conditions such as lighting or reflections[58] Larger studies are required to validate this method[55]
Noise field perimetry	Patients report abnormalities in a monochromatic field of high-frequency flickering dots while keeping vision fixed on a central point[9,60]	In-clinic	Relatively high sensitivity and specificity for AMD, particularly for advanced forms[60] Can overcome compensatory mechanisms affecting patients' subjective perception of scotomas[16] Device is somewhat portable[60]	Clinic attendance and patient instruction before use are required[60] Lacks large-scale trials to support its use[9]

Table 3. (*Continued*)

Name	Description	In-Clinic or Home-Based?	Pros	Cons
OCT/OCT-A	Noninvasive technique for obtaining detailed images of the retina[9,16,61]	In-clinic	Suitable for CNV detection and monitoring and treatment monitoring[9,16,61] High sensitivity for detection of active disease[9] Can detect CNV before patients become symptomatic[5,16] Machines are widely available and relatively quick and easy to use[9] Binocular OCT devices may facilitate monitoring outside the clinic setting in future[16,62] OCT-A involves the sequential acquisition of scans in the same retinal space, and differences in the scans as a result of blood flow are assessed. These image sets are then used to generate 3D images of the choroidal vasculature[16,43]	Requires clinic attendance[9]
MMT	Software program that briefly displays letters in central visual field with a wagon wheel-shaped background pattern to help the patient focus on the center of the display[63]	In-clinic	Provides rapid assessment of visual defects in patients with macular disease[9,16,63] Produces a quantitative score so may be suitable for monitoring disease progression[9,16,63]	Requires clinic attendance[9] Not readily available as computer software, limiting its use in clinical practice[9] Few reports of use in the literature[9]
Microperimetry (MP-1 [Nidek])	Noninvasive technique assessing the sensitivity of the central retina. Allows for correlations of macular anatomy and light sensitivity[64,65] Scanning laser ophthalmoscopy microperimetry allows for the determination of the retinal location of visual stimuli on the retinal image in real time[65]	In-clinic	Allows detailed analysis of macular function in nAMD[65] It may be more sensitive to changes in macular function due to the assessment of a large retinal area[66]	Fixation accuracy is required; therefore, it may be unsuitable for patients with unstable fixation or excessive head movement[67]

CS, contrast sensitivity; ETDRS, early treatment diabetic retinopathy study; MMT, macular mapping test; MP-1, microperimeter 1.

Table 4. Advances in Home-Based Monitoring Techniques for the Fellow Eye in Neovascular Age-Related Macular Degeneration

Name	Description	Pros	Cons
PHP	Patient is shown a pattern of dotted lines, with each line containing an artificial distortion that allows for quantification of any pathological distortion present (Foresee Home Device)[9,16]	High sensitivity for detecting recent-onset CNV[9,16] High specificity for differentiating patients with recent-onset CNV from those with intermediate AMD[9,16] Proven efficacy for the early detection of nAMD[9,15,16] Can facilitate regular monitoring without the patient leaving their home[9] Allows transmission of patient data to a remote monitoring center[9]	Use of the device may be limited by its high price, although reimbursement options may be available[9]
SDH	Involves discrimination of shapes and tests the patient's ability to detect deformations from circularity (MyVisionTrack)[9,16]	FDA-approved Smartphone app for prescription use[9,16,68] Individuals with AMD have significant defects in shape discrimination versus normal subjects, even in the presence of good visual acuity and contrast sensitivity[69] Can potentially detect progression from early to more advanced disease stages and may therefore be suitable for visual function monitoring[68] Under investigation as part of a remote monitoring system involving daily testing of SDH[70]	Use of a Smartphone-based app may be challenging for patients with poor eye, head, and hand coordination or dexterity problems[68]
PsyPad app	A test measuring central retinal sensitivity to luminance increment using an app on a portable device[41]	Showed agreement with results obtained using microperimetry[41] The app was able to be used in an elderly cohort with nAMD in a clinic setting, and differences in retinal sensitivity were correlated to pathology[71]	Potential issues of self-testing, such as consistency of viewing distance and recommended ambient illumination[41]

Table 4. (*Continued*)

Name	Description	Pros	Cons
Smartphone-based fundus imaging	Using a Smartphone and a 20D external lens, retinal images can be captured using the phone's stock camera application[36]	Smartphones are relatively universally available and can remove some of the barriers to timely detection[36] Selfie fundus imaging has also been proposed as an innovative approach to retinopathy screening. Patients can transfer their images to a screening center[72]	The correct positioning to acquire retinal images requires a certain level of skill[36,37]
Smartphone-based visual acuity testing	Peek Acuity app uses the letter "E" in four orientations[38] Eye Handbook app measures near visual acuity[39]	Patients are familiar with this type of testing[38] Eye Handbook app can easily be used in emergency or non-ambulatory situations[39]	The Eye Handbook app was found to overestimate near visual acuity as compared with the near vision card, possibly due to the high contrast levels and increased brightness of Smartphones; therefore, phone settings may need to be considered[39]
Contrast sensitivity (tablet)	Portable assessment of the contrast sensitivity function[40]	Contrast sensitivity can potentially monitor slow vision loss better than visual acuity testing[40] Reduces vision testing time[40]	No commercial app appears to be available
MultiBit test	Uses field-size bright dots briefly presented against a bright background[73]	Extensive test area using minimal information[73] Stable fixation not needed[73]	May be difficult to apply to patients at either end of the spectrum of visual acuity[73]

FDA, Food and Drug Administration; PHP, preferential hyperacuity perimetry; SDH, shape discrimination hyperacuity.

Examinations should be performed at least every 3 to 4 months after the diagnosis of CNV in the first eye. Patients examined in the clinic for intravitreal injection should also undergo examination of the fellow eye at each visit, as early detection of CNV in the fellow eye may lead to improvements in long-term visual outcomes.

As it is unlikely that patients will notice small changes in their vision during the early stages of disease, visual acuity examination and appropriate imaging (OCT and OCT-A) are important aspects of monitoring the fellow eye. Optical coherence tomography is the mainstay of monitoring patients with AMD and can indicate disease progression before evidence from examination or fluorescein angiography.[9] The recent development of OCT-A has made the visualization of the choroidal vasculature possible using a noninvasive technique.[16,27] Optical coherence tomography angiography has also been demonstrated to be a useful method for assessing CNV,[43] detecting neovascularization in cases where fluorescein angiography and OCT were negative for leakage and fluid, respectively. However, treatment decisions based on positive OCT-A results alone are still a matter of discussion.[42]

Patients should be educated on how to self-monitor their vision and their eyes frequently for signs of disease occurrence, as this will provide the best opportunities for early detection. Ideally, patients should make this part of their weekly routine. Simple tests, including monocular reading of a standardized text (e.g., a newspaper, book, or TV subtitles) at the limit of a patient's reading ability, drawing on millimeter paper, and dot-joining exercises, are the minimum requirement to detect any changes. These tests are especially important in patients who already have a diagnosis of nAMD in one eye.

In countries where home-based technologies are marketed, these should be recommended as appropriate for the patient's overall health status and abilities. Self-monitoring technologies have undergone significant developments in recent years. As this development continues, consistent re-evaluation will be needed when identifying appropriate self-monitoring modalities for individual patients. The sensitivity and specificity of the instrument should be carefully considered along with its ease of use when recommending it for patient monitoring at home. Autonomous instruments with complete connection to the patient's clinical care program are highly preferred, and features such as voice control will also aid in effective utility.

Patients may suffer from comorbid conditions and have disabilities in addition to visual impairment, and these must be taken into account when choosing a monitoring modality. It will be important to determine whether patients are able to utilize the home-based devices before making monitoring recommendations, which could be determined through in-office trials with the devices under clinical supervision. The methodology will need to be adapted to the patient's level of understanding and cooperation. If possible, a discussion with the patient's caregiver would be helpful in identifying the appropriate self-monitoring tool for the individual patient. Finally, the availability of home-monitoring devices as well as the cost of these applications will be an important consideration for most patients.

Continued advancements in OCT technology indicate the possibility of a home OCT device in the future. As OCT can detect CNV in fellow eyes early in the disease course, this development could become the standard in home nAMD monitoring. Alongside the development of smartphone imaging and testing applications,[36,38,41] home monitoring may soon become a regular part of disease maintenance.

We anticipate that detection of nAMD in the fellow eye of patients can occur at an early stage, and thus, loss of vision and subsequent decrease in quality of life could be more readily avoidable through the adherence to these monitoring recommendations. Furthermore, intravitreal injection clinics should acquire emergency capabilities and protocols for patients experiencing symptoms or CNV development to prevent delays in treatment.

Conclusion

Loss of vision in the fellow, better-seeing eye in patients with nAMD can have a profound impact on patient functioning and quality of life. However, even when CNV is present in the fellow eye, patients may remain asymptomatic for a period of time or may not notice initial small changes in their vision. If the presence of CNV is detected early, before vision loss occurs, interventions can be made in a timely fashion and visual function can be maintained or improved. Frequent monitoring of the fellow eye in patients with nAMD is therefore of critical importance to ensure CNV does not remain undetected for a prolonged duration.

Key words: age-related macular degeneration, bilateral, choroidal neovascularization, fellow eye, home-based monitoring, monitoring, vision loss.

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