2019 Clinical Practice Guide

for the diagnosis, treatment and management of Age-Related Macular Degeneration

Optometry
AUSTRALIA

Contents

Development of this guide

Optometry Australia has developed this Clinical Practice Guide in consultation with an expert working group comprised of 8 experienced practitioners who work extensively in the area of age-related macular degeneration assessment and management.

This Clinical Practice Guide provides evidence-based information about current best practice in the management of age-related macular degeneration. It is a general guide for optometrists, and is not a formal treatment or management protocol. Optometry Australia supports the various modes of optometry practice and advises adherence to the Optometry Board of Australia Code of Conduct at all times. This guide was approved by the Optometry Australia Board of Directors on February 8, 2019 and is due for revision in 2022.

Working group

Kerryn Hart – Chair
Optometry Australia National Clinical Policy and Standards Advisor

Lauren Ayton – Literature review
University of Melbourne

Carla Abbott
Centre for Eye Research Australia

Sue Kalff
Private Practitioner

Jia Jia Lek
University of Melbourne

Angelica Ly
Centre for Eye Health

Gary Page
Private Practitioner

Bill Robertson
Private Practitioner

Rebecca Tobias
Centre for Eye Health

Introduction

Age-related macular degeneration (AMD) is the most common cause of irreversible vision loss in people over the age of 50 years in Australia, affecting approximately 1 in 7.[7] This is equivalent to approximately 1.25 million people, and is expected to rise to 1.7 million by 2030.[8] Globally, it is estimated that 8.41 million people had moderate or severe vision impairment from AMD in 2015, and it is the cause of 5.64% of cases of legal blindness (1.96 million people).[9] The prevalence of late AMD in people of European ancestry is 1.4% at the age of 70 years, 5.6% at 80 years and 20% by 90 years.[10] It is a multi-factorial eye disease, with a number of known and suspected risk factors. AMD described in this guideline refers to the phenotype associated with drusen and pigmentary abnormalities associated with progression to geographic atrophy and/or choroidal neovascularisation.

AMD has a significant socioeconomic burden. In 2010, the total cost of AMD-related vision loss (including direct and indirect costs) in Australia was estimated at $5.15 billion.[8] Since this time, the utilisation of anti-vascular endothelial growth factor (anti-VEGF) injections has increased dramatically, meaning this value will now likely be higher. In addition, AMD has a high personal cost – including a loss of independence and social interaction[11], decreased quality of life[12] and increased levels of depression (up to 1 in 3 people with AMD).[13, 14] Caregivers of people with AMD are also at high risk of emotional distress and disruption to their own lives.[15]

It is important that optometrists are confident and competent in assessing patients with or at risk of developing AMD, so that they are able to provide evidence-based management and advice including appropriate communication, diagnosis and referral when indicated.

Risk factors for AMD

The following risk factors make it more likely that a person will develop AMD. The factors have been divided into those with strong, moderate and weak evidence, as determined by a systematic review.[16]

Table 1: Risk factors for AMD		
Risk factor	**Note**	**Level of evidence**
Older age (>60 years)	The strongest risk factor for AMD.[4, 16] The risk of developing AMD increases more than threefold in patients older than 75 years compared to those aged between 65 and 74 years.[4, 17]	Strong
Family history of AMD/genetics	34 different loci have been identified.[18, 19]	Strong
Smoking	The strongest modifiable risk factor. Has been shown to at least double the risk of AMD.[20] There is a direct correlation between current smoking and the number of cigarettes a person has smoked during their life and their risk of late stage AMD.[21, 22] Smokers, on average, develop age-related macular degeneration 5 to 10 years earlier than non-smokers.[8]	Strong
Hypertension	Three case control studies have identified a significant association between hypertension and late AMD.[16, 23]	Moderate
Cardiovascular disease	A history of cardiovascular disease may approximately double the risk of late AMD.[16]	Moderate
BMI of 30kg/m^2 or higher	The Blue Mountains eye study and other major prospective studies have shown that being overweight/obese increases the risk of late AMD.[16, 24-26]	Moderate
Diet low in omega 3 fatty acids, vitamins, carotenoid and minerals [27, 28]	There have been a number of studies showing interactions with diet and AMD, particularly from the Age-Related Eye Disease Studies 1 and 2 (AREDS).[29, 30] A diet high in macular carotenoids (zeaxanthin and lutein) and omega-3 long-chain essential fatty acids may be protective.[31]	Weak*
Diet high in fat (saturated fats, trans fats and omega-6 fatty acids)[32]	A 2014 Melbourne study found that a diet high in fruits, vegetables, chicken, and nuts and a pattern low in red meat seems to be associated with a lower prevalence of advanced AMD.[33] No particular food pattern seemed to be associated with the prevalence of the earliest stages of AMD.[33]	Weak*
Lack of exercise [34, 35]	A prospective study found that higher doses of vigorous exercise was associated with lower incident risk of AMD.[34]	Weak*

* Although a higher level of evidence is currently lacking, it may be nonetheless prudent for clinicians to advise patients of the potential risk of AMD associated with a lifestyle factors, including diet and a lack of exercise.

Clinical pearls

– A Melbourne-based study found that despite our knowledge of the relationship between diet and smoking with AMD, only one third of a sample of optometry patients had been routinely questioned about smoking status, diet and nutritional supplements.[1]

– Optometrists have a duty of care to raise the issue of smoking as the strongest modifiable risk factor in AMD development and progression.

– Please contact Dr. Laura Downie at ldownie@unimelb.edu.au for access to the 'Quantitative Clinical Smoking Behaviour Tool' and 'Quantitative Diet and Nutritional Supplement Tool', which are designed to capture information about these key lifestyle factors and how they affect the risk of AMD development and progression for your patient.

Clinical classification

Historically, there has been considerable confusion over even basic terms in AMD. For example, although the term "age-related maculopathy" (ARM) is sometimes used to describe exaggerated "normal" age-related changes at the macula, the exact distinction between ARM and early AMD varies. Similarly, dry AMD has been used in reference to presentations varying from drusen only to geographic atrophy.

To avoid confusion, the working group recommends limiting the use of these terms "age-related maculopathy", "wet" and "dry" AMD.

The most current clinical classification scheme for AMD is the Beckman classification (see Table 2). This scheme arose from the Beckman Initiative for Macular Research Classification Committee, a panel of expert ophthalmologists, a neuro-ophthalmologist and a methodologist.[3] The classifications are determined based on clinical examination (using common ophthalmoscopy equipment, such as an ophthalmoscope or slit lamp with accessory lenses) or evaluation of a fundus photo. Classification is based on fundus lesions within two disc diameters of the fovea in patients older than 55 years of age.
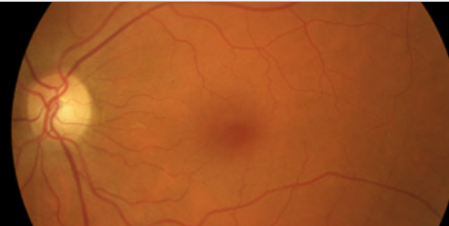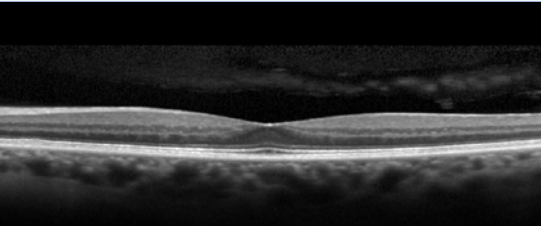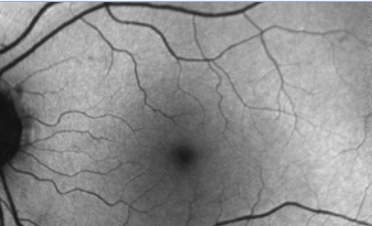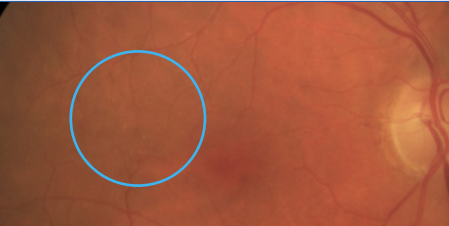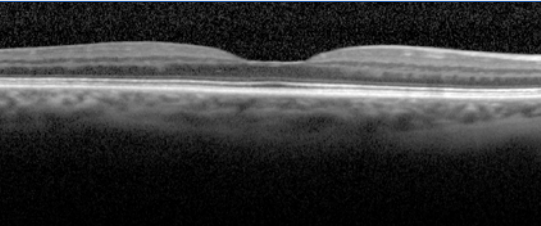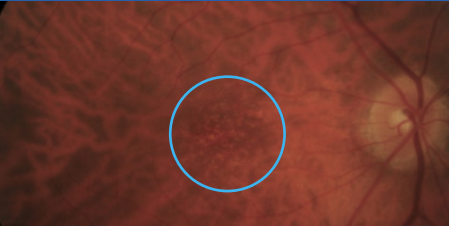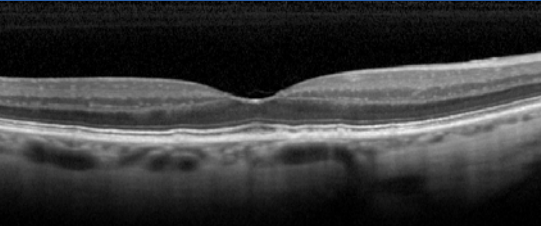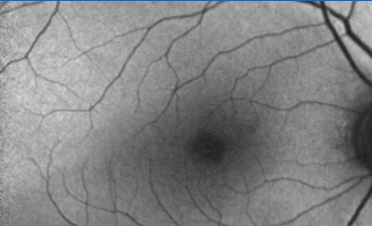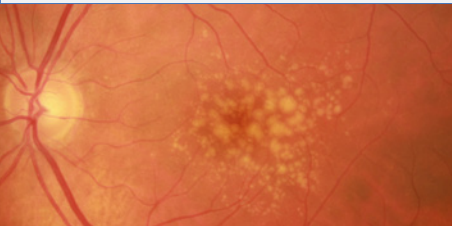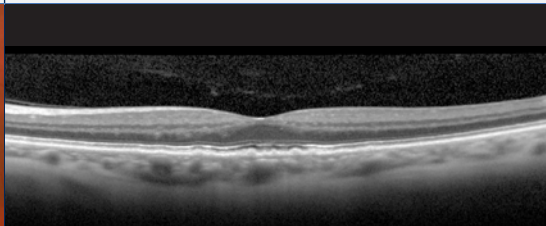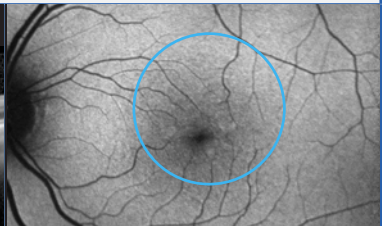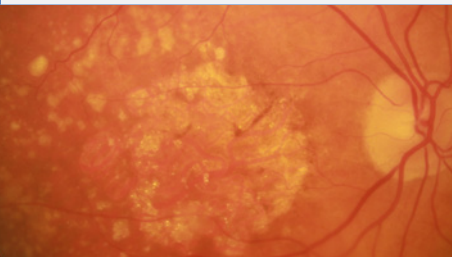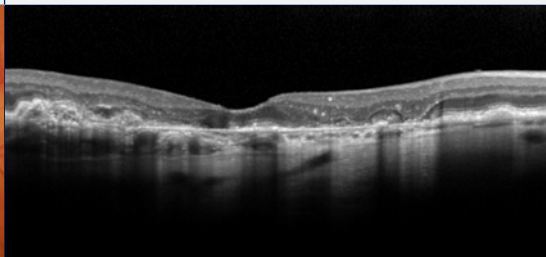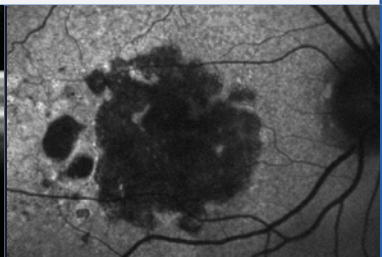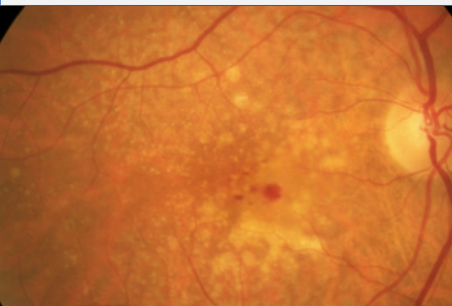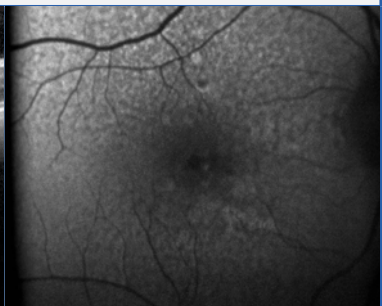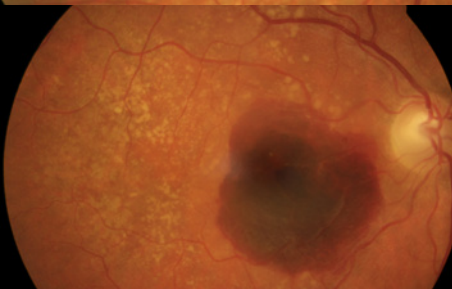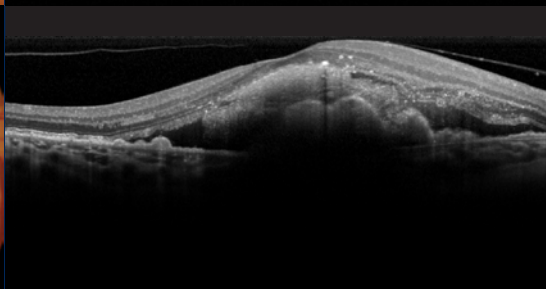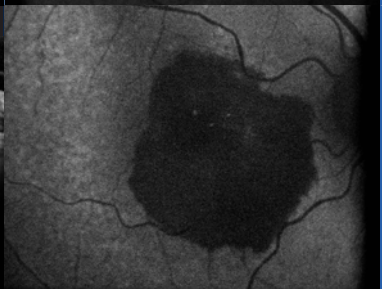
Table 2: Beckmann classification of AMD[3], with corresponding example retinal fundus photos, optical coherence tomography and fundus autofluorescence.

AMD classification	Definition	
No apparent ageing changes	No drusen and no AMD pigmentary abnormalities	

retinal fundus photo — *optical coherence tomography* — *fundus autofluorescence*

AMD classification	Definition	
Normal ageing changes	Only drupelets (small drusen ≤63μm) and no AMD pigmentary abnormalities	

retinal fundus photo — *optical coherence tomography* — *fundus autofluorescence*

AMD classification	Definition	
Early AMD	Medium drusen (>63μm and ≤125μm) and no AMD pigmentary abnormalities	

retinal fundus photo — *optical coherence tomography* — *fundus autofluorescence*

Table 2 continued: Beckmann classification of AMD[3], with corresponding example retinal fundus photos, optical coherence tomography and fundus autofluorescence.

AMD classification	Definition	
Intermediate AMD	Large drusen (>125μm), or medium drusen (>63μm) in addition to AMD pigmentary abnormalities	

retinal fundus photo	*optical coherence tomography*	*fundus autofluorescence*

AMD classification	Definition	
Late AMD	Geographic atrophy (GA)	

retinal fundus photo	*optical coherence tomography*	*fundus autofluorescence*

AMD classification	Definition	
Late AMD	Neovascular AMD (nAMD)	

retinal fundus photo	*optical coherence tomography*	*fundus autofluorescence*

Images kindly provided by Prof. Robyn Guymer, Centre for Eye Research Australia.

NB. These are examples of what each stage could look like; AMD may manifest and present differently.
Please refer to Chair-side reference: Age-related Macular Degeneration, Centre for Eye Health for more detail on what to look for on various imaging modalities.

The Beckman classification scheme was designed to reflect the fact that risk profiles are linked to the clinical signs of drusen and pigmentary abnormalities (see Table 3). In early AMD (medium drusen only), people have a 3.1% chance of progressing to late AMD within 5 years.[2] However, once a person has large drusen and pigmentary abnormalities in both eyes (intermediate AMD), this risk increases to around 47.3%.[2] If a patient presents with late AMD in one eye at baseline, the risk of progression in the other eye is slightly higher.[2]

Table 3: Five-year risk of progression to late AMD[2]		
Risk factors	**Risk of progression for patients without late AMD in either eye at baseline***	**Risk of progression for patients with late AMD in one eye at baseline^**
0	0.4%	
1	3.1%	
2	11.8%	14.8%
3	25.9%	35.4%
4	47.3%	53.1%

* Assign one risk factor:

– for each eye with large drusen

– for each eye with pigment abnormalities

– if neither eye has large drusen and both eyes have medium drusen (early AMD)

^ Assign two risk factors for the eye that has late AMD.

Assign an additional risk factor if the eye at risk has large drusen and an additional risk factor if the eye at risk also has pigmentary abnormalities.

A more detailed classification scheme based on newer imaging technologies is also emerging and will require a shift in terminology. Geographic atrophy will be re-termed complete RPE and outer retinal atrophy in the absence of choroidal neovascularisation (cRORA).

Clinical pearls

– The average width of the central retinal vein at the optic disc margin is 125μm, so drusen larger than this are considered large drusen. Medium drusen are between half and one-full width of the vein (63μm - 125μm), and small drusen are less than half the vein width (<63μm).[2, 3]

– The presence of large drusen is a risk factor for developing late stage AMD.[4]

– The presence of pigmentary abnormalities means a higher risk of developing late stage disease.[2, 3, 5]

Common signs and symptoms

Table 4: Common signs and symptoms of AMD		
Stage of disease	Clinical symptoms	Clinical funduscopic signs
Early	– Usually asymptomatic – May have reduced contrast sensitivity and difficulties with dark adaptation[36] e.g. difficulties reading in dim light or adjusting from different lighting conditions.	Medium drusen (≤125µm)
Intermediate		Large drusen (>125µm) and/or pigmentary abnormalities, pigment epithelial detachment due to confluence of large drusen.
Late: geographic atrophy	– Decrease in vision that is not improved with refractive correction – A central field defect or blur that may or may not affect fixation – Visual distortions (scotoma, metamorphopsia, micropsia or macropsia)	Area of photoreceptor and RPE atrophy, forming a well-demarcated lesion of at least 250µm in diameter, with choroidal vessels visible in its base.[38]
Late: neovascular	– Difficulties with visual tasks/ activities of daily living, such as watching television, going down stairs, reading or recognising people – Some people with late AMD and poor vision in both eyes will develop visual hallucinations in Charles Bonnet syndrome[37]. This can be distressing to patients, who will often require counselling.	Choroidal neovascularisation (CNV) which may appear as a well-demarcated grey/green area of the retina, macular fluid (sub- or intra-retinal), lipid or haemorrhage, pigment epithelial detachment.
Non-stage specific		Reticular pseudodrusen (subretinal drusenoid deposits) are yellowish, net-like deposits. They are not a unique phenotype to AMD, but they have been shown to be associated with an increased risk of progression to late-stage AMD.[39, 40]

Optometric assessment

Standard examination

A standard comprehensive optometry examination (including targeted history, high-contrast visual acuity, refraction, stereoscopic slit lamp examination and dilated fundus examination) should be performed on patients with AMD. The following table provides more detail on some of these tests:

Table 5: Optometric assessment of a patient with AMD	
Clinical test	**Notes**
History	Screen for new symptoms suggestive of AMD (see Table 4). Establish risk factors (see Table 1), including family history of AMD, smoking history and status, as well as documentation of nutritional supplement use and driving status.
Visual acuity	Monocular best-corrected visual acuity. Include near monocular visual acuity.
Fundus examination	Dilated fundus exam (DFE), including stereoscopic biomicroscopic evaluation of the macula, is recommended at least annually for those exhibiting signs or symptoms of AMD. Careful consideration of a patient's risk profile (see Table 1 and Table 3) should also help determine if the patient requires a DFE.
Amsler grid	Presentation of the grid at 30cm leads to a retinal projection of 20°, with each square representing a 1° angle.[41] It has been shown that white lines on the black background is more sensitive and reliable than the white background.[41]
Contrast sensitivity	Some patients can have symptoms of poor vision, but good visual acuity; contrast sensitivity provides additional useful information.[41]
Photostress test	The photostress test assesses retinal function, so macular disease will cause a prolonged photostress recovery time, even in early stages of AMD.[41]

Recommended ocular imaging

The following ocular imaging tools are recommended for use by optometrists, if available:

Table 6: Recommended ocular imaging of a patient with AMD	
Colour fundus photography (CFP)	CFP is often used for monitoring drusen number, size, presence of pigmentary abnormalities and signs of late disease (CNV and GA); however, may be limited by low contrast.
Optical Coherence Tomography (OCT)	OCT is one the most valuable imaging tools for the detection and management of AMD.[38] It is often used for the detection of signs of active neovascular AMD (such as retinal fluid), and can also be used for monitoring drusen and pigment.
	Advances in OCT have also enhanced our ability to detect structural retinal and RPE changes that may precede the development of late AMD[43] and vision loss, such as reticular pseudodrusen[39], hyper-reflective foci[43] and nascent geographic atrophy.[44] Refined phenotyping of macular atrophy is also possible.[38] See the 'Prognostic biomarkers' section for more detail.

Additional ocular imaging

Recent recommendations from the expert Classification of Atrophy Consensus Group is that when detecting, quantifying and monitoring late AMD (GA) then the assessment protocol should include colour fundus photography (CFP), confocal autofluorescence (FAF), confocal near-infrared reflectance (NIR) and high-resolution optical coherence tomography[45] – multimodal imaging (MMI).

MMI can also help determine if a patient has a higher risk of progression to late-stage AMD (see 'Prognostic biomarkers' section), so it is recommended to use these tools on patients with intermediate AMD. If you do not have access to these imaging tools, consider referral to a colleague or ophthalmologist.
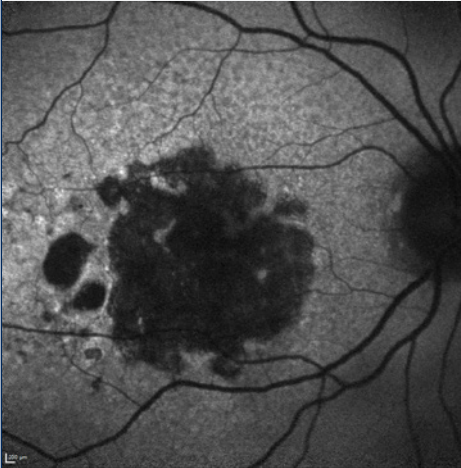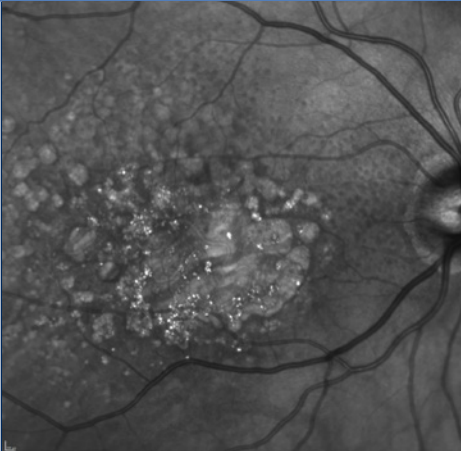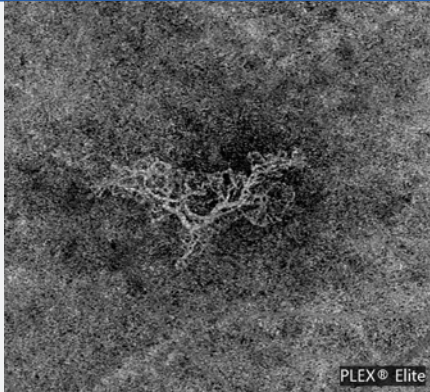
Table 7: Advanced ocular imaging of a patient with AMD		
Fundus autofluorescence (FAF)	Fundus autofluorescence (FAF) can show areas of increased lipofuscin accumulation, such as cells in oxidative stress or in drusen (as hyper-fluorescent), and areas where the RPE cells have died (hypo-fluorescent).[46] A simplified interpretation is that atrophic areas of a retina will appear dark on an AF image, whilst the areas surrounding the lesion (junctional zones) will sometimes appear bright, as a sign of an unhealthy RPE.[47] The FAF pattern is also likely to be altered in intermediate and neovascular AMD and its pattern is associated with different rates of growth of GA. Increased background FAF in non-drusenoid location is a strong indicator of inherited retinal disease rather than AMD. **Key indications:** FAF provides better demarcation of areas of GA than a photo,[48, 49] so is commonly used to measure the size and extent of atrophic lesions. Reticular pseudodrusen are more easily seen on FAF than in colour photography.	 Geographic atrophy
Near Infrared Imaging (NIR)	NIR light will be absorbed by molecules such as haemoglobin and water, meaning that any blood or fluid at the retina will be imaged as a dark area (including the normal retinal vasculature). In contrast, geographic atrophy will appear as a bright patch on the IR image due to reflection off the sclera.[50, 51] **Key indications:** NIR imaging is especially useful for imaging of atrophic lesions (particularly those involving the fovea centre) and reticular pseudodrusen.	 Geographic atrophy

Table continued over page

Table 7 (continued): Advanced ocular imaging of a patient with AMD		
OCT-angiography (OCT-A)	OCT-A allows imaging of the retinal and superficial choroidal vasculature and blood flow without the need for dye injection.[52] However, OCT-A does not detect vessel leakage, meaning that standard fluorescein angiography still has a place in the diagnostic protocol. **Key indications:** OCT-A is useful for diagnosing choroidal neovascularisation and visualising retinal vascular abnormalities.	 PLEX® Elite Choroidal neovascularisation

Images kindly provided by Prof. Robyn Guymer, Centre for Eye Research Australia. OCT-A image also courtesy of Prof. Guymer as part of the Zeiss ARI network

Prognostic biomarkers

There are three key prognostic biomarkers, namely reticular pseudodrusen (RPD), hyper-reflective foci, and nascent geographic atrophy (nGA), that can be identified with multimodal imaging in some patients with intermediate AMD and have been shown to be risk factors for progression to late AMD.

RPD can be difficult to assess with just one imaging modality, so it can be helpful to compare MMI to confirm findings, see Figure 1.

The appearance of RPD has been described in Table 4 and appear on OCT as deposits in the subretinal space above the RPE, unlike classical drusen which are below the RPE.[43] Using other modalities, such as FAF or NIR, they typically appear as collections of semi-regular, interlacing, hypo-autofluorescent or hypo-reflective ribbons or spots.

Hyper-reflective foci represent an additional, important risk factor for progression to late AMD.[43] They are best visualised using OCT as intra-retinal, hyper-reflective dots and often correspond with hyper-pigmentary abnormalities using funduscopy, see Figure 1.
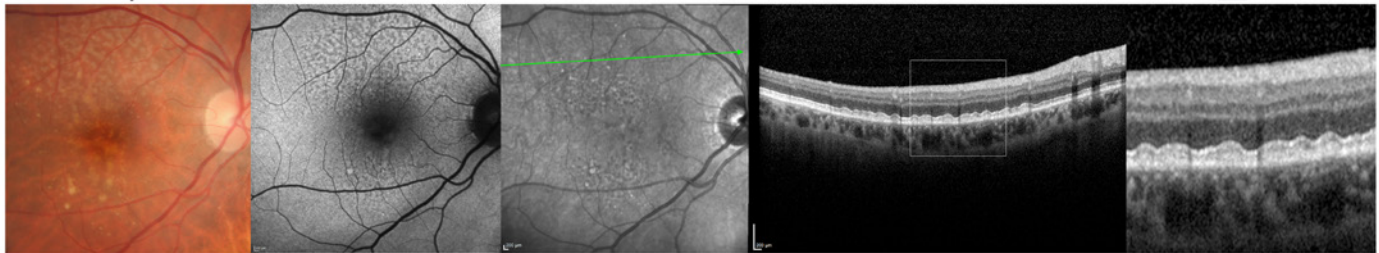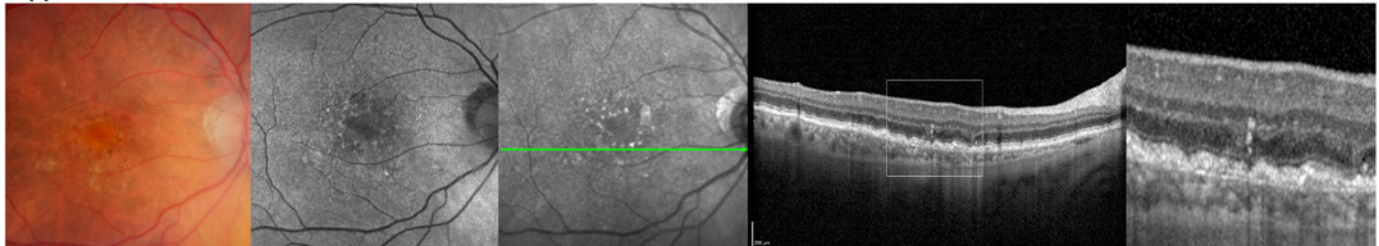
Figure 1: Case figures (CFP, FAF, NIR, OCT) illustrating the appearance of prognostic biomarkers. Images kindly provided by Angelica Ly, Centre for Eye Health

Recently, an OCT-defined GA classification scheme was proposed.[38] This scheme identifies 2 stages based upon OCT changes as incomplete RPE and outer retinal atrophy (iRORA; aka. nascent GA), and complete RPE and outer retinal atrophy (cRORA; aka GA)[38] - see Figure 2.

The RPE band is present but interrupted in nascent GA, and the hypertransmission appears more discontinuous. Nascent GA is a proposed precursor to GA and causes decreased retinal sensitivity.[53]

It is present in approximately 7% of patients with bilateral intermediate AMD[44] and is defined as the presence on OCT of:

1- Subsidence of the outer plexiform layer and inner nuclear layer; or

2- Development of a hypo-reflective wedge-shaped band within the limits of the outer plexiform layer.

By comparison, geographic atrophy presents on OCT as clear absence of the RPE band spanning at least 250μm in diameter (with overlying outer retinal thinning and dropout of the ellipsoid zone) and underlying homogeneous hypertransmission into the choroid.
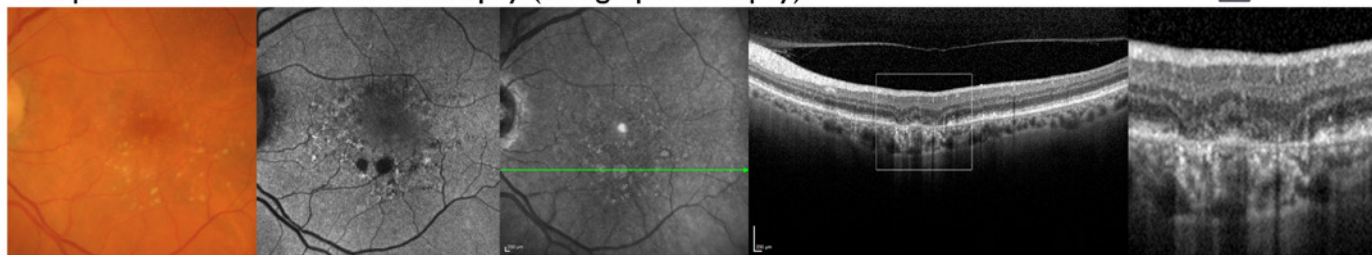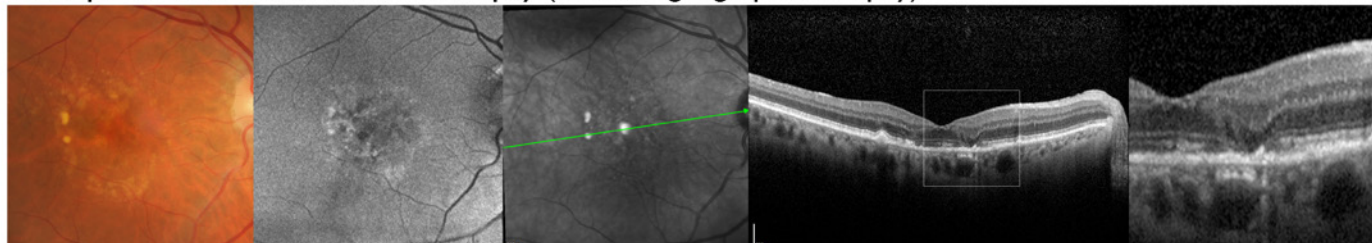
Figure 2: Case figures (CFP, FAF, NIR, OCT) illustrating the appearance of complete and incomplete RPE and outer retinal atrophy. Images kindly provided by Angelica Ly, Centre for Eye Health

Differential diagnoses

As the cardinal sign of AMD is the presence of drusen, it is possible for rarer drusen-associated retinal conditions to be misdiagnosed as AMD. Differences in drusen appearance (size and distribution), strong family history and patient age remain the key distinguishing factors in these other drusen-associated diseases. In addition, conditions which present with central serous retinal detachments (such as central serous chorioretinopathy, adult-onset vitelliform dystrophy and Best disease) can be mistaken for AMD - see Table 8.

Several conditions should be considered as a differential diagnosis to neovascular AMD. In these, choroidal neovascularisation can form, but they will not typically present with related drusen.

Examples include polypoidal choroidal vasculopathy, ocular histoplasmosis syndrome,[59] pathologic myopia,[60] choroidal rupture,[60] angioid streaks[60] or idiopathic choroidal neovascularisation. Diabetic macular oedema may be another differential diagnosis to consider when macular haemorrhage, lipid, exudate, sub- or intra-retinal fluid are discovered at the macula.

Please refer to Chair-side reference: Non-AMD Macular Conditions, Centre for Eye Health for a list of differential diagnoses and what to look for on various imaging modalities.

Table 8: Differential diagnosis of age-related macular degeneration	
Disease	**Notes**
Chronic central serous chorioretinopathy (CSCR)[54]	A serous detachment of the neurosensory retina occurs over an area of leakage from the choriocapillaris. It most often occurs in young and middle-aged adults, and in men more often than women. Vision loss is usually temporary and acute, but in chronic CSCR the impact and signs can be longer lasting. CSCR has been linked to the use of corticosteroids, pregnancy, hypertension, Cushing's syndrome, sleep apnoea and to patients with emotional distress and/or "Type A" personalities.
Adult-onset vitelliform dystrophy[54]	Similar features to Best disease, but a later onset age (usually mid-adulthood). It is characterised by a solitary, oval, slightly elevated yellowish subretinal lesion of the fovea typically spanning one third of a disc diameter in size that is similar in appearance to the vitelliform or egg-yolk stage of Best disease. Prognosis is more optimistic than for Best disease, with most patients retaining useful central vision throughout life.
Best disease[55]	Also known as Best vitelliform dystrophy, Best disease is a hereditary condition. Patients will often present in childhood or early adulthood with central vision loss and a characteristic bilateral yellow "egg-yolk" appearance of the macula. The stage of the disease dictates the clinical appearance, which may progress through: vitelliform, pseudohypopyon, vitelliruptive and atrophic stages.
Stargardt's disease / Fundus flavimaculatus[56]	Stargardt's disease is the most common inherited macular dystrophy which typically presents with foveal atrophy surrounded by discrete, pale-yellow, fleck-like or round retinal deposits in childhood.
Familial dominant drusen[57]	The drusen have a radial and symmetrical appearance, and present very early in life (usually by the third decade via autosomal dominant inheritance although expressivity varies).
Epiretinal membrane (ERM)[58]	ERM is an acquired formation of a semitransparent fibrocellular membrane at the macular and often occurs after a posterior vitreous detachment, or secondary to retinal detachment surgery or a retinal break.

Management of early and intermediate AMD

The mainstay of optometric management for early and intermediate AMD is counselling on modifiable risk factors (see Table 9 below), providing a home Amsler grid for self-monitoring and counselling on the appropriate course of action if the patient notices a change in their vision. Optometrists should consider liaising with a patient's general practitioner who can provide additional support to quit smoking and advice regarding diet, lifestyle and nutritional supplements.

Holistic patient care is important for best practice and patients with macular disease can be encouraged to connect with support services such as those offered by the Macular Disease Foundation Australia (MDFA). Patients can contact MDFA via their National Helpline (1800 111 709) or optometrists can refer patients directly via an e-referral form on the MDFA website: www.mdfoundation.com.au

Table 9: Evidence-based management of early and intermediate AMD	
Modifiable factor	**Evidence-based management**
Smoking	Given the known correlation with smoking status and risk of AMD progression,[20-22] all patients who smoke, chew or consume tobacco should be advised to quit.
Diet and lifestyle	A diet rich in green leafy vegetables, fish and antioxidants should be encouraged.[28] Systemic conditions including hypertension and cardiovascular disease, as well as obesity should be discussed with the patient as risk factors for late AMD.[16]
Nutritional supplements	It has been shown that patients with intermediate AMD (large drusen and/or pigmentary changes) may benefit from certain nutritional supplements.[29, 30] The current recommendation for the supplement ingredients is: – 500 milligrams (mg) of vitamin C – 400 international units of vitamin E – 80 mg zinc as zinc oxide* – 2 mg copper as cupric oxide – 10 mg lutein – 2 mg zeaxanthin Supplements are not currently recommended for patients with normal ageing changes, early AMD, late AMD in both eyes, or for those at risk of AMD without any signs of the disease.[61]

*This dosage of zinc exceeds the upper level of intake guidelines for Australia and New Zealand.[62] The use of supplements should be discussed in conjunction with the patient's general practitioner.

MDFA has produced useful resources such as Amsler grids, as well as publications that can be provided to patients regarding AMD, including risk factors, nutrition and supplements, lifestyle and importance of regular eye exams.

Patients with early or intermediate AMD **do not** require referral to an ophthalmologist[63] **unless:**

– They have a strong family history (in which case they may have a dominantly inherited disease which is being mistaken for AMD)

– They have abnormal structural, functional or historical clinical findings that require a second opinion, including a young age for AMD (<50 years)

– They wish to be involved in a research study or clinical trial

If there are no new macular symptoms, the following is recommended:

No AMD	Early AMD	Intermediate AMD
Review at regular intervals	Review at least every 12 months	Review every 6 to 12 months
	Does not require referral to an ophthalmologist.	Discuss healthy diet and lifestyle. One option is to consider daily use of vitamin supplements as per AREDS2.
	Discuss healthy diet and lifestyle.	Consider multimodal imaging (where available) to determine if a patient is at higher risk of progression (i.e. RPD, nGA, hyper-reflective foci signs) and thus requires earlier review.
	Baseline OCT is recommended, if available.	OCT is advised if new symptoms have developed, or if there is any suspicion that signs of neovascular AMD may be present. Refer to an ophthalmologist or colleague if needed.

Clinical pearls

– For those with established AMD, it is important to emphasise the importance of vigilant self-monitoring with a home Amsler grid at each visit. The patient should be advised to present for immediate review if symptoms suggestive of late AMD develop e.g. visual distortion, central blur or loss of vision.

Vision rehabilitation should be initiated as soon as vision causes visual disability. Please refer to Optometry Australia's resource regarding low vision and rehabilitation services here.

Management of late AMD

Geographic atrophy

Currently, there are no regulatory-approved treatments for geographic atrophy, and the standard of care is monitoring every six to twelve months depending on vision/driving status and the individual's risk of progression. Low vision care is most likely indicated. Geographic atrophy can progress to neovascular AMD, so patients should be instructed on Amsler grid use and modifiable lifestyle factors.

Neovascular AMD (nAMD)

It is recommended that optometrists refer to an ophthalmologist urgently, **within one week,** if there is suspected or definite new-onset choroidal neovascular membrane (CNVM). A telemedicine opinion may be sought via e-referral, within one week, if practising in a location with limited access to ophthalmology services.

A suggested 'urgent referral' criteria for nAMD is:

– a recent (within 3 months) history of vision loss, spontaneously reported distortion or onset of missing patch/blurring in central vision

– any of the following signs: suspected or definite new-onset choroidal neovascular membrane (CNVM), macular fluid (sub- or intra-retinal) or macular haemorrhage without other obvious cause

In the past decade, the mainstay of nAMD treatment has been anti-vascular endothelial growth factor (anti-VEGF) agents.[64-66] The main drugs in use in Australia today are ranibizumab (Lucentis) and aflibercept (Eylea). Bevacizumab (Avastin) is used off-label. All drugs have similar efficacy, so drug availability, treatment frequency and cost are often key factors when choosing the treatment drug. Thermal laser photocoagulation and photodynamic therapy (PDT) are now only considered in rare cases or in a subset of AMD - polypoidal choroidal vasculopathy, where laser or PDT is sometimes used when the neovascular lesion is well defined and extrafoveal.

Generally, initial anti-VEGF treatment is commenced with a fixed monthly interval until there are no signs of ongoing activity (e.g. fluid visible on the OCT).[67] More recently individualising the treatment based upon response has gained popularity, such as using treat and extend protocols. In treat and extend, the period between treatments is increased by 2-weeks each time there are no signs of active CNV, such as fluid on the OCT or a loss of 5 letters or fresh haemorrhage. Visual acuity outcomes in treat and extend are similar to monthly injections.[68] Ophthalmologists may also choose to treat on a pro re nata (PRN) basis, monthly or bi-monthly basis, or an "observe and plan" regime, but in general results are not as good as treat and extend or monthly.[69]

Clinical pearls

– One of the best predictors of long term visual acuity in nAMD is the presenting visual acuity; the earlier a person receives treatment, the better their chances of maintaining or improving their vision.[6] This highlights the important role optometrists play in the prompt management of patients with nAMD.

Future directions

Recent advances in nAMD research have shown that early detection and treatment is vital for best patient outcomes. As such, optometrists have a major role to play in the management of this condition. In particular, it is important that they are aware of the new imaging biomarkers, such as reticular pseudodrusen and nascent geographic atrophy, which can enable identification of those at highest risk of progression from intermediate to late AMD.

There are likely to be new AMD treatments in the near future. In particular, there are currently clinical trials underway for new early AMD interventions and possible pharmaceuticals for GA, which will significantly change the management pathways.

Due to the rapid growth in the research of AMD, there are opportunities for patients to be involved in research studies (both natural history and interventional treatment trials). A list of relevant trials can be found on the following website: https://clinicaltrials.gov/ct2/home

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