ARIC Neurocognitive Study
RETINAL GRADING PROTOCOL

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1 INTRODUCTION

The Atherosclerosis Risk in Communities Study (ARIC) recruited and examined 15,792 black and white men and women aged 45-64 in 1987-89, followed by periodic comprehensive examinations which included brief cognitive function tests. The ARIC Neurocognitive Study will include comprehensive measures of cognitive function for the survivors, aged 67-89, with cerebral imaging on a sample of participants, including a functional measure of cerebral blood flow. The overall goal is to demonstrate long-term prediction of poor cognitive function in the elderly based on modifiable vascular risk factors. The study will also identify persons with mild cognitive impairment (MCI) who may be amenable to the benefits of risk factor modification because of evidence that their impairment has a vascular basis. The ARIC Neurocognitive Study is co-funded by three NIH institutes:
Lead sponsor National Heart, Lung and Blood Institute (NHLBI);
the National Institute of Neurological Disorders and Stroke (NINDS);
and the National Eye Institute (NEI)

For the retinal examination section of the ARIC NCS, approximately 2,600 subjects from the four ARIC communities in the U.S. will be examined. The four sites include Wake Forest University, University of Minnesota- Minneapolis (UMN), University of Mississippi-Jackson, and Johns Hopkins University

In both the ARIC 3-Eye and ARIC 5-Carotid Eye, retinopathy and vessel measurements (VM) were determined using 1 field of 1 randomly chosen eye using a nonmydriatic film camera. In the ARIC-NCS, two fundus photographs of two fields of both the right and left eyes of each participant will be taken using a nonmydriatic *digital* camera. These photographs will be graded at the Ocular Epidemiology Reading Center (OERC) at the University of Wisconsin-Madison for retinal microvascular characteristics, including focal arteriolar narrowing, arterio-venous nicking and retinopathy (e.g., microaneurysms, retinal hemorrhages). In addition, generalized arteriolar narrowing will be quantified using a computer-based measure of retinal vascular caliber. Other significant retinal conditions will also be noted, such as retinopathy or vascular occlusions in people with and without diabetes.

1.1 EQUIPMENT AND MATERIALS

A Canon CR-1 Mark II digital retinal camera equipped with a digital Canon EOS 50-D camera back will be used for this project. Two digital 45^{o} retinal images (field 1 and 2) will be taken of both eyes. Field 1 of ARIC-NCS is centered on the optic disc and Field 2 is centered on the macula, providing photographic documentation of the optic disc, macula, and substantial portions of the temporal arcades. Figure 1 illustrates the standard ARIC photographic fields.

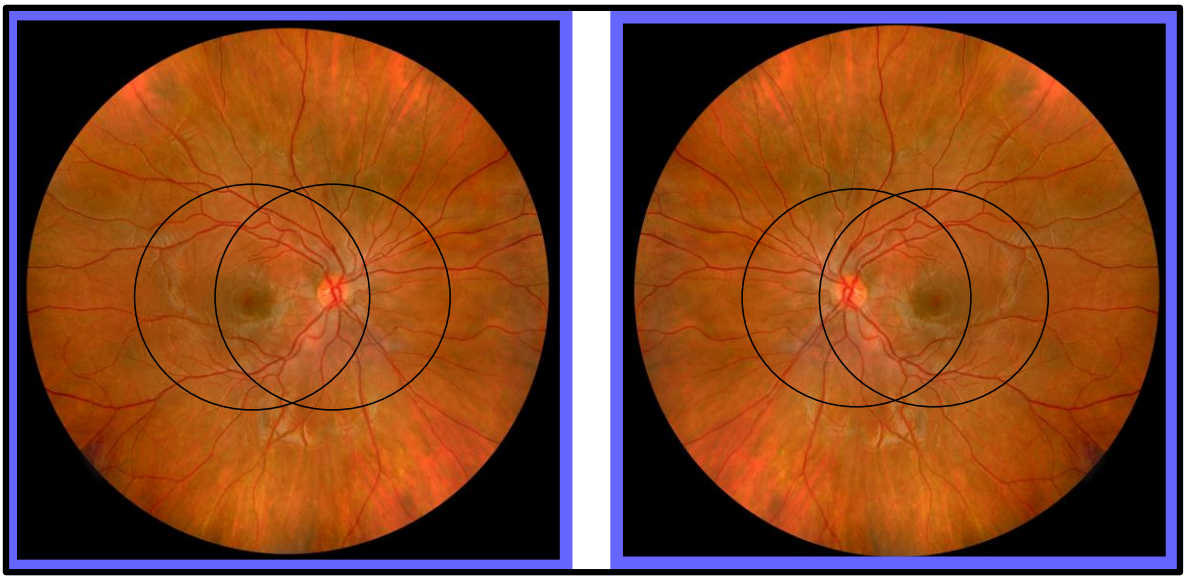

Figure 1

The photograph grader views each retinal image with a high resolution monitor using the EyeQ Lite™ image processing software and database referencing the written protocol and the digital photographic standards and examples to evaluate retinal abnormalities. The photograph grader directly enters his/her evaluations into a micro computer database. The following materials are used in the reading process:

a. Minimum Intel based 900 Mghz PC running Windows 2000 or XP with 256 MB of RAM and a dual monitor capable graphics card (recommended ATI Radeon All-in-Wonder card);
b. Primary monitor- 21 inch for image viewing, set to a resolution of 1600 X 1200 with 32 bit color, standardized using Verilum calibration software;
c. Secondary monitor- recommended minimum 15 inch LCD, set to 1024 X 768 resolution (actual value not as critical as this monitor will display the data collection database);
d. Digital Healthcare EyeQ Lite™ or Pro image™ processing software version 4.8 or higher;
e. ARIC-NCS ACCESS database- a direct entry software with a series of data collection screens built in Microsoft ACCESS available to graders on networked personal computers and based on the paper data collection form.

2 GRADING PROCEDURES AND RULES

All sets of participant images are assigned a sequential reading list (ten participants per list) as the images are received at the Reading Center. The grader selects a reading list from the ARIC coordinator's tracking binder at the beginning of a grading session. Upon completion, the grader initials and dates the tracking sheet and forwards the list to the appropriate basket provided for completed lists.

Photograph graders at the Reading Center use the following conventions in evaluating the presence and severity of abnormalities:

a) *None* is used to indicate that a lesion is absent. If there is a suggestion that a lesion may

be present, but the grader is less than 50% certain that the lesion is in fact present, the grader uses none, or absent, for that lesion.

b) *Questionable* is used to indicate the probable presence of the lesion. If the grader is more than 50% certain but less than 90% certain that the lesion is present, he/she selects questionable as the answer. Stated alternatively, if the grader thinks that the lesion is present but is unsure that all observers would agree, he/she marks the lesion as questionably present. When an abnormality is present but the grader is uncertain of its identity, the grader chooses questionable for the lesion considered most likely and answers none, or absent, for the lesion(s) considered less likely.

c) *Definite* indicates the definite presence of a lesion. If the grader is at least 90% certain that the lesion is present, he/she marks the lesion as definitely present. If a specific lesion can be seen in any part of the field, it should be assessed as such even if the remainder of the field is ungradable.

d) In questions with several codes for definite presence of the lesion, there may be several steps to indicate ascending severity of the lesion. The ascending severities may be described in general terms as mild, moderate and severe. The severities of a lesion are usually defined either in terms of the number, length, or area present, or in relation to photographic standards.

e) *Cannot grade* is used to indicate that the lesion is ungradable due to impaired photographic quality or a confounding condition. In general, if no evidence of the lesion is seen and more than 50% of the area of measurement (subfield, grid area, quadrant etc) is missing or obscured, the grader selects cannot grade rather than none. Cannot grade is also used where the area of measurement is present and unobscured but impaired to a degree that the typical appearance of the lesion in question could not be identified. For focal narrowing of arterioles in the quadrants, at least 1 1/2 DD total length of arterioles should be visible in the quadrant; if no abnormality of the arteriole is seen and less than 1 1/2 DD of arterioles are available for assessment, the grader selects cannot grade as the appropriate answer. (In judging A/V Nicking, if no arterioles cross over veins (only veins crossing over arterioles) then None is the appropriate grade.)

(f) Lesions occupying more than one quadrant are assessed as present in each quadrant and the number, length, or area involved is estimated in each quadrant separately.

2.1 THE GRADING FORM

The data collection form exists in both an original paper format (Table 2) and as a direct entry screen. In both, the data collection begins with identifying information and is followed by the collection of substantive grading data.

The identifying information (participant identification number, photo date, and name codeor acrostic) is entered first. In direct entry, the grader must correctly enter the participant identification number, photo date, and name code, which are then checked against the photograph inventory before entering data for the eye. The direct entry software does not permit data entry for a non-inventoried identification number and shows the grader if data are already present for the identification number.

Some items such as Arterial Changes, ARM lesions, Other Vascular Lesions or Any Other Lesions, are organized under gatekeeper questions. The gatekeeper for each eye asks the grader if any arterial changes (ARM Lesions, Other Vacular Lesions, etc) are questionably or definitely present in the eye, or ungradable. If yes (code 2), the grader completes all items specific to that group. Comments are used to describe other abnormalities not listed in the grading form, or to provide additional details for items graded.

2.2 PRELIMINARY GRADING

The purpose of preliminary grading is four fold: to provide immediate pathology notification to the participant and his/her primary eye care provider, to provide timely image quality review and feedback to photographers, to provide an overview of the health of the eye for general feedback letters, and for purposes of editing. The items to be evaluated are detailed below.

2.2.1 Quality Grading

Field 1 and 2: If field 1 photograph is present, the grade is “Present“, code=2. If the field 1 photograph is absent, the grade is “Absent“, code=0. If neither field 1 nor 2 is present for an eye, then the grader will not be allowed to access the grading form as the grading will already be considered final.

2.2.1.1 Focus

Focus refers to the clarity of retinal image. Because of the importance of detecting lesions in the macular area, the grader is to consider focus in 75% or more of the macula area as defined by the 3000µ diameter circle of the Macular Grid. If retinal vessels are sharply defined or slightly fuzzy and small lesions such as retinal microaneurysms and small drusen are visible, the grade is “Good/Fair”, code=0. If clarity is decreased so that small retinal lesions might be missed but larger lesions such as geographic atrophy, can be seen, the grade is “Borderline”, code=1. If there is a pronounced decrease in sharpness where detail of larger lesions cannot be recognized, the grade is “Poor”, code=2. Focus will be graded in both Field 1 and 2.

2.2.1.2 Photo Quality Problems

Other photo quality problems will be assessed for both images together. If there are other photo quality problems that affect the grader’s ability to grade the image set, the grader marks “Yes” code= 2 and chooses from the following list of problems.

Code	Definition
0	No problem
2	Yes, affects grading
8	CG photo problems

Illumination: If an image is poorly illuminated or overexposed, or there are pockets of uneven illumination (a dark macula) then Illumination should be graded ”Yes”,

code=2.

Field Definition: Field 1 is defined a centered on the optic nerve and Field 2 is centered on the macula. If either of these fields deviates more than 1 disc diameter from the optimum location then Field Definition should be graded “Yes”, code=2.

Haze - When a green/white halo or partial halo; or a green/white cast throughout the entire photograph is noted, Haze should be graded AYes@, code=2;

Dust - White dots or spots that may be varying size but are in the same location of the image no matter what field of the retina is imaged are usually caused by one or more dirty lenses on the camera. When dust or dirt spots are prominent or located in just the wrong place and cause difficulty in grading, Dust should be graded AYes@, code=2;

Lashes - Lashes or a partial blink often appear on the bottom of the image as either light or dark linear Ashadows@. These Ashadows@ can easily obscure the lower half of the image. Occasionally lashes will appear in the upper half of the image as a bright reflectance but do not affect the ability to grade as much. When lashes (or a blink) are present Lashes should be coded AYes@, code =2;

Arc - A small pupil or incorrect patient to camera distance can cause a crescent shaped arc to appear on the image. This arc can range in color from yellow orange to blue and in size from a small slice to an arc that obscures more than half of the field. Arcs normally are found along the nasal or temporal margin rather than the superior or inferior margins although they can occur anywhere. When an Arc is present the grade should be AYes”, code = 2;

Red Channel - A digital image is composed of three color channels, red, green and blue. When the retina=s pigmentation is particularly Ared@ or Alight@ there can be an overexposure effect where the red channel is saturated or washed out. This will often appear as a pink bleaching between the optic nerve and the macula and can make evaluating retinal lesions in these locations very difficult. When the red channel is washed out the grade should be AYes@, code =2;

Other - if “Other“ is noted, describe the problem or artifact in the Comment section.

2.2.2 Gradability

The grader will judge the overall quality of both images to determine the gradability. If the both fields are focused clearly enough to image the retina, optic nerve and blood vessels without any portion missing or obscured, the image is considered completely gradable. If the more than 75% of optic nerve cannot be graded, but it is possible to grade the macula, the grade is “Disc ungradable“, code=1. If a portion of the macula, between 25% (1 Disc Area (DA)) and 75 % of the macula cannot be graded, but the optic nerve is gradable, the grade is “Portion macula ungradable“, code=2;

If more than 75% of the macula area (diameter=3,000µ, inner circle of Macular Grid) is in poor focus, missing, or obscured by a retinal hemorrhage, vitreous hemorrhage, asteroid hyalosis or some other condition and no lesion of any type is seen but it is possible to grade

the disc, the grade is “Macula Ungradable“, code=3;

If a portion of the disc and the macula are ungradable (between 25-75% or each), the grade is code=4. If neither the disc nor the macula can be graded (more than 75% of each), but other portions of the retina are visible, the grade is code=5. If no part of the fields can be graded, the grade is code=6;

If both fields are judged to be ungradable the remaining eye variables will be coded ACannot Grade@ and the grader will complete grading on that eye.

Code	Definition
0	All Fields Gradable.
1	Disc Ungradable
2	Portion of Macula Ungradable
3	Macula Ungradable
4	Portion of Disc and Macula Ungradable
5	Disc and Macula Ungradable
6	All Fields Ungradable

2.2.3 Retinal Grading

ARM Exclude: If a condition exists in the macula which confounds the grader from evaluating Age-Related Macular Degeneration (ARM) lesions from similar changes in the retina due to another process the eye should be excluded (cannot grade) from evaluation of **all** ARM lesions. Typical reasons for excluding an eye are listed below and should be noted in this item. If “Other” is chosen a Comment should detail the reason for excluding the eye.

Trauma	Coloboma/ Staphyloma
Laser Rx (burns)	Retinopathy of Prematurity (ROP)
Vessel Occlusion	Non ARM RPE changes
Macular Dystrophy	Non-ARM detachment
Myopic Degeneration	Unknown etiology
Histoplasmosis/ Toxoplasmosis	Other
Inflammatory	

Pathology Notification: If it is determined that an eye has a treatable pathologic condition that poses an imminent threat to vision, the Coordinating Center will be notified within three working days of receipt of the images from the site. Notifications will be divided into Immediate (seen by an ophthalmologist ASAP) and Early (seen by an ophthalmologist within 2 months). The reason for pathology notification and the date of notification will be recorded during preliminary grading. If “Other” is chosen a Comment should detail the reason for pathology notification. Typical pathology notification reasons are listed below:

Reason for Notification	Type
Suspicious Cup/Disc (C/D) (> 0.7, **or** 0.7 + notching/undercutting)	*Early*
Proliferative Diabetic Retinopathy (level 65+)	*Immediate*
Preproliferative Diabetic Retinopathy (level 51)	*Early*
Clinically Significant Macular Edema (CSME)	*Immediate*
Edema, not CSME	*Early*
Branch Vein Occlusion (BVO) or Central Vein Occlusion (CVO)	*Early OR*

	Immediate
Treatable ARM (signs of neovascularization)	*Immediate*
Hollenhorst Plaque	*Immediate*
Irregular Nevus	*Immediate*
Macular Hole	*Early*
Epiretinal Membrane with traction in center circle	*Early*
Other	*Early OR Immediate*

ARM Feedback: A preliminary ARM summary variable will be coded to provide timely feedback to the coordinating center for letters to study participant. This variable in no way reflects what the final definition of ARM will be for this eye but is rather a preliminary grade based on clinical definitions rather than research definitions.

No ARM is defined as gradable images with no evidence of lesions associated with ARM.

Drusen Only is defined as at least one soft drusen with a diameter greater than or equal to 125μ and a grid area of greater than 500μ.

Early ARM is defined as either soft drusen present with a grid area of greater than a 500μ circle and a pigmentary abnormality present (increased pigment or depigmentation in the grid) **or** soft drusen present in the center circle and a pigmentary abnormality is present (increased pigment or depigmentation in the grid).

Late ARM is defined as the presence of any late lesions, such as geographic atrophy, PED/RD detachments, subretinal hemorrhage, subretinal fibrous scar, subretinal new vessels, or laser treatment and/or /photodynamic therapy for ARM.

Cannot Grade ARM is defined as all or some of the ARM lesions are ungradable or confounded by another condition making evaluation of ARM difficult.

The grades for ARM Feedback are:

Code	Definition
0	No evidence of age-related macular degeneration
1	Drusen only
2	Early ARM
3	Late ARM
8	Cannot Grade ARM

All other Preliminary Grading variables are defined in the detail grading portion of the protocol. The remaining variables graded during preliminary grading are:

ARM Lesions

Maximum Drusen Size > 125μ diameter circle
Soft Drusen (any soft type)
Soft Drusen Area > 500μ diameter circle
Increased Pigment
RPE Depigmentation
Geographic Atrophy

PED/RD Detachment
Subretinal Hemorrhage
Subretinal Fibrous Scar
Laser Rx for ARM

Other Vascular Lesions

Focal Narrowing
Arterio-venous Crossing Abnormalities
BVO/CVO (branch vein occlusion/central vein occlusion)
BAO/CAO (branch artery occlusion/central artery occlusion)
Hollenhorst Plaque

Other Lesions

Myopic Degeneration
Macular Dystrophy
Macular Hole
Large Cup to Disc Ratio ($\geq$ 0.7)
Surface Wrinkling Retinopathy-Traction
Other

Diabetic Retinopathy Level
Macular Edema

2.3 DETAIL GRADING

2.3.1 Image Quality

Field 1 and 2 Presence: If field 1 photograph is present, the grade is “Present“, code=2. If the field 1 photograph is absent, the grade is “Absent“, code=0. If neither field 1 or 2 are present for an eye then the grader will not be allowed to access the grading form as the grading will already be considered final.

Field 1 and 2 Gradability: The grader will be asked to assess the gradability of both Field 1 and Field 2. If at least one disc area of a field is gradable (good enough focus and illumination to see retinal details) the grader indicates the field is gradable and proceeds with evaluation of the eye. If both fields are judged to be ungradable the remaining eye variables will be coded ”Cannot Grade“ and the grader will complete grading on that eye.

2.3.2 Retinopathy Sub-section

Retinopathy Level: If there is no evidence of diabetic retinopathy, the grade is code=10, Skip to Item [Other Abnormalities]. If diabetic retinopathy is present, the grader assigns a retinopathy level (see attached Retinopathy Severity Level and Descriptions) and answers all lesion questions. A list of acronyms and their definitions are listed below:

Acronym	Definition
BVO	branch vein occlusion
DA	disc area - a standard area of measurement representing the size of the average optic nerve
DRS	Diabetic Retinopathy Study
FPD	fibrous proliferation on the disc
FPE	fibrous proliferation elsewhere
HE	hard exudates
HMA	hemorrhages and microaneurysms
HRC	high risk characteristics for visual loss
IRMA	intraretinal microvascular abnormality
MA	microaneurysm
NPDR	nonproliferative diabetic retinopathy
NVD	new vessels on the disc
NVE	new vessels elsewhere
PDR	proliferative diabetic retinopathy
PED	pigment epithelial (detachment)
PRH	preretinal hemorrhage
Q	questionable
SE	soft exudates (cottonwool spots)
SSR	sensory serous retinal (detachment)
VB	venous beading
VH	vitreous hemorrhage

2.3.2.1 Retinopathy Severity Level

DR LEVEL DESCRIPTION

10 No diabetic retinopathy visible. No other lesions that could be mistaken for diabetic retinopathy.

12 Retinopathy that is non-diabetic in nature, but which could be mistaken for diabetic retinopathy, should be noted in the lesion list (i.e. hard exudate from a SSR/RPE, detachment and HMA and/or IRMA etc. from a BVO). Some of the abnormalities from the global "Other" list would constitute a level 12 in the absence of other diabetic retinopathy.

13 Questionable diabetic retinopathy visible. Usually one questionable MA. Especially useful with non-mydriatic or monocular 45E fields as very small MAs may be difficult to discern in these photographs.

14 Any combination of definite HE, SE, IRMA and/or venous loops in the absence of definite MAs.

15 Retinal hemorrhage present without any definite MAs.

20 MAs only with no other diabetic lesions present.

31 MAs and one or more of the following: HMA < 2A, HE, Venous Loops, Q SE, Q IRMA, Q VB.

41 MAs and one or more of the following: SE, IRMA < 8A.

51 MAs and one or more of the following: VB, HMA ∃ 2A, IRMA ∃ 8A.

60 FP only with no other proliferative lesions.

61 No retinopathy and scatter treatment (rx) scars present

62 Level 20 (MA□s only) and scatter treatment (rx) scars present

63 Level 31 (Early NPDR) and scatter treatment (rx) scars present

64 Levels 41 or 51 (Moderate or Severe NPDR) and scatter treatment (rx) scars present

65 PDR < HRC. Any proliferative lesions that do not constitute DRS high-risk characteristics.

70 PDR ∃ HRC: NVD ∃ 10A
or NVD < 10A plus VH or PRH
or NVE ∃ 1/2 DA plus VH or PRH
or VH/PRH ∃ 1 DA

80 Total VH. Cannot grade the fundus through the VH haze. This can be verified with a dark or black-red reflex picture

88 Cannot assign an accurate retinopathy level usually due to poor photo quality. While the level may be 88, some lesions may be gradable.

All diabetic lesions HMA, HE, SE, IRMA, VB, NVD, NVE, FP, and PRH/VH are graded according to the ETDRS protocol.

2.3.3 Non-proliferative Lesions

Hemorrhages and Microaneurysms (Hma) The photograph reader estimates the total area of retina covered by hemorrhages and/or microaneurysms (H/Ma), in comparison to the ARIC reductions of ETDRS Standard #2A. All punctate, blot and linear hemorrhages, and all microaneurysms are included. The amount of retinal hemorrhage and microaneurysms is assessed in some detail because of its importance in determining diabetic retinopathy level.

Code	Definition
0	No hemorrhages or microaneurysms.
1	Questionable microaneurysm and/or retinal hemorrhage.
2	Definite microaneurysms only
3	Definite retinal hemorrhage only
4	HMA < ETDRS Std. Photo. #2A
5	HMA $\geq$ ETDRS Std. Photo. #2A
8	Cannot grade

Hard Exudates (HE) Hard exudates are lipid deposits within the retina. They are characteristically bright yellow-white deposits with sharp margins, and often appear waxy, shiny or glistening. Hard exudates may be arranged as individual dots, confluent patches, or in rings partially surrounding zones of retinal edema and/or groups of microaneurysms.

Code	Definition
0	No hard exudate.
1	Questionable hard exudate.
2	Definite hard exudate.
8	Cannot grade.

Soft Exudate (SE) Soft exudates indicate areas of ischemia in the retina. They appear as superficial white, pale yellow-white or gray-white areas with feathery edges, frequently showing striations parallel to the nerve fibers.

Code	Definition
0	No soft exudate.
1	Questionable soft exudate.
2	Definite soft exudate.
8	Cannot grade.

IRMA Intraretinal microvascular abnormalities (IRMA) are tortuous intraretinal vascular segments varying in caliber from barely visible to 35u (30u ETDRS) or larger. In the absence of stereo, it may be difficult to distinguish IRMA from new vessels. In general, IRMA are more delicate, more angular or jagged in their tortuousity, less likely to cross themselves or other retinal vessels, and more likely to occur in relatively open areas between major vessels. The amount of IRMA is assessed relative to the ARIC reduction of ETDRS Standard #8A.

Code	Definition
0	No IRMA.
1	Questionable IRMA.
2	Definite IRMA, < ETDRS Std. Photo. #8A
3	Definite IRMA, ≥ ETDRS Std. Photo. #8A
8	Cannot grade.

Venous beading (VB) Venous beading refers to localized increases in the venous caliber (segmental dilation), sometimes resembling a string of beads and typical of diabetic retinopathy.

Code	Definition
0	No venous beading.
1	Questionable venous beading.
2	Definite venous beading
8	Cannot grade.

2.3.4 Proliferative Lesions

The proliferative lesions assessed include new vessels on the disc, new vessels elsewhere, fibrous proliferations and vitreous and/or preretinal hemorrhage. In a non-stereo photograph, proliferative lesions which are elevated from the retinal surface are in a different plane of focus from the retinal vessels, and may therefore be out of focus when the retinal vessels and other retinal detail are in focus.

New Vessels on the Disc (NVD) New vessels on the surface of the optic disc or on the retina within 1 DD of the disc margin or in the vitreous cavity anterior to this area are considered NVD. However, when new vessels originating elsewhere than the disc extend within 1 DD from the disc but not within 1/2 DD of the disc and no other new vessels are present closer to or on the disc, they are graded as new vessels elsewhere (NVE). The amount of NVD is assessed in relation to the ARIC reduction of ETDRS Standard #10A.

Code	Definition
0	No NVD.
1	Questionable NVD.
2	Definite NVD, < ETDRS Std. Photo. #10A.
3	Definite NVD, ≥ ETDRS Std. Photo. #10A.
8	Cannot grade.

New Vessels Elsewhere (NVE) Any new vessels which are on the surface of the retina or further forward in the vitreous cavity are considered new vessels elsewhere, excluding those considered as NVD as described in Section 10.4.1. In the absence of stereo, it may be difficult to distinguish subtle new vessels from IRMA. In general, new vessels are bolder, more curvilinear, more likely to cross and re-cross both themselves and the retinal vessels, and more likely to be situated over retinal vessels.

Code	Definition
0	No new vessels elsewhere.
1	Questionable new vessels elsewhere.
2	Definite new vessels elsewhere, < 1/2 DA.
3	Definite new vessels elsewhere, ≥ 1/2 DA.
8	Cannot grade.

Fibrous Proliferation (FP) Fibrous proliferations are white sheets or fine strands of fibrotic tissues formed subsequent to neovascularization, and are therefore sited similarly. Fibrous proliferations on the disc (FPD) and elsewhere (FPE) are considered together.

Code	Definition
0	No fibrous proliferation.
1	Questionable fibrous proliferation.
2	Definite fibrous proliferation.
8	Cannot grade.

Vitreous and/or Preretinal Hemorrhage (VH/PRH) Vitreous hemorrhage (blood in the vitreous cavity) and preretinal hemorrhage (blood on the surface of the retina) are considered together. Vitreous hemorrhage is frequently diffuse and may obscure part or all of the photographic field. If localized, it is usually irregular in shape and outline. Preretinal hemorrhages may be boat-shaped, indicating a fluid level in a pocket between the retina and the detached posterior hyaloid, or flat and blot-shaped. Small preretinal hemorrhages may be distinguished from intraretinal hemorrhages by their distinctive shape or by a darker, more purple-red color.

Code	Definition
0	No vitreous and/or preretinal hemorrhage.
1	Questionable vitreous and/or preretinal hemorrhage.
2	Definite vitreous and/or preretinal hemorrhage, totalling < 1 DA.
3	Definite vitreous and/or preretinal hemorrhage, totalling more than 1 DA.
8	Cannot grade.

2.3.5 Macular Edema

Macular Edema (ME): Increased permeability of retinal capillaries and retinal microaneurysms may result in an accumulation of extracellular fluid and thickening of the normally compact retinal tissue. Initially, there may be a slight loss of the normal transparency of the retina and the edema may be missed easily. The leakage and resulting edema may be focal around retinal microaneurysms or be diffuse and in some cases lead to the appearance of cystoid spaces in the outer retina. In the absence of stereo the grader will look for signs of leakage, such as rings of organized or confluent hard exudate, large amounts of retinal hemorrhages and microaneurysms concentrated temporally or arranged concentrically around the macula, localized areas of color change and a deviation of the normal pathway of the retinal blood vessels. Clinically significant macular edema (CSME) is considered present when edema involves the fovea or is within 500 microns of the fovea, or when a 1+ disc area of edema is present with at least a portion of it within the macula.

Code	Definition
0	No Macular Edema (ME) is present.
1	Questionable ME
2	Definite ME but not Clinically Significant (CSME)
3	CSME is present
7	Edema is present but not diabetic
8	Cannot grade.

Macular Edema-Central Circle (CC): The grader assesses edema in the center circle. The choices are:

Code	Definition
0	No ME in the center circle
1	Questionable ME in the center circle
2	Definite, CSME, but no cysts
3	CSME with cysts
7	Edema is present but not diabetic
8	Cannot grade center circle

2.3.6 Laser Photocoagulation Treatment

The grader assesses the presence of photocoagulation treatment, and its type based on his/her inference of the intent of the treating physician, given the location and appearance of the photocoagulation scars.

Scatter treatment, usually administered for severe non-proliferative or proliferative retinopathy, characteristically consists of an even pattern of burns in all four quadrants and sparing the macula and the papillomacular bundle. Scatter treatment may be accompanied or, rarely, replaced by local treatment, areas of confluent burns used to treat neovascularization directly.

Focal photocoagulation treatment for macular edema is characterized by burn scars within the temporal arcades. Focal treatment may be scattered, indicating treatment of microaneurysms or other focal sources of leakage, or, more rarely, arranged in a grid pattern around the macula. Focal burns tend to be smaller and lighter, i.e., with less pigment disturbance, than scatter treatment burns.

Photocoagulation (PC) Scar: Local and/or scatter photocoagulation (panretinal or PRP) treatment usually done to treat neovascularization (also retinal detachment) as a result of diabetes. (Also used for retinal vein occlusion or a retinal tear.)

Code	Definition
0	No photocoagulation scars are present
1	Questionable or incomplete photocoagulation scars are present
2	Local photocoagulation scars only are present
3	Scatter photocoagulation scars only are present
4	Scatter + Local photocoagulation scars are present

8 Cannot grade for photocoagulation scars

Focal Photocoagulation (PC) Treatment: Focal laser photocoagulation, either as treatment of leaking retinal microaneurysms (MA's) or in a grid pattern, is done for the treatment of localized (MA Rx) or diffuse macular edema (grid Rx). If focal treatment cannot be assessed the grade is code 8.

Code	Definition
0	No focal burns present
1	Questionable focal burns present
2	Focal MA burns only
3	Grid pattern of burns only
4	Focal + grid burns are present
8	Cannot grade focal burns

2.3.7 Arteriolar Abnormalities

The arteriolar abnormalities assessed are: focal narrowing and arterio-venous crossing abnormalities (arterio-venous nicking). All abnormalities are assessed outside of Zone A on the Optic Nerve Grid (beyond ½ disc diameters from the disc margin).

2.3.7.1 Focal Retinal Arteriolar Narrowing

The grader assesses all marked constrictions of retinal arteries and arterioles in Field 1 outside of Zone A as focal narrowing. (The overlapping portions of Field 2 may be used to confirm the presence of focal narrowing in Field 1.) Definite focal narrowing in Field 1 is graded when the involved vessel is at least 40µ in diameter, or about 1/3 of the diameter of a vein at the disc margin, and the constricted area has a caliber less than or equal to 1/2 the caliber of proximal and distal vessel segments. The focal "pinch" must be at least 250µ in length to be considered definite. If the grader observes constriction in vessels less than 40µ in diameter, such constrictions should be assessed as questionable focal narrowing. If the grader feels that subtle constriction of vessels is present or that a definite Apinch@ is present but the length is shorter than 250µ long, the grader marks questionable focal narrowing.

Focal narrowing or constriction of retinal arterioles is assessed in each of the four quadrants, excluding the area within 1/2 Disc Diameter (DD) of the disc (Zone A). The photograph grader places the Optic Nerve Grid on the Field 1 image and carefully examines all arterioles ≥ 40µ in diameter, or about 1/3 the diameter of a vein at the disc margin, and evaluates the arteriole for constricted segments. There is sometimes a gradual tapering from the original caliber of the arteriole to the most constricted caliber; only the length of constriction to 1/2 or less of the original caliber is considered definite. If focal narrowing extends from one quadrant to another, the narrowing is estimated separately in each quadrant. If the total length of arterioles available for examination in a quadrant totals less than 1 1/2 DD, then the grader marks that quadrant ungradable, code 8. Cannot grade is also used if the arterioles in a given subfield are out-of-focus or obscured by artifact.

Each quadrant, superior temporal (ST), superior nasal (SN), inferior temporal (IT) and inferior nasal (IN) is evaluated for the absence of presence of focal narrowing. The following codes are used:

Code	Definition
0	No focal narrowing
1	Questionable focal narrowing
2	Definite focal narrowing
8	Cannot grade

2.3.7.2 Arterio-Venous Nicking

The photograph grader assesses abnormalities of arterio-venous crossings, or arterio-venous nicking (AV nicking), in each quadrant. Both Field 1 and 2 are used for this evaluation with the grader mentally extending the temporal quadrants through Field 2. Crossings within 1/2 DD of the disc margins (Zone A) are excluded, as are the atypical crossings where the vein crosses over the artery. The grader examines all crossings of artery over vein, and evaluates crossings where the venous blood column is narrowed as abnormal.

Tapering or narrowing of the venous blood column on three or all four sides of the crossing is required for definite AV. If the venous blood column appears tapered on only two sides of the crossing, and the appearance is not due to normal vessel undulation, then the grader assesses AV nicking as questionable. If only one side of the venous column is Anicked@ the grader considers A/V nicking absent. The grader discounts any apparent diminishments in venous caliber if the vein appears to be partially obscured by nerve fiber reflex as it approaches and crosses under the artery.

Each quadrant, superior temporal (ST), superior nasal (SN), inferior temporal (IT) and inferior nasal (IN) is evaluated for the absence of presence of AV nicking. The following codes are used:

Code	Definition
0	No AV nicking
1	Questionable AV nicking
2	Definite AV nicking
8	Cannot grade

2.3.8 Other Vascular Changes

The grader is asked to evaluate the absence or presence of other vascular abnormalities in the retina. The following abnormalities are evaluated and graded using these codes:

Code	Definition
0	None present.
1	Questionably present.
2	Definitely present.
3	Present, in the center circle
8	Cannot grade.

Branch Vein Occlusion- Obstruction of a branch retinal venule. An older occlusion may demonstrate sheathed venules and retinal collateral vessels. Localized hemorrhages and/or

IRMAs are commonly present. The occluded vessel may not always be obvious.

Central Vein Occlusion- Obstruction of a central retinal venule. A fresh occlusion is distinguished by dilated retinal venules and diffuse retinal hemorrhages.

Branch/Central Artery Occlusion- Obstruction of a branch or central retinal arteriole. If "fresh", may be associated with large grayish-white area of retinal infarction. Either generalized or localized ischemia may be noted.

Hollenhorst Plaque- Cholesterol emboli. These highly-refractile to smudgy-white lesions lie within arterioles and are quite often seen at artery bifurcations. Care must be taken to distinguish from old retinal macroaneurysms or underlying drusen. (Code 3, center circle, is not applicable.)

2.3.9 Age-related Maculopathy (Any ARM)

The following lesions are graded using the same codes as the Other Vascular Changes list that is detailed above. ARM lesions are only to be evaluated in the macular grid. If an ARM lesion is present inside the grid, but no part of it is inside the center circle, then that lesion is coded 2 (present). If any of the lesion crosses into the center circle than the lesion is graded 3 (present, center circle). If soft drusen or other ARM-like lesions are present outside the grid they should be coded under Any Other/ Other and detailed in the comments.

2.3.9.1 Drusen

Drusen are described as round or ovate, sometimes slightly elevated deposits of variable size; usually located in the plane of the retinal pigment epithelium (RPE). Drusen are classified according to diameter. It is assumed that all drusen are round or oval in shape and that a single druse is no more than twice as long as it is wide. If a druse is oval, its shorter diameter is used to classify its size. Standard circles C_0 (63 micron (μ) diameter), C_1 (125 μ diameter) and/or C_2 (250 μ diameter) are superimposed over or placed next to the largest druse in the grid area. If the shorter diameter of the druse equals or exceeds the diameter of the circle, the druse is judged to be equal to or greater than this circle in size. In using the circles, judge from the center of the line.

Hard Drusen - Hard distinct drusen are always less than 125 μ in size and are usually less than 63 μ in diameter. These drusen are hard-edged and punctate.

Maximum Drusen Size > 125 micron diameter circle - If any portion of a drusen judged to be > 125 μ in diameter (C_1) is contained inside the grid then the grade is “Yes”, code =2 or ”Yes Center Circle”, code =3.

Soft Distinct Drusen- These drusen are usually larger in size then hard distinct drusen (between 63 and 300 μ in diameter). Soft distinct drusen have sharp margins and a round nodular appearance with a uniform density (color) from center to periphery.

Soft Indistinct (or Reticular) Drusen- Soft indistinct drusen are the same size as the soft distinct but have indistinct margins and a softer, less solid appearance. These druse appear to be disintegrating around the edges and quite often have uneven coloring and thickness within. Reticular drusen appear to be Soft Indistinct Drusen arranged into ill-defined networks of broad interlacing ribbons. They form a grid pattern with very subtle borders.

Soft Drusen Area > 500 micron diameter circle - The area involved with soft drusen is measured using the appropriate grid. If the area is greater than a 500 µ (not in the center circle) within the entire grid area than code 2 (Yes) is selected. If the area of soft drusen *within the center circle* is greater than a 500 µ diameter circle than code 3 (Yes, Center Circle) is selected. If soft drusen is present but the area is less than a 500 micron circle than code 0, “No” is selected. (Questionable is not an allowed answer for this item.)

2.3.9.2 Pigmentary Abnormalities

The early progress of ARM is characterized by soft drusen, postulated to disrupt exchanges of nutrients and waste between the RPE cells and the choroidal vasculature. During this process, the RPE cells may lose their cuboidal shape and become irregular, and its pigment may begin to clump and migrate. This is called increased retinal pigment or hyperpigmentation - an early pigmentary abnormality.

Increased retinal pigment is an indicator of pathological changes in the RPE cells, and it should follow that RPE depigmentation will often be concurrent. Often a spot of increased pigment is surrounded by a pale zone of depigmentation, though sometimes the association is not so evident. The aggregated pigment granules are often a transient indicator of a stage in the disease process and can disappear, leaving only depigmented areas of the RPE. The period of time between noticeable depigmentation and nearly complete atrophy of an area of RPE cells and overlying photoreceptor cells is the depigmented stage.

Age-related pigment changes such as increased pigment and RPE depigmentation can also result from processes that are not age-related (many of which are benign).

Increased Pigment (Hyperpigmentation) - Age-related deposition of granules or clumps of grey or black pigment in or beneath the retina. When increased pigmentation is present outside of the macular area or is considered due to another cause, "Other", code 7 is marked and a comment included.

RPE Depigmentation (RPE degeneration) - Age-related depigmentation of retinal pigment epithelium characterized by faint grayish-yellow or pinkish-yellow areas of varying density and configuration without sharply defined borders. Increased pigment is frequently seen over and adjacent to these areas. When RPE degeneration is judged to definitely not be a result of ARM, Any Other "Other" should be marked and a comment included.

2.3.9.3 Late ARM Lesions

Late age-related maculopathy can be classified into two categories based on the lesions present. The first type, atrophic ARM is often called □dry□ macular degeneration. When an area of RPE (along with the overlying photoreceptor cells) has completely disappeared, the lesion is termed **geographic atrophy**. At this point, the ARM has entered a late stage. If the fovea is involved, there is usually a concurrent decrease in visual acuity. The other type of late ARM is exudative or □wet□ macular degeneration. Atrophic ARM consists of one late lesion, geographic atrophy. Exudative ARM is a cocktail of any or all of the following lesions: PED/RD (pigment epithelial detachment- retinal detachment, subretinal or subRPE hemorrhage, subretinal or subRPE fibrous scar and/or laser burns for a past presence of exudative lesions. When geographic atrophy and exudative lesions are both present in an eye, the eye is considered either exudative or mixed.

Geographic Atrophy - Appears as a sharply defined area of drop-out of retinal pigment epithelium and choriocapillaries, exposing choroidal vessels as a result of degeneration of the deep layers of the retina. When atrophic lesions are definitely not a result of ARM, Any Other "Other" should be marked and a comment included

PED/Retinal Detachment (SSR Detachment) - Clear or solid dome-shaped fluid-filled elevation indicating a serous or retinal pigment epithelium detachment of the retina. In the absence of stereo the grader will look for lines of demarcation, color change and vessel deviation in the macula as cues. The presence of other early or late ARM lesions in the vicinity of these changes will help to confirm a detachment is present. When PED/RD is definitely not a result of ARM, "Other" should be marked and a comment included.

Sub-retinal Hemorrhage - Hemorrhage below the retinal surface which may appear as a dark red, dark grey or greenish area. When sub-retinal hemorrhage is definitely not a result of ARM, "Other" should be marked and a comment included.

Sub-Retinal New Vessels (SRNV) - Abnormal blood vessels that grow beneath the RPE/retina. They will often appear as a dilated choroidal like vessel adjacent to a detachment, or subretinal scar or hemorrhage. These blood vessels are difficult to detect in a color fundus image without the aid of an angiogram, but occasionally they can be seen.

Sub-retinal Fibrous Scar (Disciform Scar) - Sheets or mounds of "white" material appearing like a scar, involving the retina. When sub-retinal fibrous scarring is definitely not a result of ARM, "Other" should be marked and a comment included.

Photocoagulation Treatment for ARM- Localized treatment within the arcades for subretinal new vessels due to ARM. This often appears as a deep and heavy white scar. Photodynamic therapy, a light activated chemical, which □clots□ in neovascular membranes should be included in this category.

2.3.9.4 Atypical ARM

Pigmentary abnormalities and/or certain late ARM lesions in the absence of drusen are an unusual appearance for age-related macular degeneration and often are due to another cause or confounding condition (i.e. trauma, hereditary condition etc.). When the grader is suspicious that the lesions present are not due to ARM, Atypical ARM is marked "yes" to prompt review by the director of the Reading Center. Further information, if available, may be requested to clarify the etiology of the retinal appearance.

2.3.10 Other Abnormalities

The following lesions are graded using same codes as the Other Vascular Changes list that is detailed above.

Peripapillary Atrophy - Choroidal atrophic area around disc, usually ∃ 1/2 the circumference of the disc and definitely not considered scleral crescents. If the atrophic area is on temporal side of the disc and fairly symmetric, it is usually a myopic or scleral crescent and should not be marked as peripapillary atrophy. (Code 3, center circle, is not applicable.)

Macular Hole - Round or sharply defined hole in the center of the macula. May be

surrounded by a gray halo of detachment of the retina. Thinning and depigmentation of the RPE develop within the hole and small retinal cysts may be evident near the hole.

Large Cup-to-Disc Ratio - If the cup-to-disc ratio is equal to 0.6, "Q" is marked and the ratio is noted in Comments. If the cup-to-disc ratio is >0.6, "Yes" is chosen and the cup-to-disc ratio is noted in Comments. (Code 3, center circle, is not applicable.)

Asteroid Hyalosis- Multiple spherical and stellate opacities in the vitreous. May be difficult to differentiate in non-stereoscopic photographs. Should appear in front of vessels and disc. Care must be taken to differentiate from retinal drusen. If asteroid hyalosis is dense, may prevent grading drusen.

Nevus - Localized increase in number of pigment bearing cells of the choroid, usually in a round or oval shape. Lack of stereopsis will make it difficult to differentiate from raised lesion (melanoma). May have drusen overlying the lesion. If possible, should be distinguished from "bear tracks" and other hyperpigmentation of the retinal pigment epithelium.

Surface Wrinkling Retinopathy -Traction - (SWR-Traction) Slight contraction of the thin membrane on the inner surface of retina. Can be associated with patches of cellophane reflex (see below). If only cellophane reflex is present, SWR-Traction should not be coded, instead SWR -Cello should be coded as present.

Surface Wrinkling Retinopathy - Cellophane Reflex - (SWR-Cello) A patch or patches of irregular increased reflection from the inner surface of retina (cellophane reflex) that may be associated with fine traction lines and vascular tortuosity. If only traction lines are present, SWR-Cello should not be coded, only SWR-Traction should be coded as present.

Histoplasmosis (POHS) - Presumed Ocular Histoplasmosis Syndrome (POHS) is characterized by one or more of the following: multiple peripheral atrophic chorioretinal scars, peripapillary chorioretinal scarring, and/or macular subretinal fibrous scar. If the latter is present without other signs of POHS, code only **Sub-retinal Fibrous Scar** as code=2.

Retinal Detachment - A condition in which the inner layers of the retina are pulled/separated from the pigment layer.

Photocoagulation Treatment for other conditions (Rx Other)- Miscellaneous treatment for other conditions such as branch vein occlusions or retinal detachment.

Chorioretinal Abnormalities/Other- Retinal and/or choroidal degeneration, regardless of cause, that does not appear to be associated with age-related maculopathy.

Myopic Degeneration- There are several lesions that can characterize the presence of high myopia (oblique insertion of the disc (or tilted disc), peripapillary atrophy, and staphyloma). Sometimes highly myopic eyes go on to develop myopic degeneration. In addition to the changes that are found with high myopia the macula may display a moth eaten appearance with thinning of the RPE and increased and decreased pigmentation, lacquer cracks, Fuchs spots; and finally subretinal new vessels, bleeding and fibrous scarring. To grade myopic degeneration definitely present, at least one of the additional lesions must be present.

Macular Dystrophy- This is genetic disorder that has varied presentations and onset depending on the specific type of dystrophy. The changes in the center of the macula can

range in appearance from a thick central egg yolk lesion (Best's Viteliform Dystophy), pigment abnormalities and degeneration with white fish tail deposits (Fundus Flavimaculatus or Stargardt's Disease), to a black pigmented butterfly like scar (Butterfly Dystrophy). When a macular dystrophy is graded as present, description of the lesions and type of dystrophy will be detailed in the comments.

Other - Detail in the Comments section.

2.3.11 Comments

A comment is necessary if:
- Photo Quality Problem, "Other" is chosen;
- ARM Exclude, "Other" is chosen;
- Pathology Notification, "Other" is chosen;
- Any Other, "Other" is chosen;
- A comment may be noted for any other unusual feature found.

3 DATA MANAGEMENT

The following activities will be implemented for the system for the ARIC Neurocognitive Study: Logging in and loading of digital images into an imaging database, preliminary grading, detailed (original) grading, editing and adjudication of the detailed gradings, data export, vessel measurement data, photo quality reporting, and quality control grading. The system contains the following seven underlying data tables for this activity: Photographer, Patient, Photo Inventory, Preliminary Data, Detailed Grading Data, Edit Grading Data, and Adjudication Data. Aspects of the software are table-driven so other tables contain choices for certain fields. The software is accessed via a main menu system. Separate screens exist for the various elements of the project. Most activities are accomplished via entry screens.

Data will be exported to the Coordinating Center (CC) on a monthly basis. The Microsoft Database files will be uploaded (in Access database format) to the CC via internet connection. Software development, maintenance and system administration will be performed by members of the Computing Group of the Ocular Epidemiology Research Group in collaboration with the data management staff and graders.

4 QUALITY CONTROL

The Ocular Epidemiology Reading Center will perform two types of light box quality control grading for the ARIC Carotid MRI Study.

4.1 REPRODUCIBILITY GRADING

The first type of quality control is called reproducibility grading. Sixty eyes will be selected for grading, to be repeated every six months. These eyes will consist of thirty images selected for a distribution of diabetic retinopathy severity and thirty images selected for a distribution of age-related macular degeneration lesions. The reproducibility set of images will be graded by all ARIC graders every six months and the data will be analyzed by a Reading Center statistician and the Co-directors of the Reading Center for reproducibility and temporal drift. No direct feedback will be given to the graders, although graders may undergo some type of

lesion review based on the data collected during this quality control pass.

4.2 FEEDBACK GRADING

The second type of grading will also occur every six months but will be offset by three months from the reproducibility grading. Thus, if reproducibility grading occurs in January and July, feedback grading will occur in April and October. Feedback eyes will consist of sixty ARIC eyes selected by a statistician from images received by the Reading Center in the last six months. These images will also be graded by all ARIC graders and the data will be analyzed by a Reading Center statistician and the Co-directors of the Reading Center. In addition, this type of quality control grading allows the graders to receive feedback about their performance as compared to other graders and gives them the opportunity to review the images and the grading data after receiving feedback from a Reading Center statistician.

TABLE 1. Glossary of Acronyms

Acronym	Definition
ARM	age-related maculopathy
AV	arterio-venous
BAO	branch artery occlusion
BVO	branch vein occlusion
CAO	central artery occlusion
CG	cannot grade
CVO	central vein occlusion
CSME	clinically significant macular edema
DA	disc area - a standard area of measurement representing the area of the average optic nerve
DD	disc diameter- - a standard area of measurement representing the diameter of the average optic nerve
DRS	Diabetic Retinopathy Study
ETDRS	Early Treatment Diabetic Retinopathy Study
FP	fibrous proliferation
FPD	fibrous proliferation on the disc
FPE	fibrous proliferation elsewhere
HE	hard exudates
Hem	hemorrhage
HMA	hemorrhages and microaneurysms
HRC	high-risk characteristics for visual loss
IRMA	intraretinal microvascular abnormality
MA	microaneurysm
NPDR	nonproliferative diabetic retinopathy.
NV	new vessels
NVD	new vessels on the disc
NVE	new vessels elsewhere
PDR	proliferative diabetic retinopathy
PED	pigment epithelial detachment
PRH	preretinal hemorrhage
PRH/VH	preretinal and vitreous hemorrhage combined
Q	questionable
RD	retinal detachment
RPE	retinal pigment epithelium
SE	soft exudates (cottonwool spots)
SSR	sensory serous retinal (detachment)
SWR	surface wrinkling retinopathy
VB	venous beading
VH	vitreous hemorrhage

ARIC Detailed Grading Form

ID #	EYE:	PHOTO DATE: / /	GRADER	DATE GRADED: / /

IMAGE QUALITY

	Absent	Present	Ungradable	Gradable
Field 1	0	2	0	2
Field 2	0	2	0	2

RETINOPATHY LEVEL

None	10	FP Only	60
Non-diab	12	No Ret w/RX	61
Quest	13	Mas Only w/RX	62
HE, SE, IRMA, W/O MAS	14	Early NPDR w/RX	63
Hem Only (no MAs)	15	Mod/Severe NP w/RX	64
MAs Only	20	PDR < HRC	65
Early NPDR	31	PDR ≥ HRC	70
Moderate NPDR	41	Total VH	80
Severe NPDR	51	CG	88

HMA		VB		PRH-VH	
None	0	None	0	None	0
Quest	1	Quest	1	Quest	1
MAs Only	2	Present	2	< 1 DA	2
Hem Only	3	CG	8	> 1 DA	3
HMA <2A	4	**NVD**		CG	8
HMA ≥2A	5	None	0		
CG	8	Quest	1	**MAC-ED**	
HE		<10A	2	None	0
None	0	≥10A	3	Quest	1
Quest	1	CG	8	Pr, not CSME	2
Present	2	**NVE**		Pr, CSME	3
CG	8	None	0	Non-diabetic	7
SE		Quest	1	CG	8
None	0	<½ DA	2	**CTR**	
Quest	1	≥½ DA	3	None	0
Present	2	CG	8	Quest	1
CG	8	**FP**		Pr, CSME	2
IRMA		None	0	CSME w/cysts	3
None	0	Quest	1	Non-diabetic	7
Quest	1	FPE Only	2	CG	8
<8A	2	FPD Only	3		
≥8A	3	FPD+ FPE	4		
CG	8	CG	8		

PC-SCAR		FOC-RX	
None	0	None	0
Quest/Incomplete	1	Quest	1
Local	2	Ma Rx Only	2
Scatter Only	3	Grid Only	3
Scatter + Local	4	Ma's + Grid Rx	7
CG	8	CG	8

COMMENTS:

ARTERIOLAR CHANGE

Focal Narrowing Quads 0 = No 2 = Yes 8 = CG

	ST	SN	IN	IT
None	0	0	0	0
Quest	1	1	1	1
Present	2	2	2	2
CG	8	8	8	8

AV Nicking Quads 0 = No 2 = Yes 8 = CG

	ST	SN	IN	IT
None	0	0	0	0
Quest	1	1	1	1
Present	2	2	2	2
CG	8	8	8	8

OTHER VASCULAR 0 = No 2 = Yes 8 = CG

	NO	Q	YES	CC	OTH	CG
Branch Vein Occlusion	0	1	2	3		8
Central Vein Occlusion	0	1	2	3		8
Br/Cent Artery Occlus	0	1	2	3		8
Hollenhorst Plaque	0	1	2	--		8

ANY ARM 0 = No 2 = Yes 7= Excluded 8 = CG

Hard Drusen	0	1	2	-		8
Drusen ≥ 125 µ	0	1	2	3		8
Soft Distinct	0	1	2	3		8
Soft Indistinct	0	1	2	3		8
Soft Area ≥500µ	0	1	2	3		8
Increased Pigment	0	1	2	3	7	8
RPE Depig	0	1	2	3		8
Geographic Atrophy	0	1	2	3		8
PED/RD	0	1	2	3		8
Subret Hemorrhage	0	1	2	3		8
SRNV	0	1	2	3		8
Subret Fibrous Scar	0	1	2	3		8
Rx for ARM	0	1	2	3		8
Atypical ARM	0	1	2	3		8

ANY OTHER 0=No 2=Yes 8 = CG

Peripapillary Atrophy	0	1	2	-	8
Mac hole	0	1	2	-	8
Large C/D Ratio	0	1	2	-	8
Asteroid Hyalosis	0	1	2	3	8
Nevus	0	1	2	3	8
SWR - traction	0	1	2	3	8
SWR - cello	0	1	2	3	8
Histoplasmosis (POHS)	0	1	2	3	8
Macular Dystrophy	0	1	2	3	8
Myopic Degeneration	0	1	2	3	8
Retinal Detachment	0	1	2	3	8
Rx / Other	0	1	2	3	8
Chorioret Abnorm/Other	0	1	2	3	8
Other	0	1	2	3	8