INTRODUCTION
The Marco Guyton-Minkowski Potential Acuity Meter (PAM) is an instrument for measuring the retinal visual acuity behind a cataract or other opacity. It does this by taking advantage of the fact that most cataracts are not homogenous but have tiny clearer areas or "windows".

The PAM projects a Snellen visual acuity chart or number chart into the eye via a narrow beam of light which converges to a minute aerial aperture only 0.1mm in diameter. When this beam is placed in a "window" of the cataract, the full acuity chart is imaged on the retina, bypassing the scattering caused by the rest of the cataract and thus allowing for accurate measurement of the retinal acuity.

CONDENSED OPERATING PROCEDURE

PATIENT POSITIONING
The patient should be comfortably seated before the slit lamp with his or her forehead firmly against the headrest.

PRELIMINARY EXAMINATION
A brief slit lamp examination of the anterior segment with retroillumination as necessary is usually helpful to determine where the clearest areas of the cataract are located.

ATTACHMENT TO THE SLIT LAMP
Before attaching the PAM to the slit lamp, rotate the microscope arm for straight ahead viewing and rotate the light column to the patient's left about 45°. Set the microscope to its lowest magnification.

Place the PAM on the slit lamp so that the mounting pin goes into the hole on the central pivot column (Fig. 1). Rotate the PAM, if necessary to set the slit lamp alignment tab on the pivot column into the PAM alignment notch. Tighten the mounting pin locking knob.

Plug the PAM into the appropriate voltage receptacle. Set the sphere power to zero or to the appropriate spherical equivalent as previously known for the patient's eye. Turn the PAM on and set the background illumination to a low level.

LOOKING FOR "WINDOWS"
For the PAM examination, tell the patient to look straight ahead and slightly down. Explain that a light will appear which may letters or numbers in it and that these may not be clearly visible initially.

Begin the PAM examination by focusing the microscopic white dot of light from the PAM onto the iris of the patient's right eye. (The white dot appears at one inch from the patient viewing window). Observe the dot by looking around the left side of the slit lamp microscope. A low level of red background illumination may be necessary for orientation in a dark room. Now, looking through the slit lamp microscope at low magnification, move the dot into the pupil and the beam will be seen by the operator as it passes through the lens. The basic strategy is to keep the eye relatively steady while aiming the examining beam through various "windows" in the cataract.

Fig. 1

The patient is asked to read the lines of the chart with the examiner encouraging the patient to read as far down the chart as possible. Once three letters or numbers on a line are correctly identified, the patient is encouraged to proceed to the next line. When a difficult line is reached, it may be necessary to slowly move the light beam to other areas. Alternately, a new quadrant or even the center of the pupil may be slowly scanned. Further encouragement and repositioning of the beam should be made until the examiner is confident that the patient cannot read any smaller letters or numbers.
The Marco Ophthalmic Potential Acuity Meter

- **Patent Viewing Window**: Aperture through which the patient observes the chart within the instrument.
- **Two Target Knobs**: (On combination Stellen/Numbers models only)
- **Background Illumination Light**: Provides red background illumination to the patient's eye when necessary.
- **Aligning Knob**: Locks PAM into correct examining position.
- **Gripping Ridges**: Finger grips to carry the PAM.
- **Sphere Power Scale**: Indicates the sphere power of the instrument (Reverse side).
- **Power On/Off Switch**: Controls the power to the instrument.
- **Sphere Power Control**: Changes the sphere power of the instrument.
- **Background Illumination Control**: Changes the intensity of the illumination being directed to the external surface of the patient's eye and lid.
- **Mounting Pin**: Holds the PAM in the slit lamp.
- **Fuse Holder**: See page 7 for changing instructions.
OPERATING PROCEDURE

The Examining Room

The examining room should be dimly lighted, preferably by a small lamp directed towards the wall behind the patient. There should be no open doors or bright lights in the field of gaze. To avoid any confusion, do not have other eye charts visible in the room.

The Patient

The patient should be comfortably seated at the slit lamp. To make it easier for the patient to speak, it is best to instruct the patient to talk through his teeth without moving his chin. ("Like a ventriloquist").

The tests may be performed with miotic pupils, however, maximal dilation is preferred because more windows are available to examine. In a darkened room patching the opposite eye is usually not necessary. However, children or patients with amblyopia may perform better by patching the good eye. The patient should be relatively fresh, both mentally and physically. Physically fresh means that bright light examinations of the retina just prior to PAM testing should be avoided.

The Slit Lamp

To observe the examining beam in the eye, the examiner should use the lowest viewing magnification of the slit lamp; sometimes it is easier to look around the microscope to locate the dot of light.

The PAM test must be performed with the slit lamp illumination turned off so as to avoid unnecessary glare.

Potential Acuity Meter

Initially, the PAM should be set to 0 diopters or to the approximate spherical equivalent of the patient's eye prior to onset of the cataract, if known. Because of its optical design, the PAM has a long enough depth of focus that the dioptic control need only be set to an approximate value. Alternatively, the patient may be tested through glasses or trial frames using known or estimated corrections for sphere and cylinder.

Strategy

To begin the test, the examiner should explain that a light will appear which may have letters or numbers on it and that these may not be clear initially. Also, the clarity may change continually. The patient should be told to avoid unnecessary talking since this causes counterproductive head movement. Tell him to talk through clenched teeth.

The basic strategy is to keep the head relatively steady while aiming the examining beam through various "windows" in the media. Meanwhile, the patient reads the lines of the chart with the examiner encouraging the patient down the chart until a difficult line is encountered. Then further encouragement and repositioning of the beam are done until the examiner is confident that the patient cannot read any finer letters or numbers.

Some patients will comment that the letters or numbers jump around, or that spider webs, floaters, or other images are also visible. The examiner should assure the patient that such phenomena are normal and then encourage the patient to continue reading the chart.

Looking For Windows: Theory

Basic Rule: If any retinal detail has been seen by ophthalmoscopy or fundus contact lens exam, then there is always an adequate window for PAM testing, and the media are not too dense. This is because the portion of the pupil used by the PAM light beam is only 0.1 mm in diameter - much smaller than the area of the pupil required to see the retina.

The following media problems may exist:

Cataracts: Large refractive errors, especially irregular astigmatism: Cornea: Partial hyphema; Pupillary membrane; IOL deposits: Others.

Since the approach to each of the above media problems are the same, only cataracts will be discussed.

There are numerous types of cataracts, but they may be divided into four groups:

1. Anterior Cortical Changes (ACC)
2. Nuclear Sclerosis
3. Posterior Subcapsular Cataracts (PSC)
4. Combinations (Most cataracts are combinations).

The easiest lenses to penetrate are those with very discrete lesions in one place such as central PSC, or those with relative homogeneity, such as nuclear sclerosis. Discrete lesions are easily bypassed using a peripheral window. Even nuclear sclerotic cataracts have areas of minimal scattering. Because the beam of the PAM is only 0.1 mm in diameter, it is effectively able to isolate a tiny area in the nuclear cataract which is behaving like a clear lens locally or window. This allows a clear image of the chart to be projected through what may appear to be a relatively dense nuclear cataract. Of course limits do exist, and so as the cataract becomes more and more dense, penetration is less probable.

Looking For Windows: Practice

Before using the PAM, a brief slit lamp examination of the anterior segment, with transillumination as necessary, is usually helpful to determine where the clearest areas of the media are located. If this fails, one may sample various areas of the pupil at random with an attempt to avoid obviously dense areas (of P.S.C. for example). The least scatter will be obtained when the beam is seen as a discrete line passing through the lens or when it disappears through a hole in a pupillary membrane. Although some experience is required to learn how to find difficult windows, if they exist, most eyes are easily tested even by beginners.
PAM TESTING

With the PAM turned on, the eye to be tested will be dimly lit by the red background light. Initially, the beginning examiner may have trouble seeing the beam as it traverses the media and so it is suggested that the beam be aimed at the iris where the minute white dot will be noted as the iris is brought into focus with the slit lamp microscope. This dot is then brought into the pupil and the beam will then be seen as it traverses the lens. Occasionally, the patient can see better when the narrowest part of the beam is moved out of the lens and into the anterior chamber. The patient is asked to look at the light, thus ensuring proper alignment of the visual axis. The patient is then asked to read a few of the larger letters or numbers on the chart. As her or she does, their head may bounce up and down in the chin rest and they may have to be re-instructed to talk through their teeth without moving their head.

The examiner must keep the beam where the patient is able to see letters or number and the patient is asked to read down the chart. Once three characters on a line are correctly identified, the patient is encouraged to proceed to the next line. The examiner will have a corresponding key or will have memorized the chart. Encourage the patient, because some are discouraged by their previous difficulties with eye charts, by an initial doubleness or by the intermittancy of the clearer views of the chart. Move as quickly as possible to the first difficult line in order to avoid fatigue, especially in older individuals.

Once a difficult line is reached, several adjustments may be made as follows:

1) The slit lamp is moved laterally, vertically or slightly front to back to try neighboring windows. Alternatively, a new quadrant or even the center of the pupil may be slowly scanned. Often the patient may suddenly exclaim that the letters were clear but they did not have time to read them. This area should be re-scanned. Do not rush. The less movement, the better the final result.

2) The dioptric setting may be controlled separately or in combination with the steps outlined above. Begin by using increments of about three diopters. If a good dioptric setting is found for one “window”, it is usually good enough for all other “windows” except when a lens is subluxed. For aphakes, the instrument should be set to about +12.00 diopeters initially.

To fine tune the dioptric setting, adjust in the plus or minus direction until the patient signals optimal clarity using the larger letters or numbers of the chart. Once set, avoid changes in the dioptric setting of greater than plus or minus 2.00 dioplers.

3) Self-adjustment: Certain patients are able to control the dioptric setting and move their heads relative to the beam so as to obtain the most precise view. This method often gives the most accurate results. However, advise the patient to change the dioptric control as little as possible, if at all, once the optimal setting has been found. Otherwise, the patient may just twirl the knob while the beam has been self-directed to the densest part of the lens.

Once the best dioptric setting is found, head movement—self-scanning—becomes the more important self-adjustment. Monitor the self-adjusting patient because they may occasionally lose sight of the beam when it leaves the pupillary aperture.

Techniques to “Squeeze” extra lines

Once several areas of the lens have been tested and it has become clear the patient is having difficulty, several of the following steps may be used to “squeeze” an extra line or two:

1) Raise the chin rest to stabilize the head.
2) Try to direct the beam into a more optimal window.
3) Direct the patient to a particular letter or number (e.g., line 6, second letter) and wait; often after a few seconds the letter or number will be correctly identified.
4) Try minimal adjustments to the dioptric control (less than plus or minus 2.00 dioplers).

Testing Endpoint

If a patient correctly identifies all three letters or numbers on a line, that level of visual acuity is established. Occasionally, a patient will correctly identify a line only to lose sight of it with further testing. Nevertheless, the level of vision established is the smallest one for which three characters are correctly identified. (Note: the number which indicates the line on the chart is larger than the characters on the line and therefore should only be used as an identifier and not for determining visual acuity.)

Testing should take one to five minutes per eye. One should rarely extend testing time beyond ten minutes per eye. There are some limiting factors, such as those listed below, which may prolong testing time.
"No Light Seen" By Patient

If the light is not seen by the patient, make sure the instrument is functioning by identifying that the light is on by observing the white dot and making sure it is not striking the iris, sclera or lid. If the light is on, try other areas of the pupil.

Finally, be sure that the patient is looking toward the beam. While this is easy when the patient sees the light (self-aligning), it is not so easy for patients with retinitis pigmentosa, severe glaucomatous field loss and other conditions with tunnel vision because the light may fall on non-seeing retina.

If the light still is not seen, then no further testing is possible. A totally opaque cornea, dense hemorrhage, mature cataract, total pupillary membrane, severe retinal or optical nerve disease will result in a "no light seen" reading. However, "no light seen" is not "No Light Perception" (N.L.P.), since the latter determination should be made with the brightest available direct light (e.g. indirect ophthalmoscope).

Other Uses

The PAM is primarily used in patients with cataracts. Other uses include:

1) Testing retinal acuity in patients with other media problems.
2) Rapid potential vision screening without refraction for vitreoretinal, retinal vascular and neuroophthalmic patients.
3) Rapid potential vision screening in patients with large or irregular refractive errors.
4) Rapid retinal visual acuity testing without refraction in post-surgical cases.

Note: Some post-operative patients with cystoid macular edema may have slightly higher PAM visual acuities than if measured by other conventional methods.

Limitations

The following limitations may make testing more tedious and sometimes impossible:

1) Poor pupillary dilation
2) Dense media (finger counting)
3) Poor patient posture at the slit lamp
4) Communications problems
5) Alphabet illiteracy
6) Nystagmus, tremor
7) Senility
8) Fatigue
INTERPRETATION OF RESULTS

Since the ability of the PAM to penetrate a lens decreases as the density of the cataract increases, the accuracy of the PAM reading to the true retinal acuity fails as cataract severity increases. Hence, true retinal acuity is equal to or better than the PAM reading with the disparity increasing as cataract density increases.

Cataracts denser than 20/300 may cause a clinically significant disparity between the PAM acuity and true retinal acuity. Nonetheless, since true retinal acuity is equal to or better than PAM acuity, the PAM acuity represents the “worst case” post-operative acuity, barring complications, and this acuity is often sufficiently better than present best acuity to recommend surgery. For example: When best correctable visual acuity equals 20/400 and PAM visual acuity equals 20/60, a clinically significant improvement has been predicted, and the patient will achieve 20/60 or better with 95% probability. 1,2

Conclusion

If PAM acuity is 20/40 or better or four lines or better than best correctable visual acuity, then beneficial surgical results are strongly suggested, given that a visual need for surgery exists.

If PAM acuity is not 20/40 or better, or less than four lines or better than best conventional visual acuity, then a good postoperative result is questionable. Clinical judgement is still necessary, however, because the limiting factors mentioned previously as well as operator inexperience and special problems such as intoxication, hysteria and malingering must be taken into consideration. If the patient can cooperate fully, then a media problem, retinal disease, or a combination of both is the cause of the poor PAM result.

If any retinal detail is visible by ophthalmoscopy or fundus contact lens exam, then the media are not likely to be responsible for a poor PAM result. In other words, if one is able to see any posterior pole disease, then a low PAM acuity more accurately reflects true retinal acuity.

Conversely, the same patient with a high PAM acuity will do well surgically, barring operative complications.

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Testing: 25 mild to moderate cataract patients is considered adequate operator experience.

SPECIFICATIONS:

Optical Range .......... -10.00D to +13.00D
Target ............... Snellen letters or numbers
20/400 to 20/20

Electrical ............. 115VAC 50/60Hz., 12 W
Dimensions............. 14 x 8 x 3.5 in. 
(360x205x87mm)

Weight ................ 5 lbs. (2.3 kg)
Fuse ..................... 3AG 1/4 A

INSTRUCTION FOR CHANGING FUSE

1. Turn off instrument and unplug power cord.
2. Push in and unscrew 1/4 turn.
3. Remove the fuse by pulling it straight out from its holder.
4. Replace the fuse with new 3AG 1/4A fuse.
5. Replace the fuse cap.

Caution: To avoid electrical shock, replace the fuse cap if worn or damaged.
CHANGING THE TARGET ILLUMINATION LAMP CAT. NO. PAM-1010

1. Turn off the instrument and unplug the power cord.

2. Using a 5/64 hex wrench, remove the one screw (1) from the small upper gray cover (2).

3. Remove the small gray cover (2) by inserting a screwdriver at one end of the slot (3) in the cover and gently twisting the screwdriver.

4. CAUTION! If the lamp has been on, wait for it to cool before proceeding.

5. Using the hex wrench, remove the two screws (4) holding the white rectangular lamp socket (5).

6. Lift the lamp socket up and out. (Wires must remain attached)

7. Remove the lamp by pulling it straight out from its socket.

8. Replace the lamp with a new Marco # PAM-1010.

9. Replace the lamp socket (5) with screws (4). Replace gray cover (2) taking care to see that it is fully seated around the edges and securing with screw (1).

WARRANTY

This product is warranted to be free from defects in workmanship or materials. Any product proving defective in workmanship or materials will be repaired or replaced at the discretion of Marco Ophthalmic, Inc., free of charge, up to one year from the date of purchase. This warranty covers all repairs and service of parts that have proved to be defective by manufacture and not by misuse or mishandling. This type of service will be provided by our trained service department at our factory. Shipping charges for returns for repair of non-warranted items will be the responsibility of the customer. Alteration, repair or modification of any product by persons not authorized by Marco Ophthalmic, Inc., will result in immediate loss of warranty.

CLAIMS FOR SHORTAGE OR DAMAGE

Extra care has been taken in packaging and shipping the Marco Guyton-Minkowski Potential Acuity Meter (PAM). If you find any shortages or damage, contact your Marco representative or Marco Ophthalmic, Inc., (see "Parts and Factory Service").

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PARTS AND FACTORY SERVICE

For information on parts or service, call Marco Ophthalmic, Inc., toll-free in the continental U.S.: 800-974-5274

Within Florida call: 904-542-9330

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Please specify the equipment model and serial number when calling or writing.

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