

Procedures for ETDRS Refraction and Vision Testing

Refraction and visual acuity measurements will be performed for all subjects by trained visual acuity examiners (VAEs) only. The **name and certification number** of the VAE examiner should be documented in the subject's **source document** at each visit. VAEs are "masked" to study drug assignment and previous visual acuity (VA) testing results. Therefore VAEs should not have access to the subject's chart or previous VA testing results. Only the previous refraction should be made available. Refraction should be conducted prior to VA testing to obtain best-corrected visual acuity (BCVA) as described below. BCVA is measured at all study visits using standard charts, lighting, and procedures. Best correction is determined by careful refraction at that visit according to the standard protocol for refraction as described below.

Equipment

Refraction equipment required includes:

1. Retroilluminated Light box and ETDRS 4 meter distance acuity chart set
2. Trial lens frames
3. Trial lens set with plus or minus cylinder lenses
4. Jackson cross-cylinders of 0.25, 0.50, and 1.00 diopters
5. Pinhole occluder
6. Tissues or eye pads and tape
7. A 1 meter rigid measuring stick

Visual Acuity Charts

Chart 1 is used for testing the VA of the RIGHT eye; Chart 2 for testing the LEFT eye; and Chart R (or 3) for refraction only. Subjects should not be allowed to see any of the charts before the examination.

Visual Acuity Lane and Visual Acuity Box

A distance of **4 meters** is required between the subject's eyes and the VA test chart. With the box light off, not more than **15 foot-candles of light** (161.4 Lux) should fall on the center of the chart. To measure the amount of light, the room is set up for visual acuity testing, but with the box light OFF. The light meter is placed at the fourth line from the top of the chart, with its back against the chart and the reading is taken. If different lanes are used to test visual acuity, they must each meet the same standards.

Retro illuminated ETDRS charts are used in this trial. The illuminator box will be either wall-mounted or mounted on a stand. The light box should be mounted at a height such that top of third row letter is 49 ± 2 inches from floor.

The retro-illuminated light box is equipped with two General Electric 20-watt fluorescent tubes and ballast. Each tube is partly covered by a 14-inch fenestrated sleeve, which is centered on the tube and open in the back. This serves as a “baffle” to produce even illumination over the testing chart. Alternatively, the light tubes may have the sleeves directly mounted ON the bulb itself. Because the illumination of fluorescent tubes diminishes by 5 percent during the first 100 hours and by another 5 percent during the next 2000 hours, new tubes should be kept on for 4 days (96 hours) continuously, and should be replaced once a year.

A **sticker** should be placed on the back of the light box, indicating the date on which the present tubes were installed. A spare set of burned in bulbs should be available on site.

Beginning Approximate Refraction

At the Baseline visit, the subject’s beginning refraction is determined by one of the following ways:

- a) If the subject’s VA is 20/100 or better and the subject does not require glasses for distance vision, then the beginning approximate refraction should be no lens correction or plano.
- b) If the subject’s VA is 20/100 or better and the subject requires glasses for distance viewing, the glasses should be measured using a lensometer, and these measurements are used for the beginning refraction.
- c) If the subject’s VA is less than 20/100 with or without correction, then retinoscopy or autorefractometry should be performed to determine the beginning approximate refraction.
- d) If the subject wears contact lenses for refraction, a notation should be made that the refraction was over contact lenses. It is suggested that the subject wear the contact lenses for future examinations. If the subject is not a regular contact lens wearer and wore the lenses by mistake, they should be removed and you should wait at least 30 minutes before beginning the refraction. The subject should be reminded not to wear contact lenses at subsequent visits.

Refractions are performed with either plus or minus cylinder power. Whichever cylinder type is used at baseline (minus or plus) must be used for all subsequent visits. BCVA results should be recorded on the sponsor provided worksheet which will be included in the source documents. At each **follow-up visit, the results of the protocol refraction from the previous visit are used as the beginning approximate refraction.** If the previous refraction is not available for some reason, the procedure described immediately above should be used.

The charts used for measuring distance VA must NOT be used for refraction. Refraction for each eye should be performed at **4 meters** unless the subject’s VA measured at 4 meters on the refraction chart (Chart R or Chart 3) is **worse than 20/160. If VA is worse than 20/160 the eye is refracted at 1.0 meter.** If during the refraction process at one meter, the subject is reading letters on the eighth line or lower line of the chart, the refraction should continue at 4 meters. Whenever a subject cannot read any

letters on the top line of Chart R or Chart 3 at 1.0 meter the vision should be checked with a pinhole to see whether reduced vision is due, at least in part, to a larger refractive error. If there is no improvement with the pinhole, then the eye is exempt from refraction.

Subjective Refraction

Subjective refraction allows one to determine the best correction for a subject to perform the visual acuity tests. The “**push plus**” approach is used. Add minus diopter spherical corrections **only when the subject is able to read at least one more letter** on a line or a letter on a smaller line.

Procedure

1. Measure and record the distance vision of the eye being tested using Chart R while occluding the fellow eye. The fellow eye should be lightly patched with an eye pad or tissue and tape. Subjects should be reminded to blink and encouraged to use eccentric fixation, or their side vision, when necessary.
2. All refraction and vision testing must be done at 4 meters or 1 meter. Distance for 4 meters is 13 feet and 1.5 inches or 157.5 inches. The one meter distance is 39 and 3/8 inches.
3. All subjects should be seated for testing. A **rigid measuring device** should be used to measure the distance from the subject to the chart if testing is done at **1 meter**. The distance is measured from the outer canthus to the center of the second letter (left eye) or fourth letter (right eye) of the third line of the chart. For **4 meter** testing, **clear and permanent floor markings** should be used to mark the distance for consistency.
4. Place and adjust the trial frame on the subject's face so that the lens cells are parallel to the anterior plane of the orbits and centered in front of the pupils. Adjust the lens cells for the proper distance from the cornea. Be sure the trial frame is comfortable on the patient's face.
5. Occlude the left eye by lightly patching with an eye pad or tissue and tape.
 - a) Place the spherical lens correction in the compartment closest to the eye.
 - b) The cylindrical lens correction, if present, is placed in the compartment in front of the spherical correction. Adjust the axis.
6. **Spherical Correction:** To determine the highest plus or least minus sphere, refract the right eye. **The following refraction steps are recommended for VA of 20/10 to 20/80 with the beginning approximate refraction. For VA less than 20/80, refer to the refraction table for the appropriate sphere and cylinder powers and testing distance (See summary below) and follow a similar procedure. Note: Whenever VA is improved to a higher range, refraction should be performed with the smaller sphere and cylinder powers given for the better visual acuity level (See table at end of protocol).**

- a) Hold a **+0.50 sphere** in front of the subject's right eye. The subject should be looking at the smallest legible line on the VA chart. In these exact words, ask the subject, **"Is this better, worse, or no change?"**
- b) If the subject responds that the vision is **worse or blurred**, remove the +0.50 sphere from in front of the trial frame and **go to Step 6d**.
- c) If the subject responds **better or no change**, remove the +0.50 sphere from in front of the trial frame and replace the spherical lens in the trial frame with a spherical lens that is one-half diopter more positive. Continue this procedure by returning to Step 6a and repeating this process **until a +0.50 makes the VA worse** or blurred and then go to Step 6d.
- d) Hold a **-0.50 sphere** in front of the subject's right eye. In these exact words, ask the subject, "Is this better, worse or no change?" If the subject replies "worse" or "no change", go to Step 6f. If they reply "better" go to step 6e.
- e) Hold the -0.50 sphere in front of the eye. If the subject responds that the vision is better, ask the subject to read the VA chart. **Only when the VA is improved, by at least one letter, may you increase the minus** by 0.50 (or decrease the plus) and repeat Step 6d. Whenever VA is not improved, go to Step 6f.
- f) Remove the -0.50 sphere from in front of the eye and hold a +0.50 sphere in front of the right eye. In these exact words, ask the subject, "Is this better, worse, or no change?" If the subject responds that vision is better or unchanged, then return to Step 6c. Otherwise, go to Step 7. **Spherical testing should always end with a plus lens.**

7. **Cylinder Axis:** To determine and refine the cylinder axis for **PLUS** cylinder, proceed as follows; *(If minus cylinders are used, the appropriate technique using minus cylinders must be employed and minus cylinder must be used throughout the trial.)*

- a) Have the subject look at a line which is either **one or two lines larger** than the smallest line the subject is able to read. Ask the subject to focus on a rounded letter such as "C", "D", or "O". The subject should focus on this same letter throughout this procedure.
- b) If a cylinder is present in the beginning approximate refraction, then go to Step 7c. Otherwise, follow the option listed below to determine if cylinder may be needed.

Testing for cylinder when there is none in the beginning approximate refraction:

Place a **+0.50 diopter** cylinder with the positive axis first at 90°, then compare this to no cylinder; repeat this procedure for 180°, then 45°, and 135° always comparing to no cylinder after each axis position. If the subject says that vision is improved at any one of the four axis positions, place a +0.50 cylindrical lens in the trial frame at the preferred axis and go to step 7c. If the subject prefers no cylinder at all four axis positions, then go to Step 9.

- c) Place the +0.25 diopter hand held cross-cylinder (for VA 20/10-20/80) first with the positive axis 45° to the right of the preferred cylinder axis (as determined above), and second with the positive axis 45° to the left of the preferred cylinder axis. Ask the subject, “Which do you like better, position one or position two?” Also, tell the subject that both positions may blur their vision. The subject must choose the least blurred position, either one or two. “Neither” is allowed only if both positions are equally blurred or equally good.
- d) If “neither” position is better and this was the first test of axis position, move the axis of the cylinder in the trial frame 15° to the right or left and return to Step 7c. Otherwise, proceed to Step 7e.
- e) When one position is preferred over another, move the cylinder to the preferred positive axis position in the step sizes noted below and return to Step 7c. If no single position is better than another than go to Step 8.

Cylinder Refinement Cylinder Power	<i>suggested axis step sizes</i> Axis Step Sizes
<1.00D	15°
1.00 - <2.00D	10°
2.00 - <3.00D	5°
3.00 - <5.00D	3°
5.0 - <8.00D	2°

8. **Cylinder Power:** Cylinder power is refined by following the steps:

- a) Ask the subject to look at the **smallest line** that can be read on the visual acuity chart.
- b) Test the cylinder power by placing the 0.25 diopter cross-cylinder (for vision of 20/10-20/80) first with the positive axis and second with the negative axis coincident with the cylinder axis. Ask the subject, “Which is better, position one or position two?” Do not give the subject the choice of neither.
- c) If the subject prefers the minus axis coincident with the cylinder axis, the total power of the correcting plus cylinder is reduced by 0.25 diopter. Repeat the process until the subject cannot choose one of the cross cylinder positions over the other. If the subject indicates a change that would introduce negative cylinder power, remove all cylinder power and continue testing for positive cylinder power at an axis 90° away from the previous axis. Otherwise go to Step 8d.
- d) If the subject prefers the plus axis coincident with the cylinder axis, increase the power of the cylinder by 0.25 diopters and return to Step 8b. Otherwise proceed to Step 8e.
- e) When the subject feels that both positions are equally bad or good, and the cylinder power in the trial frame has changed by more than 0.50 diopter, return to Step 7c and re-check the axis if necessary. Otherwise, proceed to Step 9.

*Note: If the cylinder is changed by more than 0.50 diopter, the **spherical equivalent** should be maintained. (For each 0.50 **plus** CX increase, add -0.25 to the sphere, for each 0.50 **minus** CX increase, add +0.25 to the sphere).*

9. **Spherical Correction Refinement:** Recheck, or “*refine*” the power of the sphere by adding **+0.25 and -0.25** spheres and changing the spherical power by 0.25 diopter increments of the appropriate sign until the subject cannot detect any improvement in vision. As a reminder, **minus sphere should only be added if the patient can read additional letters** and spherical testing should always begin and end with a plus lens.
10. Record the lens corrections obtained by subjective refraction for the right eye on the examination form in the section for visual acuity measurements as the corrections obtained by protocol refraction for the right eye.
11. Repeat the entire process (Steps 1-10) for the left eye and record the refraction result on the VAE worksheet.

Best Corrected Visual Acuity Measures

- As a reminder, Charts 1, 2, and R (or 3) are used for testing the right eye, left eye, and refraction, respectively. Subjects should not see the charts until the test begins.
- The lens correction from the subjective refraction should be in the trial frame worn by the subject.
- **All eyes must be tested at 4 meters first, even if the refraction was performed at 1 meter**
- The subject should be seated comfortably directly in front of the chart so that the eyes remain at the 4 meter distance. Testing always begins with the right eye. The fellow should be occluded with a folded tissue or eye pad lightly taped over the eye behind the trial frame serves as an effective occluder that allows eccentric fixation without inadvertent use of the covered eye. After testing the right eye, occlusion of the right eye should be done BEFORE Chart 2 is put up for testing the left eye.
- The subject is asked to read the letters slowly, approximately one letter per second. The subject should be told that only one chance is given to read each letter, but may change their mind before moving to the next letter. If the subject is unsure about the identity of the letter, then the subject should be encouraged to guess.
- **The subject should begin by reading the top line of the chart and continue reading every letter on each smaller line, from left to right on each line. *The subject should be encouraged to continue reading even if making mistakes. Each letter read is counted.*** The examiner circles every correct letter read and totals each line and the whole column (0 if no letters are correct) on the data collection form. An X is put through letters read incorrectly. Letters, for which no guess was attempted, are not marked. When a subject reaches a level where he/she cannot guess, the examiner may stop the test provided that the subject has made errors on previous guesses, which is a clear indication that the best visual acuity has been obtained.

- **When a subject cannot read at least 20 letters on the chart at 4.0 meters, the subject is tested at 1.0 meter.** The distance from the subject to the chart should be measured again using the rigid one meter stick. **The distance is measured from the outer canthus to the center of the fourth letter (right eye) or the second letter (left eye) of the third line of the chart.** The spherical correction in the trial frame should be changed by **adding +0.75** to correct for the closer test distance. The subject may fixate eccentrically or turn or shake his/her head to improve visual acuity. Particular care should be taken to make sure the subject does not move forward when testing at 1 meter. The subject should be reminded to blink.
- The examiner should not tell the subject if a letter was identified correctly. The subject may be encouraged by neutral comments, such as “good”, “next”, and “OK”.
- The examiner should not stand close to the chart during testing. Attention should be focused on the subject and the data collection form. If the subject has difficulty locating the next line to read, the examiner may go up to the chart and point **briefly** to the next line to be read, but then must move away from the chart.
- **When 20 or more letters are read at 4 meters the visual acuity score for that eye is recorded as the number of letters correct at 4 meters plus 30** (refer to the VA worksheet) The subject **gets credit for the 30 1M letters** even though they did not have to read them. Otherwise, the visual acuity score is the number of letters read correctly at 1.0 meter plus the number, if any, read at 4M. If no letters are read correctly at either 4.0 meters or 1 meter, then the visual acuity score is recorded as 0.

Testing for Count Fingers Vision, Hand Motion Vision and Light Perception/No Light Perception (NLP) Vision

If the subject's visual acuity is so poor that he/she cannot read any chart letters when tested at one meter then the subject's ability to count fingers, detect hand motion, or have light perception should be evaluated.

Testing for Count Fingers Vision

In testing for count fingers vision, the examiner's hand holding 1, 2, or 5 fingers is held steady at a distance of two feet directly in front of the eye being examined. The fellow eye is completely occluded with a patch on the face. A light should be shown directly on the hand from behind the subject. The examiner's fingers should be presented in random order and repeated 5 times. Eccentric fixation, if present, should be encouraged. If the subject correctly identifies three of the five presentations, then count fingers vision is noted. If not, then the subject must be tested for hand motion vision.

Testing for Hand Motion Vision

The examiner's hand with all fingers spread out should be extended two feet directly in front of the eye being examined. The fellow eye should be occluded with a patch on the subject's face. A light should be shone directly on the examiner's hand from behind the subject. The examiner's hand should be moved in an up-and-down direction (vertically) or in a side-to-side direction (horizontally) at a constant speed of approximately one back and forth presentation per second. The subject is instructed that the examiner's hand will be presented and they will have to respond to the question: "What am I doing with my hand?" This should be repeated five times. Three out of five correct responses indicate that hand motion vision is present. If the subject does not correctly identify three of five presentations, then you must test for light perception.

Testing for Light Perception/No Light Perception Vision

Light perception should be tested with an indirect ophthalmoscope in a darkened room. The fellow eye should be completely patched and also covered by the subject's hand. The indirect ophthalmoscope light should be in focus at 1 meter with the rheostat set at maximum voltage. From that distance the beam should be directed in and out of the subject's eye at least four times, and the subject should be asked to respond when he or she sees the light. If the examiner is convinced that the subject perceives the light, vision should be recorded as "light perception", if not, vision should be recorded as "no light perception".

4M Refraction Protocol Summary							
Refraction Distance	Check Sphere First		Check Cylinder Axis then Power			Sphere "Refinement"	
If VA on "R" chart is between:	Power (a)	Increment	Axis (b)	Power (c)	Increment	Power (d)	Increment
20/10 - 20/80 (4 meters)	+.50 -.50	+.50 -.50	.25 JCC	.25 JCC	+.25 -.25	+.25 -.25	+.25 -.25
20/100 - 20/160 (4 meters)	+1.00 -1.00	+1.00 -1.00	.50 JCC	.50 JCC	+.50 -.50	+.50 -.50	+.50 -.50
20/200 - 20/400 (1 meter)	+2.00 -2.00	+2.00 -2.00	1.00 JCC	1.00 JCC	+1.00 -1.00	+1.00 -1.00	+1.00 -1.00
<20/400 (1.0 meters) sequence refraction a-d	+2.00 -2.00	+2.00 -2.00	No cylinder test required			No refinement required	