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Imaging and Perimetry Society Standards and Guidelines

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ABSTRACT

Purpose. To provide readers with standards, recommendations, guidelines, and requirements for the application of perimetry to clinical ophthalmic practice and scientific study.

Methods. A working group of perimetry and visual field specialists from many parts of the world constructed a document that would allow current and future perimeters to be assessed by the same criteria. Because hardware and software technology, statistical procedures and clinical conditions are constantly changing, the characteristics in this paper emphasize general concepts rather than specific implementations employed by current devices.

Results. Critical aspects of perimetry included indications for perimetry, perimetric techniques, stimulus characteristics, test administration, patient preparation, data display, statistical analysis, interpretation of visual field findings, a glossary of terms and definitions, and standards for comparison of different perimetric tests. Each of these topics is discussed, along with their advantages and disadvantages.

Conclusions. These guidelines serve as a basis for practitioners to evaluate their perimetric needs in relation to their clinical practice and patient population so that informed decisions can be made for visual field testing. In addition, these issues should be used as a cornerstone for future technological and practical improvements to the visual field diagnostic procedures.

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In 1978, the Perimetric Standards and Perimetric Glossary of the International Council of Ophthalmology was developed and published by the Imaging and Perimetry Society (IPS) Research Group on Standards chaired by Jay M. Enoch. In 1990, this work was extended by the IPS Perimetric Standards, First Codicil. In 1994, the IPS determined that a further update was required. This update has evolved over a series of meetings from 1995 onward. Initially, the intent of the document was to provide definitions and recommendations for the application of differential light sensitivity (DLS) perimetry (see Appendix A—Glossary of Terms and Definitions, available online at http://links.lww.com/OPX/A35), which covered most applications of perimetry to clinical practice at that time. Since then, however, perimetric instrumentation has evolved considerably to include many other forms of perimetry, some of which are now used in clinical practice. Many more are in use in the research environment. As a result, the intent of this document has been widened to include recommendations that can be generalized to apply to all types of perimetry and to provide an updated set of definitions and recommendations that refer primarily to DLS perimetry.

Parallel to the development of perimetry standards published by the IPS, in 1991, the International Organization for Standardization (ISO) decided to formulate an industry standard for perimeters (ISO/TC 172/SC7). This standard (ISO 12,866:1999) http://www.iso.org/iso/ defines the minimal requirements for manu-

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facturers of DLS perimeters. Because this standard is confined to DLS perimeters, rather than perimetry in general, it was deemed necessary to develop this codicil as a more complete guideline for the clinical and scientific application of any type of perimetry.

Scope

The purpose of this codicil is to set out standards, recommendations, and requirements for application of perimetry in clinical practice and scientific study. It is written for all individuals involved in perimetry, including clinicians, scientists, and manufacturers.

The codicil covers perimetric uses, implementation, psychophysics, examination strategies, stimulus characteristics, data analysis, test administration, and interpretation. It is not concerned with the specification of instrument tolerances and the methods for testing such tolerances for DLS perimeters, which is covered by the ISO (ISO 12,866:1999).

This was approved by the Standards Group and by the Board of the IPS, and the codicil remains in force until revised by the IPS. It replaces the IPS Perimetric Standards, 1978, and the IPS Perimetric Standards First Codicil, 1990. This second codicil shall be reviewed every 4 years and reaffirmed, modified, or replaced. All correspondence concerning this codicil should be directed to the Secretary of the International Perimetric Society.

Introduction

The visual field is that portion of the external environment from which an observer can obtain visual information when fixating. The size of the measured visual field depends on the characteristics of the stimuli, the measurement conditions, and the response criteria of the observer.

Perimetry is the technique used to measure the extent of the visual field or to assess the sensitivity of the visual system to stimuli presented within the visual field. When the stimuli are presented on a flat surface, the technique is sometimes referred to as campimetry, which in this document will be regarded as a form of perimetry.

Indications for Perimetry

Suprathreshold tests are designed to efficiently evaluate visual field status and are used for screening purposes and on subjects who are inexperienced or incapable of taking detailed visual field examinations. Suprathreshold static or kinetic perimetry techniques are usually used in these instances because the procedures should be easy to perform. With suprathreshold (static) strategies, the stimulus intensities are set a specified interval above an expected threshold level.

Quantification of visual field loss is performed using threshold tests. The test patterns should have adequate spatial resolution to permit the characterization of the visual field deficits. Threshold strategies estimate the sensitivity at each test location. Threshold strategies include staircase algorithms and other techniques based on Bayesian statistics.

Follow-up testing procedures are designed to detect change. Provisions need to be made to allow the practitioner to compare visual fields over time.

Vision standards assessments are required to determine if an individual meets a specific level of visual capability. For disability and occupational standards, assessments of binocular measures of peripheral vision are often necessary. Testing procedures and patterns for binocular testing should be available. Methods that depend on attention and cognitive function may also be useful.

Perimetric Techniques

There are many different forms of perimetry that are currently in use and many different types of perimeters. There are static and kinetic forms of DLS perimetry. In static perimetry, stationary stimuli are presented at different visual field locations and the intensity[a] of the stimuli is modified depending on the subject's responses. Kinetic perimetry uses stimuli of a defined intensity and size that are moved from areas of non-seeing toward seeing areas of the visual field.

Standard automated static perimetry measures DLS, in which a stimulus of varying luminance is presented on a background of specified luminance. The technical requirements for the design of perimeters measuring DLS are provided in Appendix B (available online at http://links.lww.com/OPX/A35), and also in the ISO standard for perimeters (ISO 12,866:1999; http://www.iso.org/iso).

Stimulus Characteristics

In addition to DLS, other types of perimetry examine the sensitivity across the visual field with spatial, temporal, and chromatic variations of the stimulus. For example, contrast sensitivity, flicker, motion, and color stimuli are used to quantify the visual field. Such stimuli can be presented with or without prior cueing.

In static perimetry, stimulus locations are chosen to estimate the distribution of sensitivity across the visual field. The examined portion of the visual field is often confined to the central 30°. In certain situations, other regions of the visual field may be selected (macular and more peripheral visual fields). The spatial resolution is determined by the spatial arrangement (grid) of test locations. The grid of test locations preferably respects physiological zones of interest such as the vertical meridian or the nasal part of the horizontal meridian, which corresponds to its anatomical correlate, the temporal horizontal raphe of the retinal fiber nerve layer.

The background luminance provides a constant state of adaptation. Standard automated perimetry uses background luminances in the range of 1 to 10 cd/m^2.

In perimetry, stimulus intensity (based on, e.g., luminance, size, contrast, motion or vernier displacement, density, and temporal frequency) is usually defined on a logarithmic and instrument-dependent scale in decibel (dB) units. Spatial characteristics (e.g., stimulus size and spatial frequency) are expressed in degrees (°) of visual angle. Temporal characteristics (stimulus duration, on- and offset ramps, and temporal modulation) need to be described in terms of waveform, duration (ms), and frequency (Hz or cycles/deg).

Test Administration

There are many factors involved in achieving a reliable and valid test. The manufacturer's instructions for proper test performance

[a] "Intensity" refers to physical units of stimulus strength, such as magnitude of visibility (size, luminance, intensity).

should be followed and must be clear and explicit. Devices should be easily calibrated or selfcalibrating.

It is critical that room lighting be at the level recommended by the manufacturer and should be constant throughout the test. Any external incidence of light into the cupola should be strictly avoided. The subject should be given sufficient time to adjust to the ambient lighting conditions.

Preparing the Patient

It is important that the test be fully explained and that the patient understands the purpose and process of the examination. A demonstration program can provide the practice to better understand the test and lessen learning effects. An often overlooked source of poor test results are insufficient instructions to the patient. Large differences in sensitivity can occur with seemingly small differences in instruction sets. Most perimeter manuals provide appropriate recommendations for a standard instruction set. Use of these instructions will improve consistency of results. Instructions should be adjusted for patients who appear to have inappropriate response criteria (e.g., a large proportion of false-positive or false-negative responses, see below).

With rare exception, it is important that the individual's appropriate (thin rimmed) refractive correction be in place for the test distance when examining the central visual field within an eccentricities out to 30°. A refinement can be made at the perimeter device. No glass correction is used for examination of the visual field beyond an eccentricity of 30°.

The type of occlusion device for patching the non-test eye should correspond to that recommended by the perimeter's manufacturer. If the pupil size is smaller than the minimum specified by the manufacturer, pupil dilation should be performed. If the pupil has been dilated, lens correction should be adjusted accordingly.

Many perimetric artifacts can occur due to misalignment of the head and eye. The subject should be alert, fixating, and properly aligned with regard to visual axis, brow, and lens. Eyelids that interfere with the visual field can be taped open; in this case, adequate artificial tears have to be provided. It is important to monitor alignment and lid position throughout the test.

Perimetry is done by the perimetrist, not the perimeter. It is important that the patient is monitored throughout the test and that realignment, rest breaks, reinstruction, and reassurance be provided if necessary.

Reliability indices (subject response indices) are used to estimate how closely a patient complies with the instructions provided. However, the rate of false-positive and false-negative responses and responses to fixation loss trials have all been shown to have limited utility for judging the reliability of the test result.

Fixation monitoring, using gaze tracking or blindspot checking (e.g., the Heijl/Krakau method) and/or subjective evaluation of fixation, can provide valuable information on patient performance and their understanding of the test. Poor fixation, misalignment, ptosis, rapid blinking, tear film irregularities, and pupil constriction can be detected. Perimetrists should note their impression of the patient's cooperation, reliability, and level of attention.

Data Display

The general data display shall contain the type and serial number of instrument and software version, examination date and time, options for the patient names and identification number, date of birth, eye examined, refractive correction, pupil size, details of the examination program and the specifications of the stimulus parameters, the perimetrist's identity and any comment. Following is additional information usually provided on printouts from standard DLS perimetry. Other forms of perimetry should include these where appropriate.

Subject response indices (reliability indices) shall contain the accessible information concerning the integrity of fixation, the proportion of false-negative and false-positive responses, number of stimulus presentations, total test time, and an indicator of within-test variability of response, if available.

In static perimetry, the numerical display shall contain the sensitivity (or size or contrast level) at each stimulus location and the corresponding deviation at each/all locations from the age-related normal values arranged to reflect the topographical representation of the visual field. Sensitivity values may be displayed in shades of gray (grayscale) or colors, explained by a key on the plot. Non-interpolated gray scales are preferred, but if interpolations are used, the specific methods for this need to be stated (the location of the stimuli should be documented in the grayscale plot).

The results from kinetic perimetry are displayed as a series of isosensitivity borders (isopters). The depth and extent of localized depressions shall be made visible.

Statistical Analysis

The results should also be compared with an appropriate dataset of healthy subjects. Global and local characteristics of the (static) visual field can be summarized into a series of visual field indices. An index of the overall function is given by a mean value across all test locations, and an index of localized perturbation is given by the variance or SD of values. A topographical representation of the statistical visual field abnormality is provided by probability plots. These plots compare the subject's results, at each test location, with the distribution found in a healthy sample. The plots may (e.g., the pattern deviation plot) or may not (e.g., the total deviation plot) be corrected for general sensitivity loss due to refractive media opacity, reduced pupil size, etc.[b] Other useful methods to represent the visual fields include the cumulative defect curve (Bebie curve) and boxplot displays.

Analyses of a series of visual fields of the same eye can help to distinguish real change from random variability. Such analyses can be local (separate for each test location), sectoral (on groups of test locations), or global (visual field indices). Learning and aging effects as well as changes in test variables should be considered. Details of the methodology for each statistical procedure should be specified.

Any perimeter should be able to export and import digital data in one or more universal formats (ASCII, comma-delimited text file,

[b] The age range and size of the sample, together with the detailed methodology (including subject recruitment and perimetric experience) for acquisition of the normative database should be provided by the manufacturer of the perimeter (see Appendix C, available online at http://links.lww.com/OPX/A35).

XML). This committee endorses the Digital Imaging and Communications in Medicine standard (http://medical.nema.org/).

Interpretation of Visual Field Findings

Interpretation of visual fields requires an appreciation of the patient's medical history, an understanding of anatomy and pathology, knowledge of psychophysics and the relevant methods of statistical analysis and of potential artifacts, and the ability to synthesize this information. The interpretation should assign the visual field defect to a specific pattern and, in case of follow-up, take a stand on deterioration, improvement, or stability of the current visual field with respect to previous results. A number of tools described in this codicil are available to assist clinical decision making (Appendix C—available online at http://links.lww.com/OPX/A35).

APPENDICES

The appendices are available online at http://links.lww.com/OPX/A35.

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