

Automated Pupillometry

Accurate, Reliable & Objective Pupil Measurement Improves Quality of Vital Neurological Examinations

Images of a physician shining a penlight into the eyes of a patient to assess the pupil response to light are universal. Pupillary examination has long been a critical component of neurological assessment, but traditional methods are subjective, inaccurate, and prone to variability and error. Technical advances pioneered by NeurOptics have taken pupillary evaluation of patients with neurologic injury to a new level of accuracy, consistency, and clinical value.

The NeurOptics® NPi®-200 Pupillometer is an easy-to-use, hand-held device that provides accurate, reliable, and objective pupil size and reactivity data independent of examiner—removing variability and subjectivity. The Pupillometer expresses pupil reactivity numerically so that now, for the first time, both pupil size and reactivity can be accurately trended for changes, just like other vital signs. Hospitals now are adopting automated pupillometry as a standard of care in their critical care units.

Pupil Examination—A Long-Time Standard of Care

- The clinical neurological exam is a cornerstone of providing care to patients with a wide variety of neurological injuries.^{1,2}
- For more than 100 years, clinicians have evaluated the pupils of patients with suspected or known brain injury or impaired consciousness to monitor neurological status and trends, checking for pupil size and reactivity to light.⁴
- Historically, before the advent of electricity, clinicians checked a patient’s pupillary reaction to light using a candle.
- Today, clinicians routinely evaluate pupils as a component of the neurological examination and monitoring of critically ill patients, including patients with traumatic brain injury and stroke.^{2,5,6}

Focal Point

The American Association of Neurological Surgeons and Brain Trauma Foundation *Guidelines for Management and Prognosis of Severe Traumatic Brain Injury* recommend that:

- Pupillary light response should be evaluated and used as a prognostic parameter
- Pupil dynamics and asymmetry should be documented in the clinical record.³

Pupil Evaluation Is Important to Patient Care & Outcomes

- Numerous studies have shown the importance of pupil evaluation in the clinical setting, and pupillary information is used extensively in patient management and as an indication for possible medical intervention.
- Alterations of the pupil light reflex, size of the pupil, and pupil inequality (anisocoria) are correlated with outcomes of patients with traumatic brain injury.^{3,7-17}
- Blood flow imaging has shown that pupil changes are highly correlated with brainstem oxygenation and perfusion.^{14,16,18}

- Anisocoria can be an indicator of a pathological process or neurological dysfunction.^{15,19,20}
- Investigators have used pupil size and reactivity as fundamental parameters of outcome predictive models in conjunction with other clinical information such as age, mechanism of injury, and Glasgow Coma Scale,^{18,22,23} and have correlated the models with the presence and location of intracranial mass lesions.³
- The *National Institutes of Health Stroke Scale* (NIHSS) uses pupillary response as a systematic assessment tool to provide a quantitative measure of stroke-related neurologic deficit and to evaluate the acuity of stroke patients, determine appropriate treatment, and predict patient outcome.²¹
- Patients who undergo prompt intervention after a new finding of pupil abnormality have a better chance of recovery.¹¹

Focal Point

- The *American Association of Critical-Care Nurses (AACN) Procedure Manual for High Acuity, Progressive and Critical Care, 7th Edition*, features a new section on pupillometry, noting that the pupillary examination is a key assessment performed during neurological examinations and guiding nurses on the use of automated pupillometers.
- The new edition of the *American Association of Neuroscience Nurses (AANN) Core Curriculum for Neuroscience Nursing, 6th Edition*, includes a new section on automated pupillary assessment, which states that use of a pupillometer removes measurement subjectivity and provides a way to track and trend pupillary reactivity in a consistent, objective, and quantifiable way.

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Manual Pupil Assessment Is Subjective & Inaccurate

- Manual pupillary assessment is subject to significant inaccuracies and inconsistencies.^{1,2,5,6,24-27}
- Traditionally, pupil measurements have been performed in a very subjective manner by using a penlight or flashlight to manually evaluate pupil reactivity, and using a pupil gauge to subjectively estimate pupil size.
- Common terminology to describe the pupil light reflex and pupil size includes “unilateral” or “bilateral non-reactive pupils,” “fixed” or “dilated pupils,” and “brisk,” “sluggish,” or “non-reactive pupils.” These are subjective terms applied without a standard clinical protocol or definition and yielding a significant level of inter-examiner variability and error.^{5,6,12,24,28,29}
- A variety of factors can affect the validity of the visual assessment of the pupil and increase inter-examiner disagreement, including poor lighting conditions, the examiner’s visual acuity, and the strength, distance, and orientation of the light stimulus with respect to the patient’s eye.^{6,26}

- Studies have shown inter-examiner disagreement in the manual evaluation of pupillary reaction to be as high as 39 percent.^{5,25,26,28}

Focal Point

- A recent study published in the *American Journal of Critical Care* revealed that critical care and neurosurgical nurses consistently underestimated pupil size, were unable to identify anisocoria, and incorrectly assessed pupil reactivity. It concluded that automated pupillometry is a necessary tool for accuracy and consistency, and that it might facilitate earlier detection of subtle pupil changes, allowing more effective and timely diagnostic and treatment interventions.¹
- A study from The University of Texas Southwestern Medical Center compared 2,329 manual pupillary exams performed simultaneously by two examiners (neurology and neurosurgery attending and resident physicians, staff nurses, and mid-level practitioners) under identical conditions and showed low inter-examiner reliability.^{25,26}

Automated Pupillometry Improves the Quality of Neurological Exams

- Automated pupillometry provides accurate, reliable, and objective pupil data— independent of examiner—resulting in a significant quality improvement for this important component of the neurological examination.
- The NeurOptics NPi-200 Pupillometer is a portable, hand-held, infrared device that provides a reliable and objective measurement of pupillary size, symmetry, and reactivity through measurement of the pupillary light reflex.
- The numeric scale of the Neurological Pupil index (NPi®) allows a much more rigorous interpretation and classification of the pupil response than subjective assessment.
- The Pupillometer and the NPi scale provide objectivity in measurement by comparing the patient’s pupillary light reflex to normative data in the NPi model. By automatically deriving whether the pupil reflex falls within the normal range (“brisk”) or outside of the normal range (“sluggish,” “atypical,” or “non-reactive”), the Pupillometer provides a reliable and effective way to quantitatively classify and trend the pupil light response.^{2,5,8,28}
- The most effective way to use the Pupillometer is to establish the earliest possible baseline measurement when the patient is admitted into the critical care unit or emergency department, and then trend for changes over time.
- Automated pupillometry and the objective NPi scale benefit clinicians and patients by removing subjectivity from the pupillary evaluation, providing more accurate and trendable pupil data, and allowing earlier detection of changes for more timely patient treatment.



Additional Benefits—Eliminating Errors & Decreasing Nursing Workload

- Despite best intentions, entry errors during charting and manual upload of pupillary data can occur. With automatic upload of data directly from the Pupillometer, the possibility of data entry error is eliminated.
- With the NPi-200 Pupillometer System, patient data can be uploaded into the hospital's electronic medical record (EMR) system, saving valuable nursing time and eliminating potential charting errors. The optional SmartGuard® Reader allows automated patient identification entry and upload of data to the EMR.

Focal Point

- NeurOptics Pupillometers have been adopted in more than 400 critical care units across the U.S. in Level 1 and Level 2 trauma centers, Comprehensive Stroke Centers, and Primary Stroke Centers.
- Academic institutions are now adopting pupillometry as a standard of care in their neurocritical care units by equipping their staff with Pupillometers in every patient room, including Yale-New Haven Medical Center, Stanford University Medical Center, Legacy Emmanuel Medical Center, and University of Utah Medical Center.
- More than 25 pediatric institutes utilize automated pupillometry, including Boston Children's Medical Center, Massachusetts General PICU (Harvard), St. Louis Children's Hospital, Northwestern Medicine Central DuPage Hospital, University of California at San Francisco PICU, and Children's Hospital of Orange County (Calif.).

Company Background

NeurOptics® is the leader in the science of pupillometry. Driven by a passion to help clinicians improve patient outcomes, NeurOptics develops and markets innovative technologies facilitating improved medical decision making and enabling clinical research in critical care medicine, neurology, neurosurgery, emergency medicine, ophthalmology, and research. Headquartered in Laguna Hills, California, NeurOptics, Inc. is represented in over 20 countries worldwide. For more information, visit www.NeurOptics.com. Follow NeurOptics on [Facebook](#) and [Twitter @NeurOpticsInc](#).



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