Automated Pupillometry in Neurocritical Care

Introduction:
Clinicians have been checking the pupils of patients with suspected or known brain injury or impaired consciousness for over 100 years (13). The scientific literature provides much evidence that alterations of the pupil light reflex, size of the pupil or anisocoria, are correlated with the outcome of traumatic brain injury (2,4,6,11,16,22,23). It has been also been shown that depending on the pupillary status neurosurgeons triage patients into conservative therapy or surgical evacuation of mass lesions (19,23). Patients that undergo prompt intervention (i.e., surgery or hyperosmolar therapy) after a new pupil abnormality have a better chance of recovery (7).

Studies have shown the importance of pupillary evaluation in the clinical setting. Traditionally, pupil measurements have been performed in a very subjective manner, with a pen flashlight to evaluate for reactivity and a pupil gauge for pupil size. Common terminology employed in the clinical literature to describe the pupil light reflex and pupil size includes “unilateral” or “bilateral nonreactive pupils,” “fixed” or “dilated pupils” as well as “brisk,” “sluggish” and “nonreactive pupils”. These are all subjective terms applied without a standard clinical protocol or definition and yielding, in fact, a pronounced level of inter-examiner variability and error (8,10,12,17,24).

The NeurOptics® NPi™-100 Pupillometer is a hand held portable infrared device which allows a reliable and objective measurement of pupillary light reflexes and pupil sizes. More importantly, the numeric scale of the Neurological Pupil index (NPi™), allows a much more rigorous interpretation and classification of the pupil response. The Pupillometer and its NPi™ scale reduce subjectivity from the measurement by comparing the pupillary light reflex against normative data in the NPi™ model and automatically deriving whether the pupil reflex falls within the normal range (“brisk”) or outside of the normal range (“sluggish”) and provide a reliable and effective way to quantitatively classify the pupil light response (3).

It is already part of the protocol to check the pupils
Clinicians routinely check the pupils of ill and critically injured patients. The American Association of Neurological Surgeons and the Brain Trauma Foundation guidelines (4) recommend that pupillary light response should be evaluated and used as a prognostic parameter and pupil dynamics and asymmetry should be documented in the clinical record. The pupils of patients with suspected stroke or neurologic insult are also evaluated as part of the routine neurologic exam.

Pupillary evaluation is clinically important
Pupillary information is used clinically, as an indication for surgical intervention. Anisocoria (unequal pupils), especially if the disparity is greater than 1 mm, can indicate a pathological process or a neurological dysfunction. A dilated, sluggishly reactive or nonreactive pupil in one eye can suggest transtentorial herniation and compression of the third cranial nerve (9,14) and has been proposed as a prognostic indicator of functional recovery after traumatic transtentorial herniation (1,21).

In addition to herniation and third nerve compression, it has been shown through blood flow imaging that pupil changes are highly correlated with (and can be used for monitoring) brainstem oxygenation and perfusion (20,26).

Many investigators have used pupil size and reactivity as the fundamental parameters of more general outcome predictive models in conjunction with other clinical information such as age, mechanism of injury and Glasgow Coma Scale (GCS) (15,18) and correlated such models with the presence and the location of intracranial mass lesions (5). Finally, neurosurgeons use pupillary information for triaging patients into conservative therapy or surgery (19,23). This is important because patients promptly operated on after a new pupil abnormality have a better chance of recovery (7).

Measuring pupils is difficult and not accurate
Manual pupillary assessment as part of the clinical examination is subject to compounded sources of inaccuracies and inconsistencies and is characterized by large inter-examiner variability (12). Moreover, ambient light conditions can affect the validity of the visual assessment of the pupil and increase the inter-observer disagreement. These factors may include, for example, poor lighting conditions in the patient’s room, the examiner’s visual acuity, and the distance and orientation of the flashlight stimulus with respect to the patient’s eye and its strength (24). In a recent study (8,17), the inter-examiner disagreement in the manual evaluation of pupillary reaction was as high as 39% (24).

Pupillometer removes subjectivity from the pupillary evaluation
In summary, pupil checks are clinically very important and are already part of the protocol for managing critically ill and injured patients as well as patients with suspected stroke or neurologic insult. Manual pupillary measurements are known to be characterized by high inter-examiner variability and error. Automated pupillometry and the objective scale of the NPi™ may benefit clinicians managing patients with suspected or known intracranial injury or insult by removing subjectivity from the pupillary evaluation.
References: