Clinicians have been checking pupil for over 100 years.
Already part of protocol to check the pupils
Major Tool for Clinical Evaluation

• Modern emergency guidelines: nearly all patients with head trauma/stroke are *sedated, intubated, ventilated*

• Most patients *not fully assessable* (e.g., using GCS, etc.)

• Pupil evaluation one of few ways to assess neuro status in these patients
How do we use information from the pupillary evaluation?

- TRIAGE
- PROGNOSIS
- INDICATION FOR SURGERY
“conservative therapy” or “surgery”?

• Neurosurgeons are less likely to operate and more likely to withdraw care on patients who present with BFDP and GCS of 3 because of poor prognosis

PROGNOSIS

• “...Unfavorable outcome at 12 months was ...inversely related to pupillary responsiveness...”

• “...pupil dilation may be an indicator of ischemia of the brain stem. If cerebral blood flow and cerebral perfusion pressure can be rapidly restored in the patient with severe head injury who has dilated pupils, the prognosis may be good.”

“No competent neurosurgeon would allow a patient in this clinical scenario [GCS≤8 and a “blown pupil”] to be neglected when the need for surgical relief of brain compression is so clear.”

Very subjective measurement

• Subjective terminology applied without standard clinical definition
  – “Brisk”
  – “Sluggish”
  – “Nonreactive”
Do we need to assess the pupils better?

- Clinical Measurement Issues
  - Size
    - Change of Shift: Did the pupil get bigger or is the observer’s baseline different?
    - Darkly Pigmented eyes: Where is the iris/pupil boundary?
  - Reactivity
    - Fixed and Dilated: Are the pupils really fixed, or did I see a reaction?
    - Pin Point Pupils: What is a brisk pupil?
How well do we currently measure the pupil?

• High inter-examiner variability (up to 39%) and a severe lack of reliability is reported in:
  

Why is it so hard to assess the pupils? Why the variability?

- Small pupils (patients on medication) extremely difficult to assess
- Darkly pigmented iris
- Poor/inconsistent lighting
- Examiner’s visual acuity
- Strength of flashlight/penlight
- Distance and orientation to patient’s eye
What is a Pupillometer?

OBJECTIVE

EASY TO USE

TRENDABLE

ACCURATE

RELIABLE
NeurOptics® Pupillometer removes the subjectivity from pupillary evaluation
pupils erroneously classified as **non-reactive**

pupils erroneously classified as **reactive**
What is the NPi™ (Neurological Pupil index™) ?

- rates strength of pupillary reaction on scale from 0-5.
- **Purpose**: to quantify pupillary reactivity and remove subjectivity from assessment
- Algorithm developed by NeurOptics scientists based on >half a million pupil measurements
- Variables include size, latency, constriction velocity and dilation velocity.
What is the NPi™?

- Npi™ value ≥3 = “normal” per NeurOptics algorithm
- NPi™<3=“abnormal” (weaker than normal pupil response per NeurOptics algorithm).
- NPi™=1 more abnormal than NPi™=3, allows TRENDSING
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NPI
## Measurement Parameters

<table>
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<tr>
<th>Parameter</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Maximum Diameter</td>
<td>Largest diameter of eye during measurement. Occurs prior to stimulus.</td>
</tr>
<tr>
<td>Minimum Diameter</td>
<td>Smallest Diameter of eye during measurement</td>
</tr>
<tr>
<td>Latency of constriction</td>
<td>Time lag for the eye measured from the initiation of the stimulus pulse.</td>
</tr>
<tr>
<td>Velocity of constriction</td>
<td>Vector quantity, which describes the slope of the diameter vs. time profile between the initial reaction to the stimulus and the minimum, constricted diameter.</td>
</tr>
<tr>
<td>First dilation velocity</td>
<td>Vector quantity, which describes the slope of the diameter vs. time profile after the eye escapes or begins to dilate after the maximum response (minimum constriction) is obtained.</td>
</tr>
<tr>
<td>Second dilation velocity</td>
<td>Vector quantity, which describes the slope of the diameter vs. time profile after a point of inflection seen in the speed of dilation.</td>
</tr>
</tbody>
</table>
Npi™-100 Pupillometer System

Pupillometer & Charging Station

Printer Kit (optional)

Single-patient Use Headrest (to prevent cross-contamination)
Sample Protocol/Guidelines

• **Populations:**
  - Closed head injury, TBI, Subarachnoid Hemorrhage, ICH, Ischemic Stroke with MCA/Brainstem infarct, Post-op Craniotomy, Multisystem trauma presenting to ED unconscious or in extremis
  - *Uncooperative patients should have manual flashlight pupil assessments

• **Recommendations:**
  - Q 1–2 hr. Pupillometer*
    - Minor or moderate TBI or other neuro pathology without an ICP in place
    - ICP > 20 mm Hg requiring aggressive management. If time permits, obtain repeat pupillometer reading 30 minutes after intervention.
  - Q Shift Pupillometer**
    - ICP < 20 mm Hg requiring minimal Tx
    - ICP removed
    - Barbiturate Coma after pupils are no longer reactive to light
Subjects with abnormal/nonreactive NPi™ had a peak of ICP higher than subjects with normal NPi™. The first occurrence of abnormal NPi™ relative to the time of the first peak of ICP was 15.9 hours. (CI=-28.56,-3)
Conclusions

• The NPi™-100 pupillometer can reliably detect smaller changes than the human eye and allows trending of gradual changes.

• Scalar value of NPi™ can quantify rates of change giving more discrimination than simply “Brisk”, “Sluggish” or “Non-reactive”.

• Pupillometry is an important tool in the management of patients with traumatic brain injury, stroke and other critical care emergencies.
“When you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind”
– William Kelvin (of temperature scale fame)
The Pupillometer is used at over 100 civilian and military hospital on both adult and pediatric populations