Changes in pupillary examination values as predictors of clinical outcomes in subarachnoid hemorrhage

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30th STTI Nursing Research Congress
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Conflict of Interest

• No conflicts of interest to report.

• Financial support was provided to the institution (UTSW) for salary support and study procedures for the END PANIC Registry Study from NeurOptics Inc.
Where the idea came from?

Establishing Normative Data for Pupillometer Assessment in Neuroscience Intensive Care: The “END-PANIC” Registry

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Bedside nursing assessment of the pupil is a key component of the neurological examination in neurocritical care patients.

Where the idea came from?

The pupillary examination has traditionally been used to monitor these patients; and includes assessment of pupil size, shape, symmetry, and reactivity to light.

Current practice includes mostly subjective estimation of pupil size in millimeters and it is common to hear descriptive terms such as small, moderate, or large accompanied by terms such as brisk, sluggish, or fixed to determine the reactivity of the pupil.

Today, an objective way to perform pupillary examination is by using the automated pupillometer to obtain more reliable results and provide several new variables that are not available with subjective assessment.

<table>
<thead>
<tr>
<th>Maximal Diameter (Max)</th>
<th>Minimal Diameter (Min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constriction Velocity (CV)</td>
<td>Dilation Velocity (DV)</td>
</tr>
<tr>
<td>Latency (Lat)</td>
<td>Neurological Pupil Index (NPI)</td>
</tr>
</tbody>
</table>

3 – 4.9 = Normal/brisk  
Below 3 = Abnormal/sluggish  
0 = Non- Reactive/Immesurable/Atipical response

Olson, 2016, 2017; Shoyombo, 2018.
Recent studies have shown some association between pupillometer readings and intracranial pressure (ICP), neurological deterioration, pain, sedative response, and as a predictor of secondary brain injury and poor clinical outcomes.

**Objective**

To explore how PLR readings (size, CV, DV, NPi and latency) might predict clinical outcome in patients with subarachnoid hemorrhage (SAH).

**Hypothesis**

The variation of pupillometer values are associated with modified Rankin Scale (mRS) at discharge.
Methods

• This is a secondary analysis of a prospective multicenter END-PANIC registry. The pupillometer used for this registry was the NPi-200 (Neuroptics, Inc).

• Data was collected from three neurocritical intensive care units (NICU) in the United States that use pupillometers as standard of care. Patients are included in the registry if:
  – They are older than 18 years.
  – Were admitted to the NICU with SAH [including aneurysmal subarachnoid hemorrhage (aSAH)].
Statistical Analysis

- Descriptive statistics included measures of central tendency and frequencies and percent.

- The **within-subject standard deviation (W_{SD})** of PLR readings (Size, CV, DV, NPi and latency) were first derived to provide an estimate of the spread of data for each individual patient. The $W_{SD}$ values were then used as the predictors of the mRS at discharge.

- Correlation and logistic regression analysis for normally distribution data was performed using SAS v9.4.
Results

- 82 patients with a total of 4,403 pupillary readings

Table 1. Baseline characteristics of demographic and SD of pupilometer readings.

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean (SD)</th>
<th>Median</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>82</td>
<td>57.7 (15.8)</td>
<td>54</td>
<td>19-87</td>
</tr>
<tr>
<td>GCS</td>
<td>82</td>
<td>11.4 (4.1)</td>
<td>14</td>
<td>3-15</td>
</tr>
<tr>
<td>mRS on admission</td>
<td>82</td>
<td>0.6 (1.3)</td>
<td>0</td>
<td>0-5</td>
</tr>
<tr>
<td>mRS at Discharge</td>
<td>82</td>
<td>2.8 (2.1)</td>
<td>4</td>
<td>0-6</td>
</tr>
</tbody>
</table>

- Primary diagnosis was 77% SAH (n=63) and 23% aSAH (n=19).

- Hunt & Hess scale showed 40% grade 1 (n=33), 27% grade 2 (n=22), 33% grade 3 (n=27), with no cases in grade 4 and 5.
Bivariate analysis showed a moderate negative correlation with the dependent variable, mRS at discharge, and the within-subject standard deviation ($W_{SD}$) for PLR values in both eyes ($r= -0.3$ to $-0.47; \ p<0.01$, Table 2).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Range</th>
<th>Correlation coefficient</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>$W_{SD}$ NPi RE</td>
<td>0 - 1.73</td>
<td>-0.36934</td>
<td>0.0006</td>
</tr>
<tr>
<td>$W_{SD}$ NPi LE</td>
<td>0 - 1.80</td>
<td>-0.36593</td>
<td>0.0007</td>
</tr>
<tr>
<td>$W_{SD}$ MIN RE</td>
<td>0 - 1.03</td>
<td>-0.40264</td>
<td>0.0002</td>
</tr>
<tr>
<td>$W_{SD}$ MIN LE</td>
<td>0 - 1.04</td>
<td>-0.34272</td>
<td>0.0016</td>
</tr>
<tr>
<td>$W_{SD}$ MAX RE</td>
<td>0 - 1.13</td>
<td>-0.31327</td>
<td>0.0042</td>
</tr>
<tr>
<td>$W_{SD}$ MAX LE</td>
<td>0 - 1.25</td>
<td>-0.30071</td>
<td>0.0061</td>
</tr>
<tr>
<td>$W_{SD}$ CV RE</td>
<td>0 - 0.97</td>
<td>-0.40565</td>
<td>0.0002</td>
</tr>
<tr>
<td>$W_{SD}$ CV LE</td>
<td>0 - 0.90</td>
<td>-0.41447</td>
<td>0.0001</td>
</tr>
<tr>
<td>$W_{SD}$ DV RE</td>
<td>0 - 0.32</td>
<td>-0.46787</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>$W_{SD}$ DV LE</td>
<td>0 - 0.42</td>
<td>-0.38578</td>
<td>0.0003</td>
</tr>
<tr>
<td>$W_{SD}$ LAT RE</td>
<td>0 - 0.96</td>
<td>-0.33544</td>
<td>0.0021</td>
</tr>
<tr>
<td>$W_{SD}$ LAT LE</td>
<td>0 - 0.32</td>
<td>-0.29704</td>
<td>0.0067</td>
</tr>
</tbody>
</table>
A logistic regression after controlling for admission GCS indicated that $W_{SD}$ for NPi, size, CV and DV for both eyes are predictors of mRS at discharge ($\beta = -1.21$ to $-10.21, \ p<0.05$), suggesting that higher variation in pupillometer readings is associated with lower scores in mRS at discharge.
McNell et al.\textsuperscript{2} published findings that show statistically significant relationship between NPi <3 and increased ICPs.

Aoun et al.\textsuperscript{1} that NPi changes are strongly associated with the advent of delayed cerebral ischemia.

Zafar et al.\textsuperscript{,21} suggest that PLR values are important in determining neurologic outcomes and prognosis for NICU patients.
Discussion

Correlation of Objective Pupillometry to Midline Shift in Acute Stroke Patients.

Osman M1, Stutzman SE2, Alem P3, Olson D3, Hicks AD2, Ortega-Perez S4, Aoun S5, Salem A2, Alyapari V3.

Optical pupillometry in traumatic brain injury: neurological pupil index and its relationship with intracranial pressure through significant event analysis

A. R. Stevens, Z. Su, E. Toman, A. Belli & D. Davies

Quantitative pupillometry for the monitoring of intracranial hypertension in patients with severe traumatic brain injury

Fritz-Patrick Jahns, John Paul Miroz, Mahmoud Messerer, Roy T. Daniel, Fabio Silvio Taccone, Philippe Eckert and Mauro Oddo
Conclusion

- Patients with higher $W_{SD}$ in PLR values had lower (better) discharge mRS, suggesting that patients unable to respond to changes in intracranial dynamics are at higher risk for poor outcomes.

- PLR values may be a marker for neurocritical care patient’s outcomes.
And for Nursing Practice.....

The Cue-Response Theory and Nursing Care of the Patient with Acquired Brain Injury

And for Nursing Practice.....

• The clinical relevance of these results strengthens the contention that PLR values could be an early herald of clinical changes that causes secondary brain injury that is a major cause of poor neurological outcomes.

• Use the PLR values to determine the optimal timing of neurocritical patient care interventions.

• Recognize cues through the PLR values in neurocritical patients.
Pupillary Light Reflex Variability as a Predictor of Clinical Outcomes in Subarachnoid Hemorrhage

Ortega-Perez, Stefany; Shoyombo, Ifeoluwa; Aiyagari, Venkatesh; Atem, Folefac; Hill, Michelle; Stutzman, Sonja E.; Olson, DaiWai M.

Journal of Neuroscience Nursing: June 6, 2019 - Volume Publish Ahead of Print - Issue - p
doi: 10.1097/JNN.0000000000000443
Article: PDF Only
Referencias


Thank you!!!