Correlation Between Pupillary Reactivity and Intracranial Pressure in Infants and Children

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BACKGROUND

- Comprehensive neurological examination includes assessment of pupillary light reflex which provides information about the functional status of the optic and oculomotor nerves[1].
- Changes in pupillary size and reactivity are early indicators of neurological change and are routinely used to guide clinical decision-making and interventions[1].
- Automated pupillometry overcomes the limitation of subjective penlight exam improving accuracy and, reliability, and allows for trending of data over time.
- Chen et al. (2011) reported an inverse relationship between objective pupillary measurements and intracranial pressure (ICP) in *adult* patients[2].
- Subsequent studies provide empirical evidence that early detection of subtle changes using pupillometers may improve clinical outcomes[3].
- Despite the widespread use of automated pupillometry across diverse patient populations, there are limited studies on its use in pediatrics.

PURPOSE

- To examine the correlation between automated pupillary measurements and ICP in pediatric critical care patients.

METHODS

- Single-center, retrospective review of patients admitted to the pediatric intensive care unit for ICP monitoring assessed per standard of care using an automated, handheld NeurOptics NPi-200 pupillometer device.
- A linear mixed-effect model with subject-level random effect was used to analyze the association between NPi and ICP measurements documented within 30 minutes of each other.
- Patients' demographic and clinical characteristics were included as covariates in the model.
- After log transformation of ICP, a generalized estimating equation (GEE) model was run with a compound symmetry covariance matrix for repeated measures.

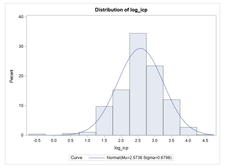
Neurological Pupil Index (NPi)

- Pupillary metrics including size, latency, constriction velocity, dilation velocity are obtained using a handheld device, and the measurement is compared against a normative model of pupil reaction to light on a scale of 0 to 5.
- An NPi value closer to 5 is considered more "brisk" than an NPi value closer to 3. An NPi score <3 represents an abnormal pupillary light reflex.

RESULTS

- Fifteen patients ranging from 3-16 years of age (M= 8.7, SD = 4) yielding over 2,600 ICP measurements were included.
- NPi was negatively associated with log ICP.

Figure 1: Following log transformation, normality assumption was satisfied



- Estimate of NPi was -0.0514; that is, a 1-unit increase in NPi was associated with 0.0514 unit decrease in log of ICP, with a significant p-value of 0.0104.

Table 1: Spearman's Rank Test Between ICP and NPi

Association	Spearman's Correlation	p-value
ICP vs. NPi	-0.079	0.0816

Table 2: GEE model for log of ICP vs. NPi, adjusting for the time between two measurements.

Outcome	Parameter	Estimate	Std	p-value
Log of ICP	Intercept	2.5725	0.1439	<.0001
	NPi	-0.0514	0.02	0.0104
	Time b/t ICP & NPi	0.0483	0.0953	0.6125

CONCLUSIONS

- Results are consistent with adult data that indicate automated assessments of pupillary reactivity inversely correlate with intracranial pressure.
- Pupillometry is a valuable adjunct to traditional invasive monitoring. An abnormally low NPi score may require emergent intervention. A baseline reading should be obtained as early as possible and routine exams should be conducted.
- Larger prospective studies are needed to validate these findings and explore if changes in pupillary reactivity precede increases in ICP.

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