

Range of quantitative pupillometry measurements and its association with traditional monitoring metrics in the Neuro ICU

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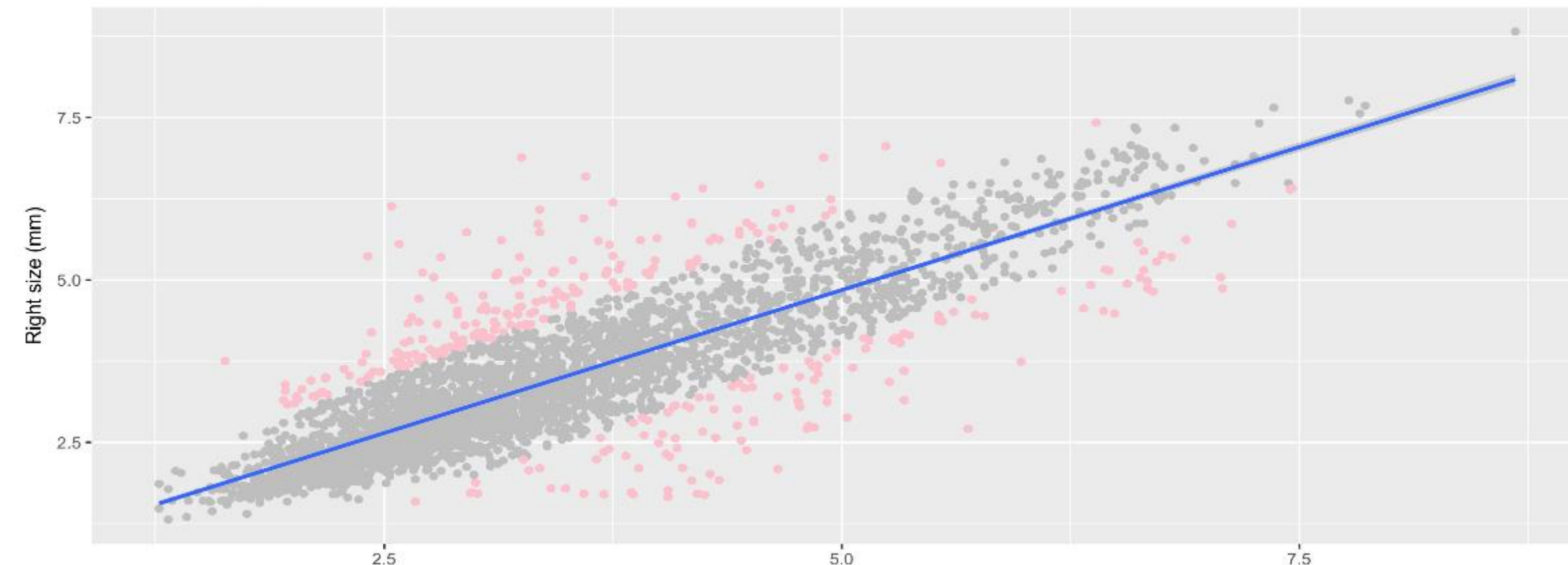


OBJECT AND METHODS

Background: Automated devices that collect objective quantitative data on pupil size and reactivity are increasingly used for critically ill patients with neurologic disease. However, there is limited data on the normative range of pupillary reactivity in the critically ill, and the relationship between reactivity and traditional monitoring metrics. To determine pupil characteristics in this population, we prospectively collected quantitative pupillometry data in patients admitted to the Neuro ICU with an expected stay of at least 24 hours.

Methods: Trained nursing staff measured pupillary reactivity with the NeuroOptics-200 pupillometer device every 2-hours. Measurements included the Neurologic Pupil Index, (NPi) a composite metric ranging from 0-5 in which >3 is considered normal, resting and constricted pupil size, constriction velocity, dilation velocity and latency. These recordings were compared with averaged intracranial pressure (ICP) and Glasgow Coma Scale (GCS) assessments within the same hour. We used univariate and spearman's rank tests to explore associations between pupil characteristics and clinical variables, followed by multi-level linear regression to account for intra- and inter-subject variability.

PUPIL SIZE COMPARISON



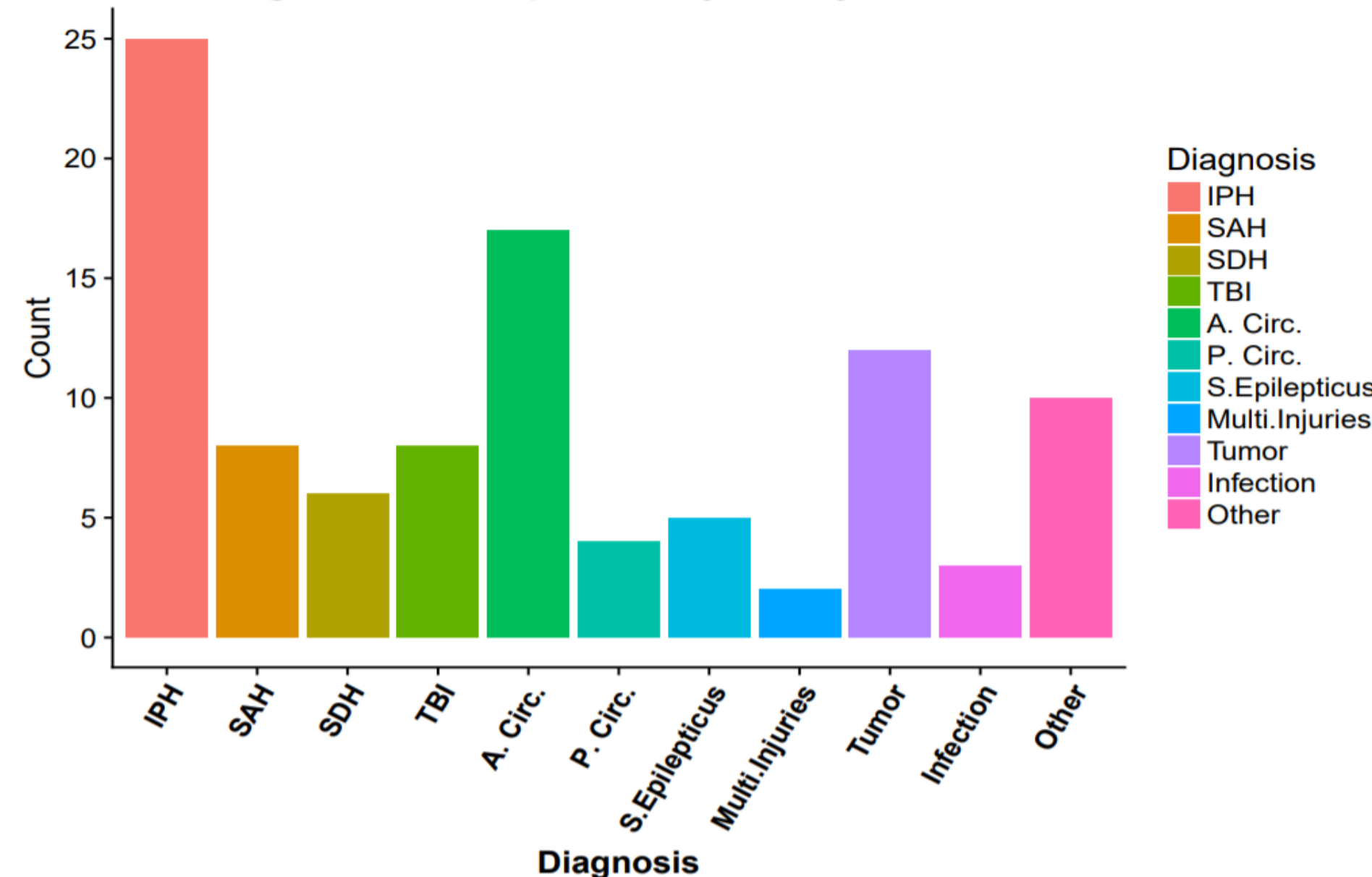
Pupil size measurement in the ICU: Red dots demark patients with clinically relevant anisocoria (>1mm difference in pupil size). 55 patients had at least one recorded episode of anisocoria.

MULTI-LEVEL MODEL

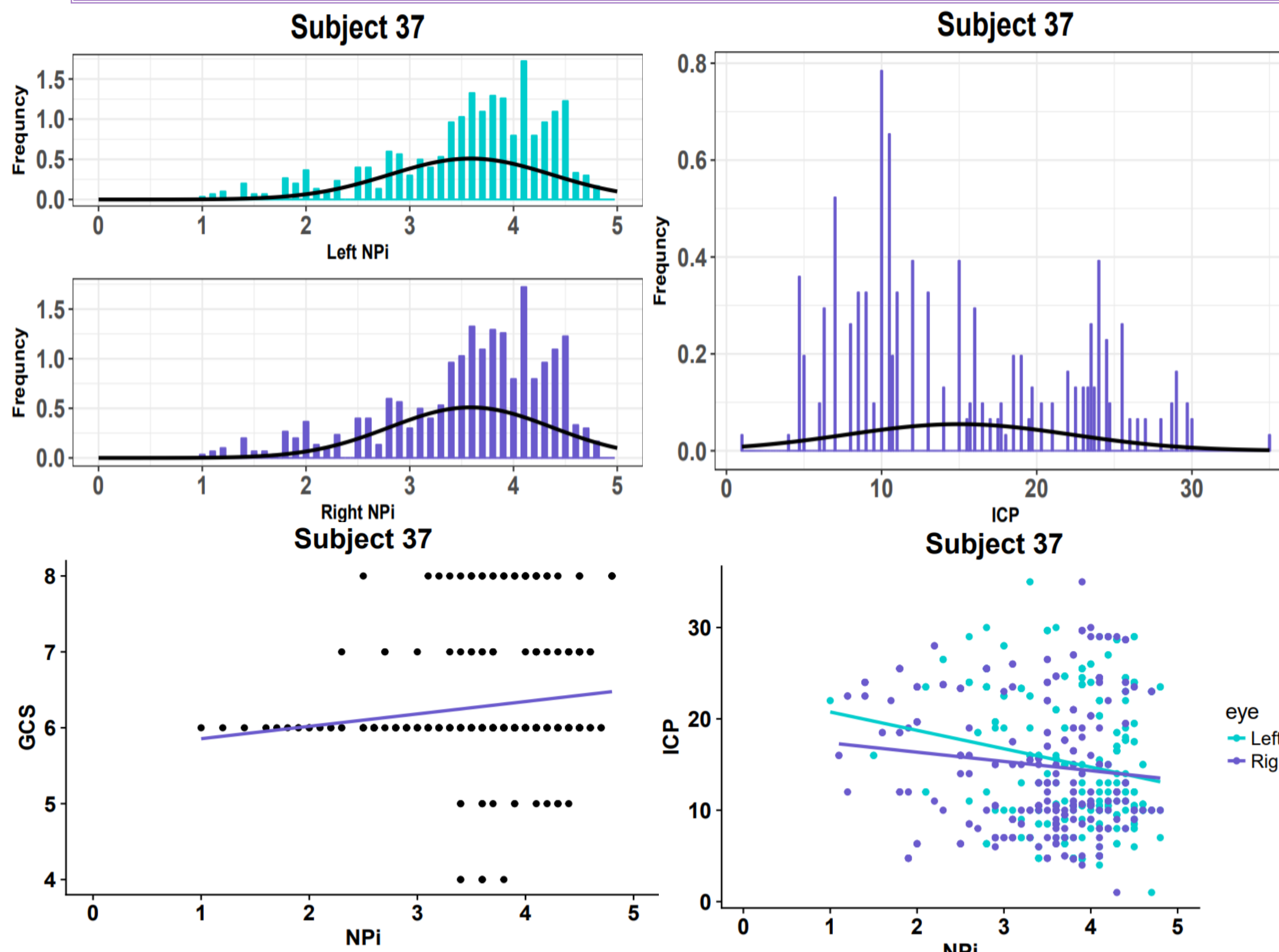
All ICP Values (ICP)	Estimate	Standard Error	P-value
Intercept	13.91	2.17	1.6 e-10
Mean NPi	-0.18	0.21	3.6 e-01
High ICP Values (>23 mmHg)	Estimate	Standard Error	P-value
Intercept	32.3	1.82	0
Mean NPi	-1.92	0.31	4.59 e-10
Mean GCS	Estimate	Standard Error	P-value
Intercept	7.14	0.63	0
Mean NPi	0.26	0.31	1.44e-08

A multilevel model controlling for subject and eye demonstrates significance between mean NPi measured over an hour and patients with elevated ICP (>23 mmHg). Mean NPi over one hour is also significantly correlated with GCS.

Diagnosis of Pupillometry Study Patients



Among the 100 patients studied, intraparenchymal hemorrhage (IPH) was the most common diagnoses, followed by anterior circulation stroke (A. Circ) and tumor.



Case Analysis: A 50 year old woman with HH5MF4 SAH and elevated ICPs on maximum medical therapy. She developed anisocoria intermittently that improved with hyperosmolar therapy. The graphs demonstrate the inverse correlation between ICP and NPi, and positive correlation between GCS and NPi.

RESULTS

Results: One-hundred patients underwent 4200 paired observations. Fifty-five patients had at least one recorded episode of anisocoria, 27 had low NPis in more than 10% of recordings, and 29 had normal pupil reactivity. Average and minimum NPi was correlated with average and minimum recorded hourly Glasgow Coma Score (GCS) (p values <0.001). Increased asymmetry in both pupil size (p=0.002) and dilation velocity (p=0.02) was associated with increased intracranial pressure (ICP). Anisocoria was associated with hyperosmolar therapy (p=0.002). The presence of low NPis in more than 10% of total pupil measurements was associated with death at discharge (p=0.02).

CONCLUSIONS

Conclusions: The range of pupillary metrics varies among critically ill neurologic patients and correlates with GCS and ICP. Further study is needed to establish whether change in pupil metrics predict specific clinical events.