



Introduction

- After Targeted Temperature Management (TTM) for encephalopathic cardiac arrest survivors, prognosis is primarily based on neurological examination, but sedation and hypothermia can alter the exam and may not always be accurate predictors of neurological recovery.
- The pupillary light reflex has been shown to be a robust indicator of neurological outcome, and Quantitative pupillometry appears to be more reliable than subjective assessment.
- Primary Objective: Evaluate pupillometry results in a cohort of TTM patients, and compare values between those with good and poor outcomes.

Methods

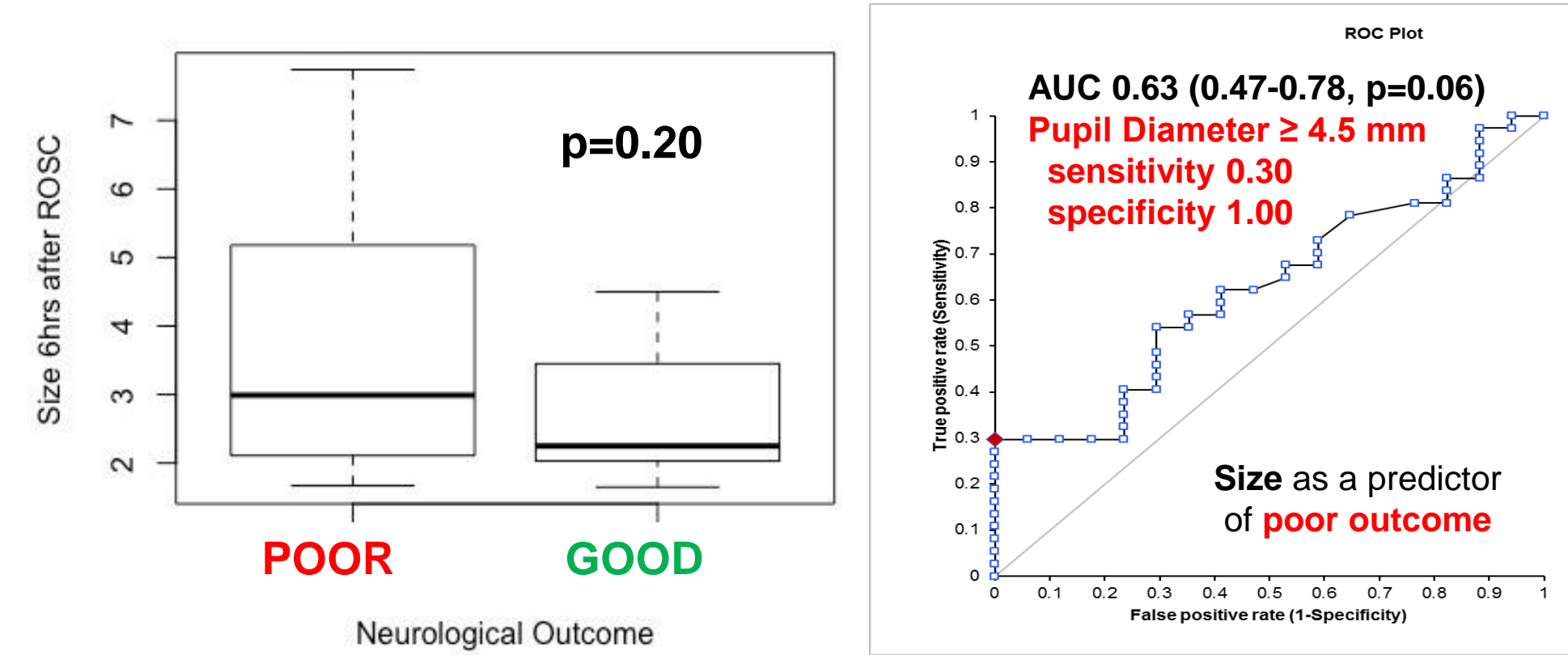
- Encephalopathic adult patients surviving an initial cardiac arrest (any location or initial rhythm) were treated with TTM with the Arctic Sun (Bard), usually at 33°C for 24 hours, with 12 hour rewarming.
- Outcome was classified as **Good** if hospital discharge Cerebral Performance Category (CPC) score was 1-2, and **Poor** if CPC was 3-5.
- Data was prospectively entered into the [International Cardiac Arrest Registry \(INTCAR\)](http://www.intcar.org), (www.intcar.org).
- As part of routine bedside clinical assessment, objective pupil monitoring with the NeuroOptics NPi-200 pupillometer was introduced July 2016.
- No specific timing requirement for Npi-200 use was mandated, but expected to be used when pupil assessments were done as part of neurologic exam during and after TTM.
- Data was automatically stored on the pupillometer Smartguard, which was saved after patient transfer from the ICU whenever possible.
- Smartguards available from July 2016-July 2017 were downloaded July 2017, and data reconciled with INTCAR data.
- Comparison of the various pupillometer values at initial ICU assessment and at 6 hours post-ROSC for the worst scoring eye between Good and Poor outcome was assessed by Wilcoxon Rank Sum test.
- Performance of the various pupillometer values at initial ICU assessment and at 6 hours post-ROSC for the worst scoring eye as a predictor of poor outcome was assessed by Receiver Operator Characteristic curves.
- Additional descriptive data evaluated patients whose pupillary light reflex became "sluggish" (NPi <3) or became non-reactive (NPi = 0)

Results

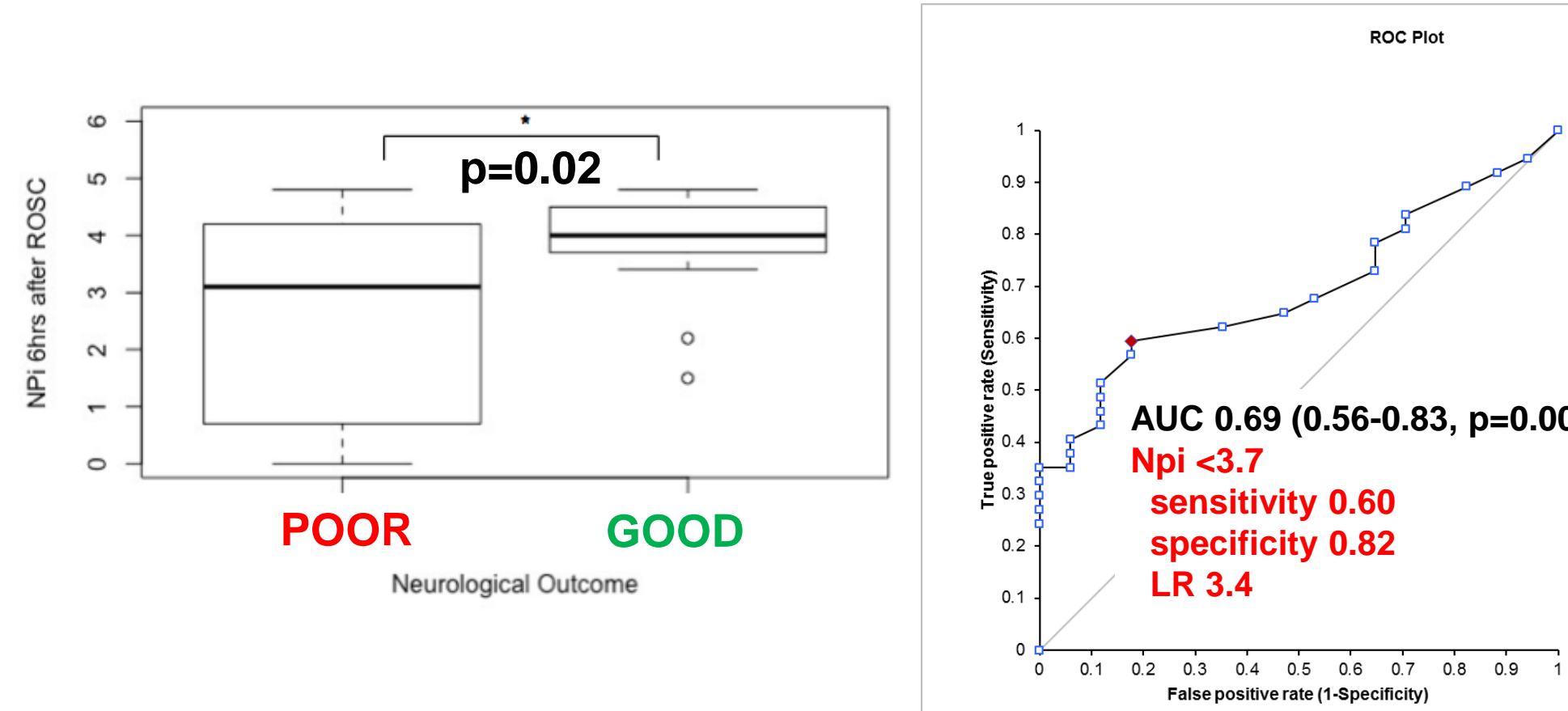
- 55 adult patients underwent TTM therapy after cardiac arrest and had pupillometer SmartGuard data available
- Demographics displayed in table 1
- 20 patients developed an NPi = 0 (Non-reactive pupil)
 - 1 of 20 (5%) Good Outcome
- 35 patients developed NPi ≤ 3 (Sluggish)
 - 6 of 35 Good Outcome (%)
 - 4 discharged alive with Poor Outcome (CPC=3) (18%)
 - 25 died (71%)

Age, years Median (IQR)	57 (48-68)
Male, n (%)	36 (65%)
Initial Rhythm	
VT/VF/AED shockable	28 (51%)
Asystole	14 (25%)
PEA	11 (20%)
Unknown	2 (4%)
Witnessed arrest	38 (69%)
Time to ROSC, minutes	23 (14-34)
OOHCA	44 (80%)
Good Outcome (CPC 1-2)	16 (29%)

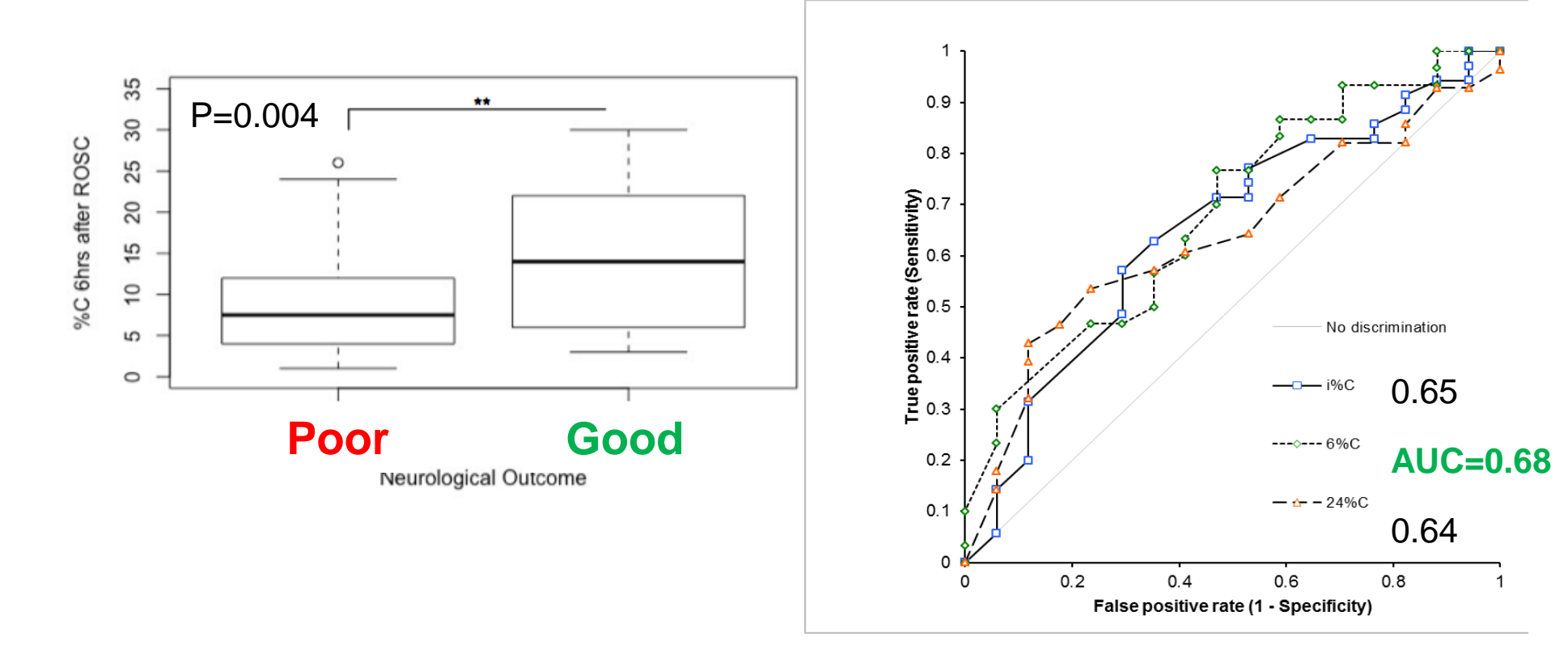
Pupil Size 6 hours post-ROSC



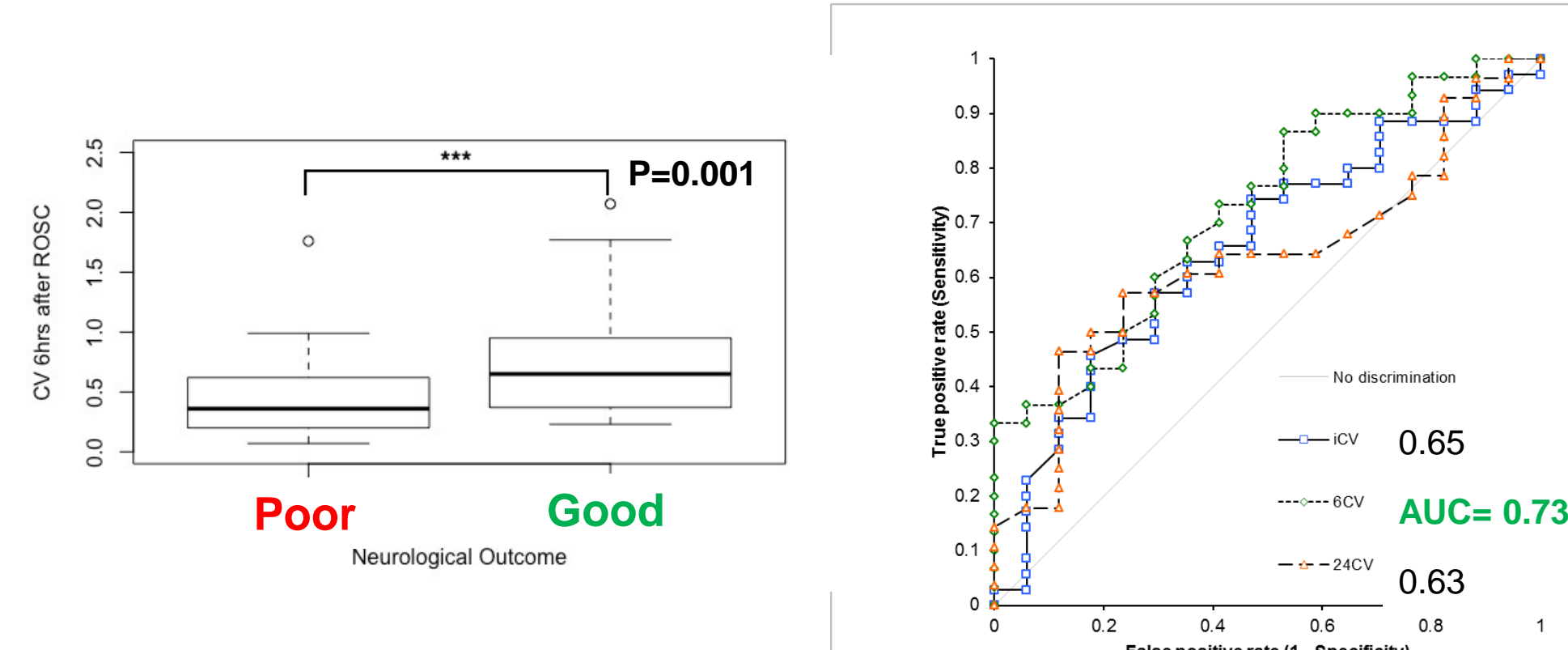
Neurological Pupil index (NPi)



% Constriction



Constriction Velocity



Results

Pupillometer Variables vs Outcome

	Good Outcome	Poor Outcome	p-value
NPi	N=17 (31%)	N=38(69%)	
Initial	4 (3.7-4.3)	3.4 (1.1-4)	0.02
6hrs	4 (3.7-4.5)	3.1 (0.7-4.2)	0.02
24hrs	4.3 (4.1-4.4)	3.7 (3-4.3)	0.004
Size (mm)			
Initial	2.25 (2.03-3.45)	3.06 (2.11-4.7)	0.3
6hrs	2.25 (2.03-3.45)	2.99 (2.11-5.18)	0.2
24hrs	2.2 (2.02-2.81)	2.32 (2-3.11)	0.8
Constrict Velocity			
Initial	0.59 (0.32-1.04)	0.34 (0.23-0.59)	0.04
6hrs	0.65 (0.37-0.95)	0.36 (0.2-0.6)	0.001
24hrs	0.61 (0.51-0.71)	0.43 (0.28-0.71)	0.009
% Constriction			
Initial	11 (5-17)	6 (4-13)	0.04
6hrs	14 (6-22)	8 (4-12)	0.004
24hrs	13 (11-16)	10 (5-15)	0.008

NPi = 0 (Non-reactive Pupil) (n=20)

	Good Outcome	Poor Outcome	Total
NPi = 0	1/20 (5%)	19/20 (95%)	20/55 (36%)
Pupil Size (mm) when NPi=0			4.6 (2.1-5.6)
NPi exam just Prior to 0			3.7 (3.3-4.1)
Time prior evaluation to Npi = 0 (hrs)			2.7 (1.8-4.5)

- 1/20 NPi=0 Good Outcome vs 17/35 if NPi not 0 (p=0.002)
- 18/20 NPi=0 patients died, Cerebral cause in 16/18 (89%), compared to 8/13 (62%) for non-NPi=0 (p=0.09)

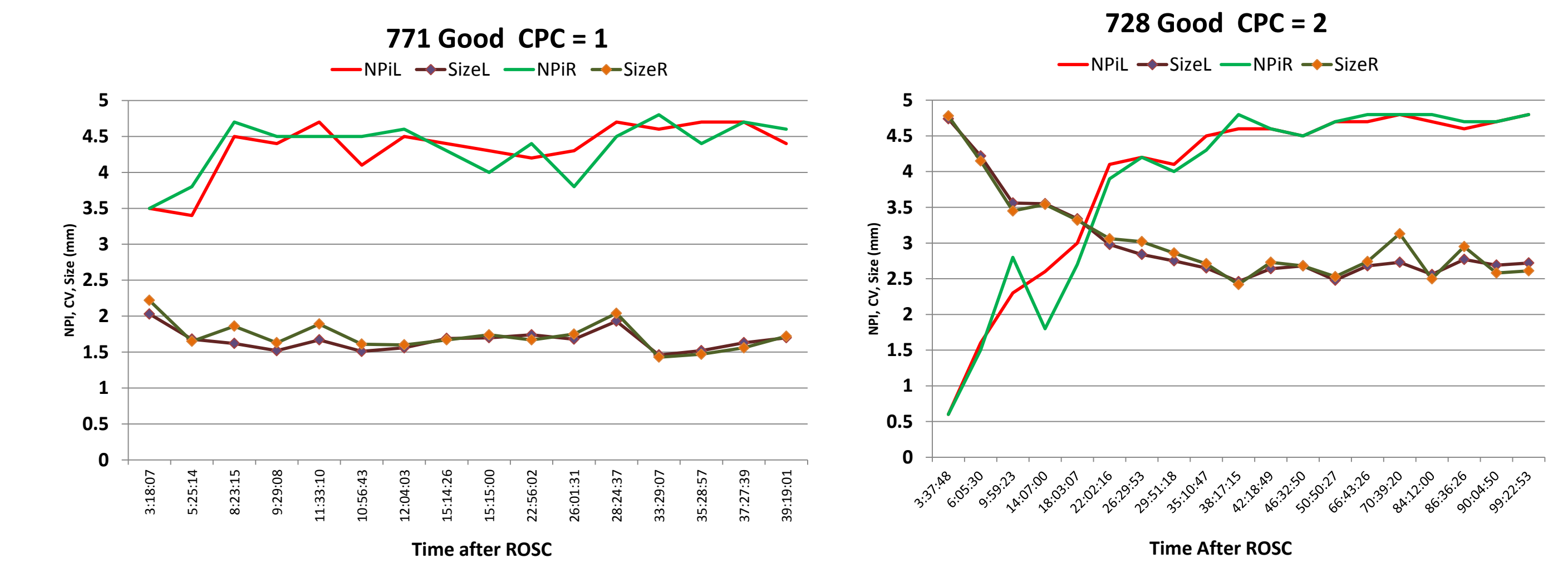
NPi ≤ 3 (Sluggish Pupil) (n=35)

	Good Outcome	Poor Outcome	Total
NPi ≤ 3	6/35 (17%) **	29/35 (83%)	35/55 (64%)

- 6/35 NPi ≤ 3 Good Outcome vs 10/20 if NPi >3 (p=0.02)
- 25/35 (71%) NPi ≤ 3 died vs 7/20 (35%) if NPi >3 (p=0.019)

Results

Example Tracings of Good Outcome Patients



Example Tracings of Poor Outcome Patients



Conclusions

- During TTM for adult cardiac arrest patients with encephalopathy, monitoring with pupillometry detected an abnormal light reflex:
 - Non-reactive (NPi = zero)
 - Sluggish reactivity (Npi <3)
- Either of these events is associated with dramatically worse outcomes
- These changes in reactivity occur most commonly WITHOUT dilated pupils
- It is not clear whether early recognition of declining pupillary light reflex would allow interventions that might improve outcome, or what those interventions might be.
- More frequent monitoring in higher risk patients may show a progressive decline in NPi or other pupillometry variables, but this has not been confirmed.

Pupillometry and Cardiac Arrest

With different devices

- Suys. Neurocritical Care 2014;21:300-8.
- Solari. Ann Neurology 2017;81:804-10.
- Heimburger. Resuscitation 2016;103:88-93.

With our same device – NeuroOptics NPi-200

- Behrends. Resuscitation 2012;83:1223-8

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