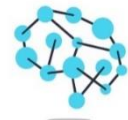


Insights into the pathophysiology of hypoxic ischemic brain injury

“Beyond temperature control”

ICM+ Workshop
Sept 11, 2018

Myp Sekhon MD FRCPC
Clinical Assistant Professor
Division of Critical Care Medicine
University of British Columbia



VGH Neurocritical
Care

Disclosures





Cardiac arrest





Cardiac Arrest is NOT a *heart* problem

Cardiac arrest





Cardiac Arrest is a *brain* problem

Cardiac arrest



Case

- 31 year old female
- PMHx: Wolf Parkinson White
No other cardiac risk factors
- Drugs: None
- Fam Hx: No cardiac history or sudden cardiac death
- Social: Full time student, occasional alcohol, no illicit drugs





Case

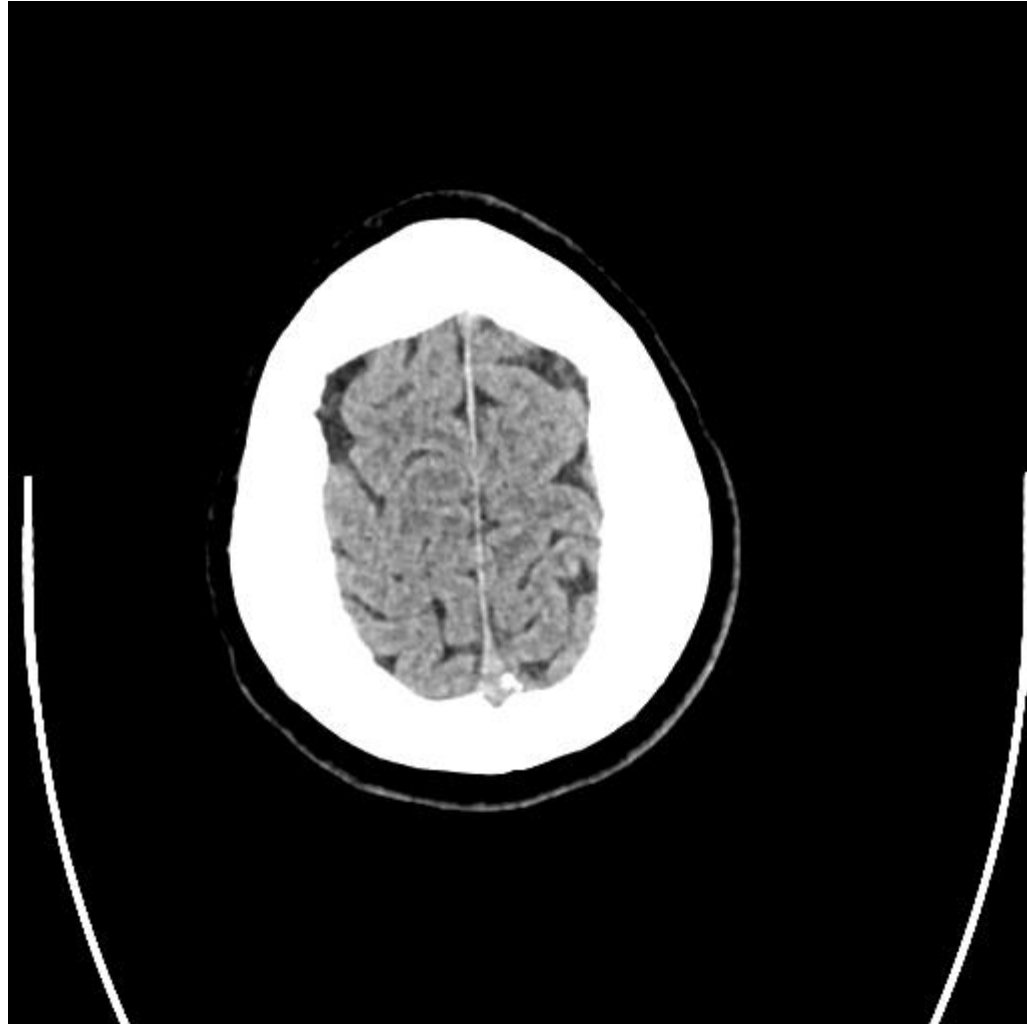
- 31 year old female
- 9:00am – collapses at desk while in class, pulseless
- 9:02am – bystander CPR commenced
- 9:10 – EMS arrives
 - Initial rhythm – Ventricular fibrillation
 - Defibrillation x 4
 - Epinephrine x 3
- 9:25am – Return of spontaneous circulation
- Post resuscitation GCS: 3
- 9:37am – Arrival at VGH

Case

- 31 year old female
- Day 1
 - Pupils 3/3 and reactive
 - Sedated with Propofol and fentanyl
 - TTM – 36°C with surface cooling
 - MAP ~ 70's. Levophed 0 to 10mcg/min
 - Initial lactate 7.6mmol/L
 - ECG – No ischemic changes. Sinus tachycardia.
 - ECHO – low normal LV function. No regional wall motion abnormalities. No significant valvular disease.



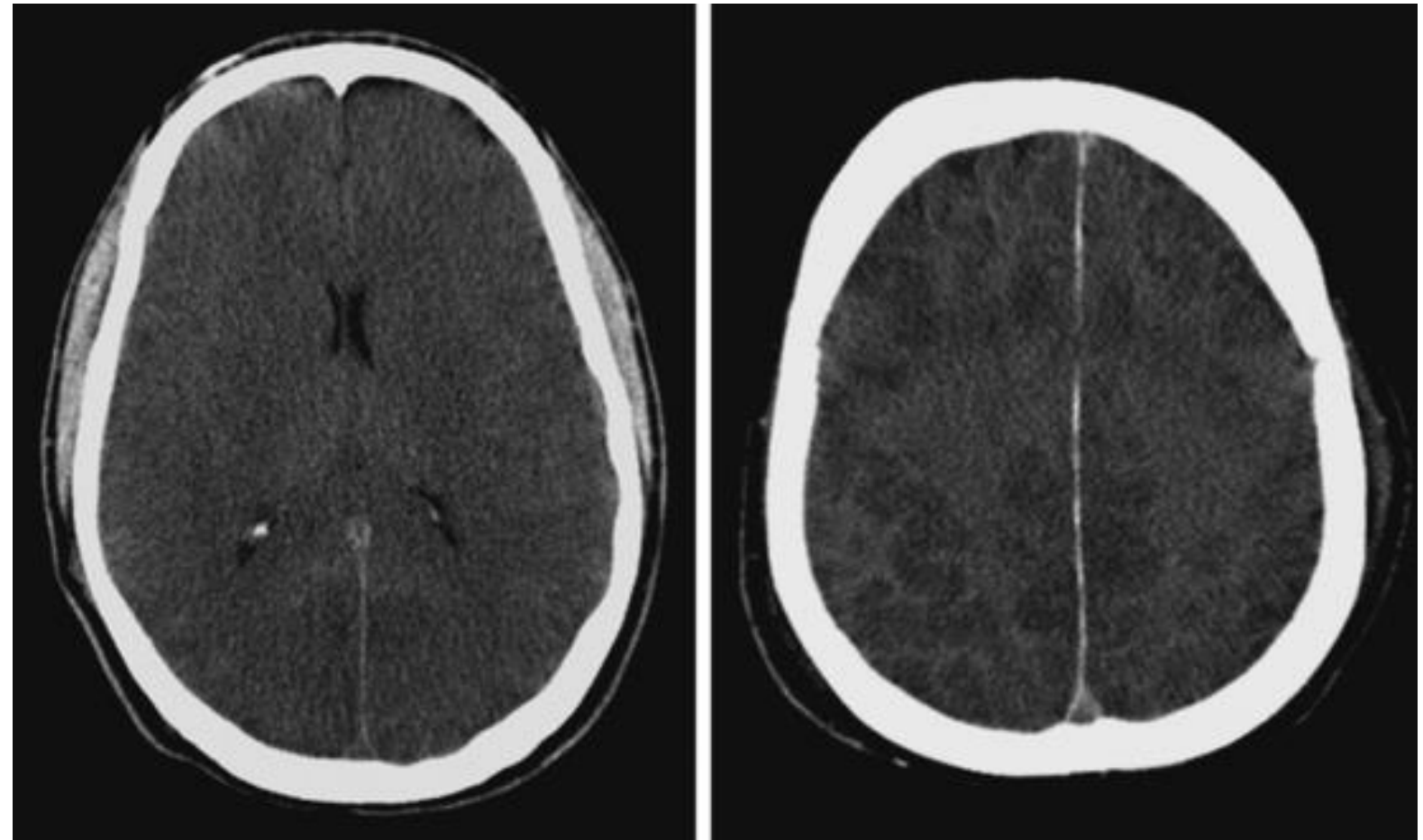
Case



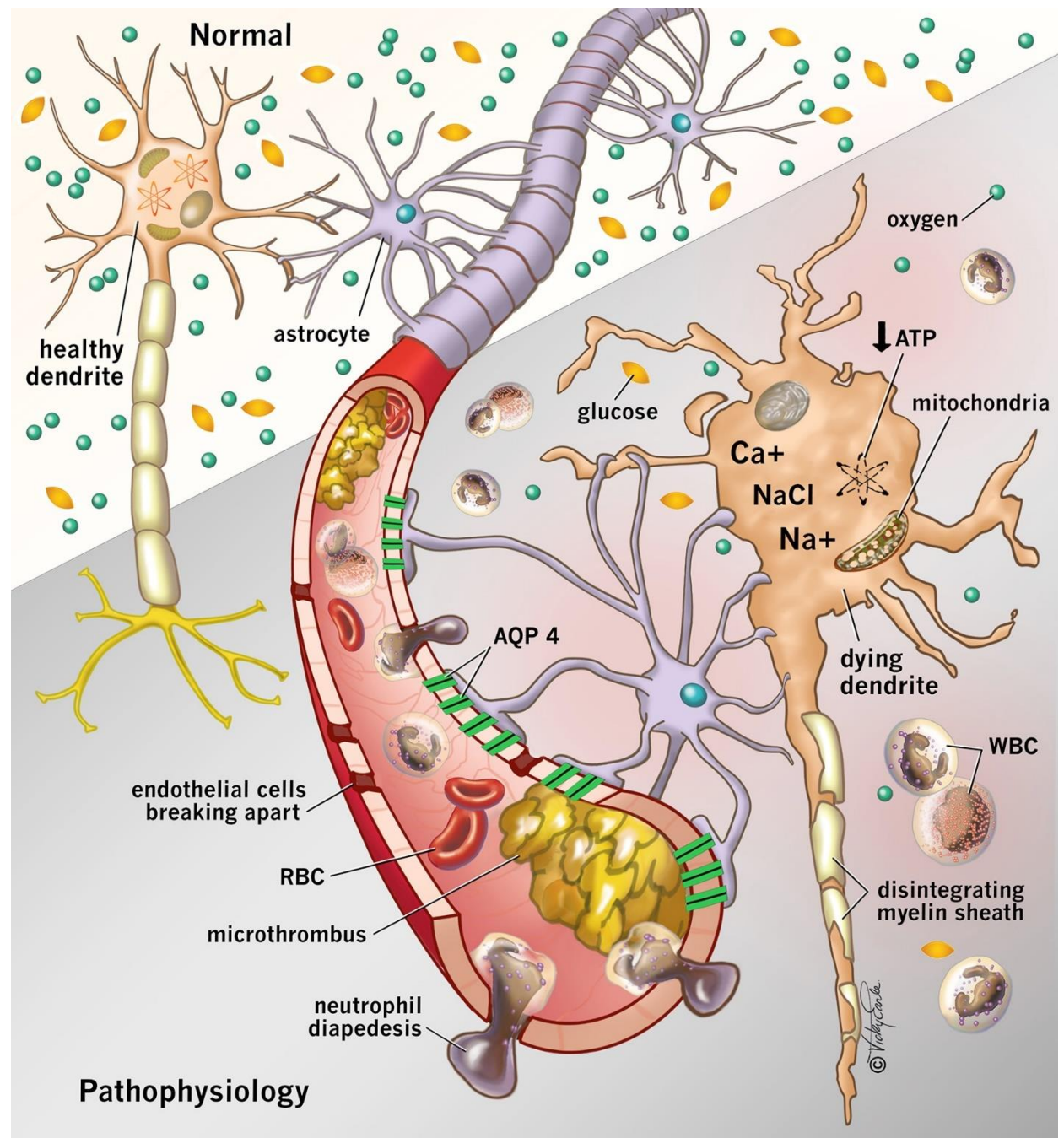


Hypoxic ischemic brain injury

HIBI



HIBI



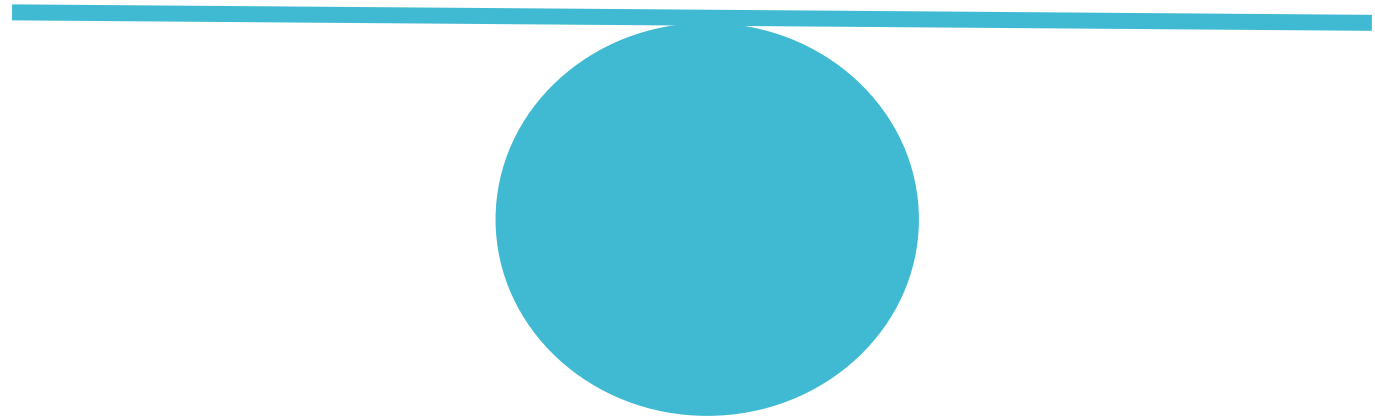
HIBI Management Paradigm

Prevention of Secondary Injury

Cerebral oxygen
delivery

Cerebral oxygen
utilization

Management



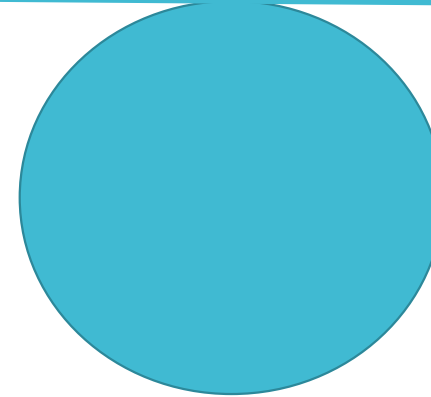
HIBI Management Paradigm

Prevention of Secondary Injury

Cerebral oxygen
delivery

Cerebral oxygen
utilization

Management





Cerebral Oxygen Delivery

Prevention of Secondary Injury

Management

$$\text{CDO}_2 = \text{CBF} \times \text{O}_2 \text{ content}$$



Cerebral Perfusion Pressure



Mean arterial pressure - Intracranial Pressure



Cerebral Oxygen Delivery

Prevention of Secondary Injury

Management

$$\text{CDO}_2 = \text{CBF} \times \text{O}_2 \text{ content}$$



Cerebral Perfusion Pressure



Mean arterial pressure - Intracranial Pressure

Management

Mean Arterial Pressure

*What is the **optimal mean arterial pressure** to perfuse the brain in hypoxic ischemic brain injury?*

Management

Mean Arterial Pressure

Part 9: Post-Cardiac Arrest Care

2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Vasoactive drug infusions such as dopamine, norepinephrine, or epinephrine may be initiated if necessary and titrated to achieve a minimum systolic blood pressure of ≥ 90 mm Hg or a mean arterial pressure of ≥ 65 mm Hg.

LOE B). Although human studies have not established ideal targets for blood pressure or blood oxygenation,^{11,12} a mean arterial pressure ≥ 65 mm Hg and an ScvO₂ $\geq 70\%$ are generally considered reasonable goals.

Management

Mean Arterial Pressure

The New England Journal of Medicine

EARLY GOAL-DIRECTED THERAPY IN THE TREATMENT OF SEVERE SEPSIS AND SEPTIC SHOCK

EMANUEL RIVERS, M.D., M.P.H., BRYANT NGUYEN, M.D., SUZANNE HAVSTAD, M.A., JULIE RESSLER, B.S.,
ALEXANDRIA MUZZIN, B.S., BERNHARD KNOBLICH, M.D., EDWARD PETERSON, PH.D., AND MICHAEL TOMLANOVICH, M.D.,
FOR THE EARLY GOAL-DIRECTED THERAPY COLLABORATIVE GROUP*

Management

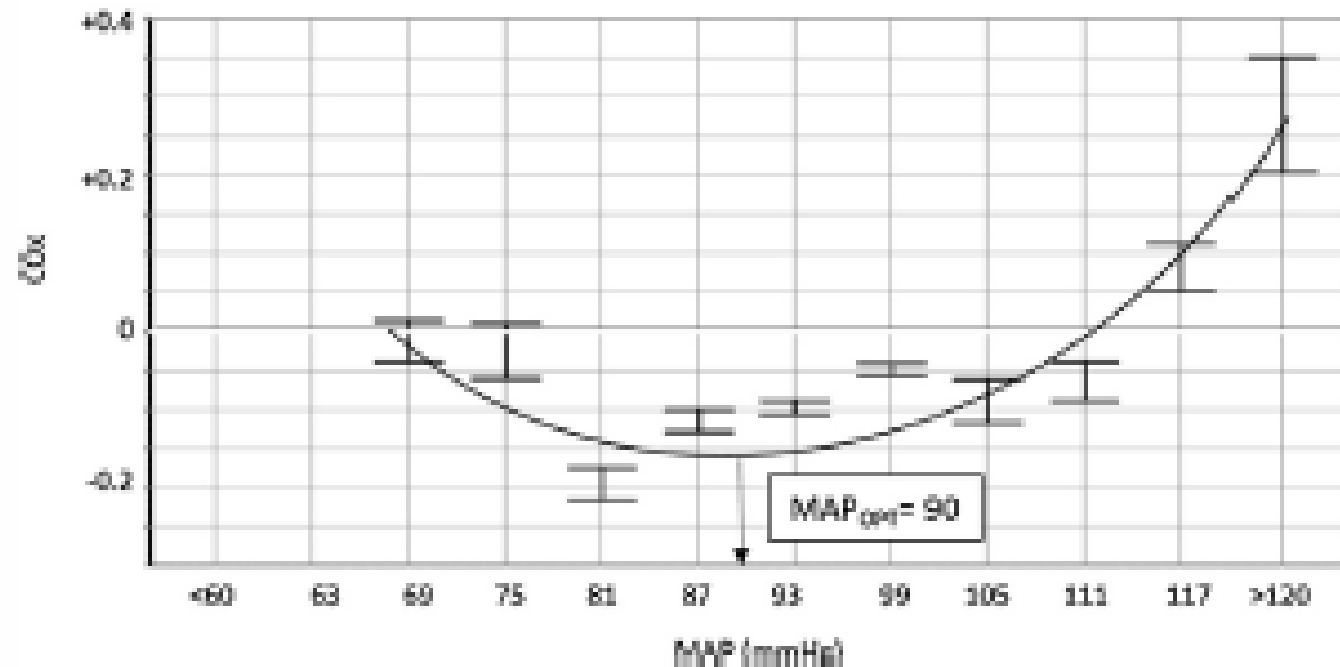
Mean Arterial Pressure

Resuscitation

Using the relationship between brain tissue regional saturation of oxygen and mean arterial pressure to determine the optimal mean arterial pressure in patients following cardiac arrest:

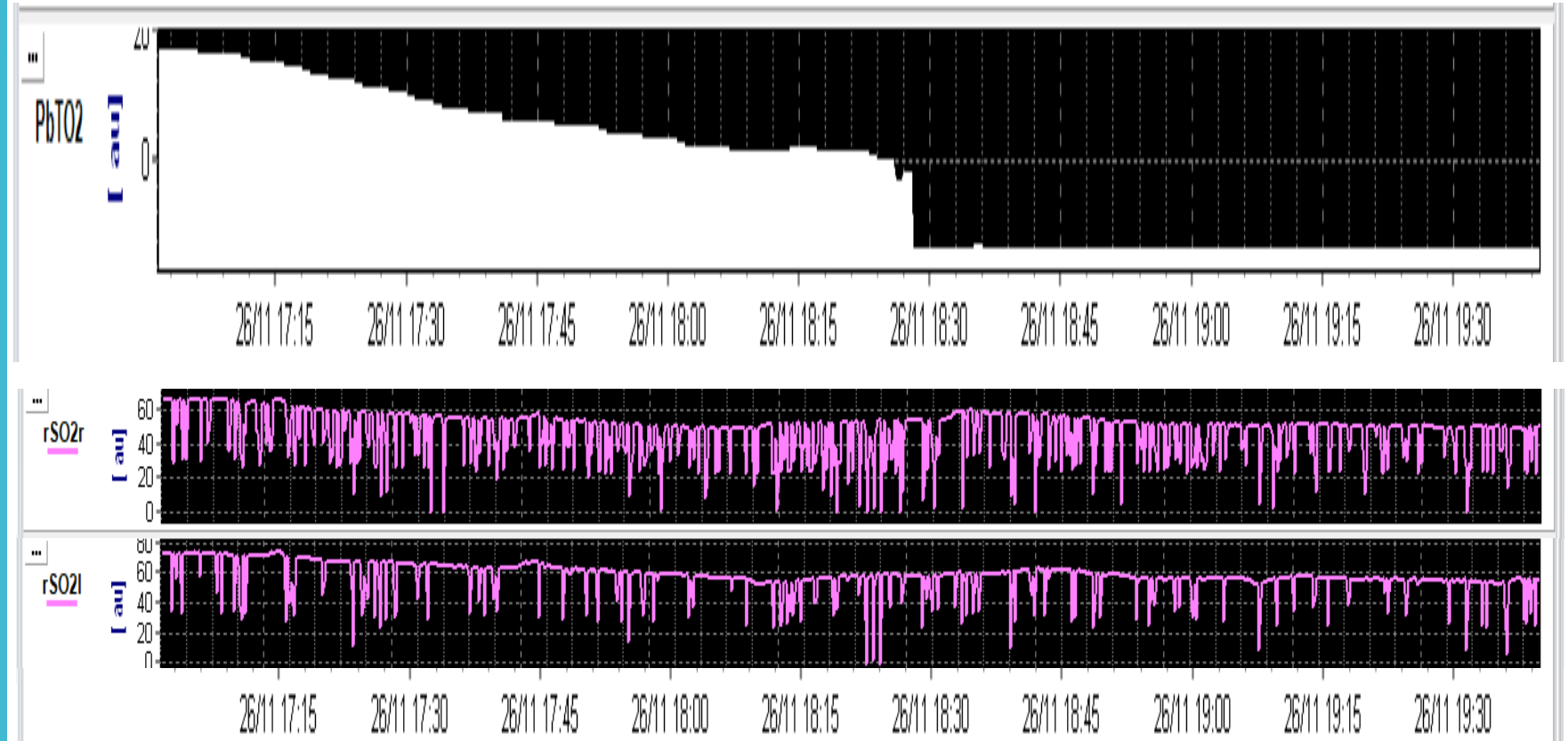
A pilot proof-of-concept study[☆]

Mypinder S. Sekhon^a, Peter Smielewski^b, Tahara D. Bhate^a, Penelope M. Brasher^c, Denise Foster^a, David K. Menon^b, Arun K. Gupta^b, Marek Czosnyka^d, William R. Henderson^a, Kenneth Gin^e, Graham Wong^e, Donald E. Griesdale^{a,c,f,*}

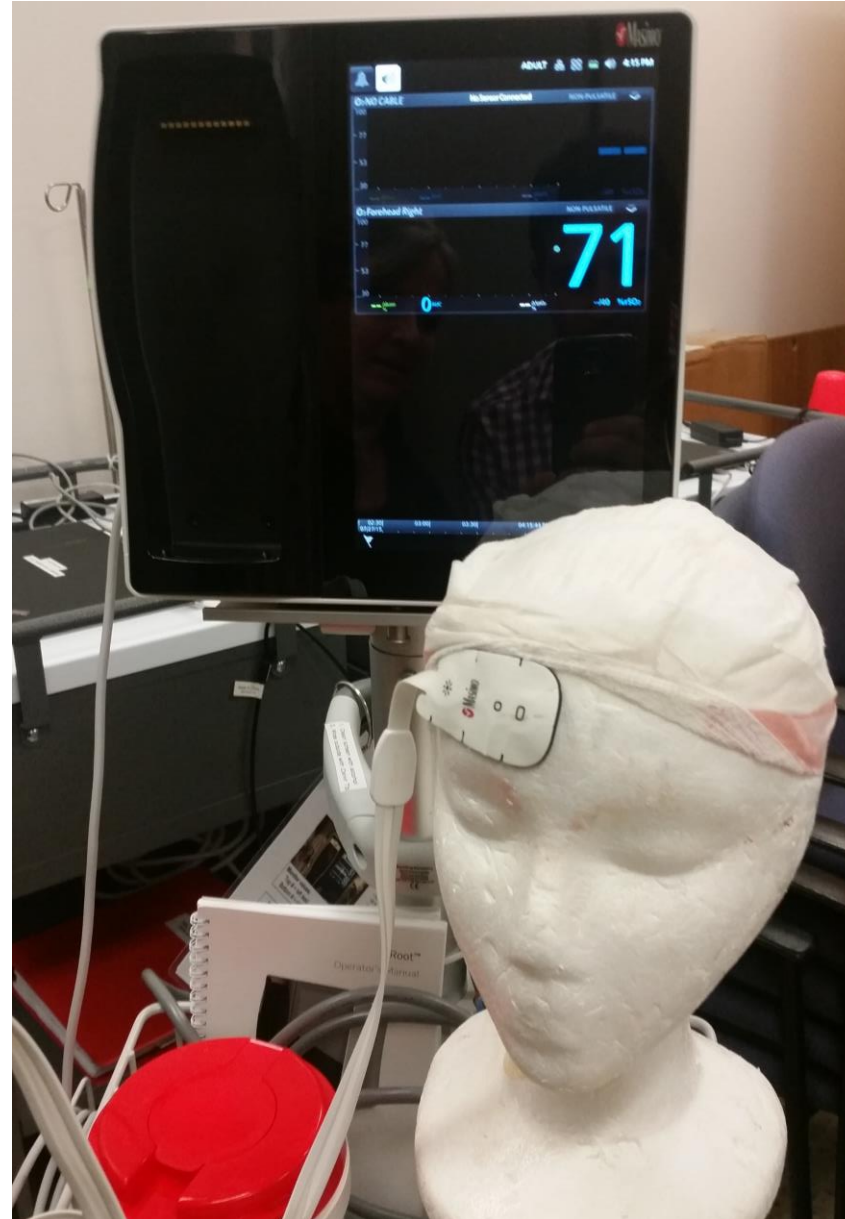




NIRS Validity?



NIRS Validity?





Cerebral Autoregulation Monitoring using COx and PRx in Hypoxemic Ischemic brain Injury (CAMP – HIBI)

CAMP HIBI

- **Study design:**
 - Single center interventional study of invasive ICP / PbO₂ monitoring in patients who remain comatose after cardiac arrest
- **Research Objectives:**
 1. Assess feasibility to collect invasive monitoring data
 2. Characterize the temporal trends of ICP / PbO₂ and cerebral autoregulation
 3. Assess the agreement between:
 1. PbO₂ and rSO₂ / SjO₂
 2. Relations of CDO₂ determinants with PbO₂
 3. Determination of MAPopt
 1. Invasive methods vs. non-invasive comparison

Cerebral Autoregulation Monitoring using COx and PRx in Hypoxemic Ischemic brain Injury (CAMP – HIBI)

CAMP HIBI



1) PbtO₂

2) ICP

3) NIRS – rSO₂

4) Continuous SjO₂

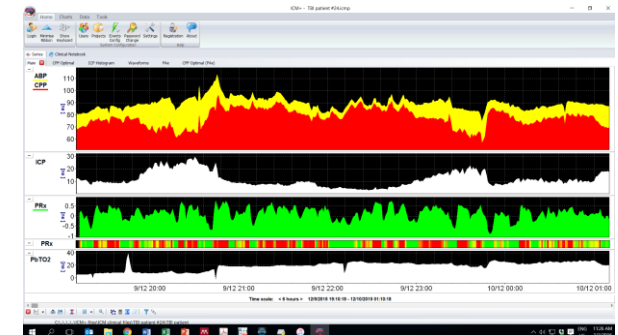
CAMP - II

5) Microdialysis

6) Hemedex

- Autoregulation indices – PRx
- Additionally collect: temp & EtCO₂

ICM+



Cerebral Autoregulation Monitoring using COx and PRx in Hypoxemic Ischemic brain Injury (CAMP – HIBI)

Study ID	Age	Gender	Arrest Etiology	Rhythm	Witnessed	Time to ROSC (mins)	Post ROSC GCS	Time to MMM (h)	Duration of MMM (h)	6 month GOS
1	20	Male	Hypoxia	PEA	No	12	5	16	24	4
2	47	Male	Hypoxia	PEA	No	15	3	6	39	1
3	23	Male	Hemorrhage	PEA	Yes	22	3	14	51	5
4	71	Female	Hypoxia	PEA	No	14	4	8	37	1
5	31	Female	VF	VF	Yes	25	4	43	94	5
6	57	Male	Anaphylaxis	PEA	No	24	6	7	42	1
7	37	Male	Drowning	PEA	Yes	36	3	6	18	1
8	67	Female	Hypoxia	PEA	Yes	17	3	8	8	1
9	48	Male	Opioid overdose	PEA	No	27	3	10	62	5
10	49	Male	Asthma	PEA	Yes	18	4	9	47	1
Abbreviations: PEA – Pulseless electrical activity; VF – Ventricular fibrillation; ROSC – Return of spontaneous circulation; GCS – Glasgow coma scale; MMM – Multimodal monitoring; GOS – Glasgow outcome score										



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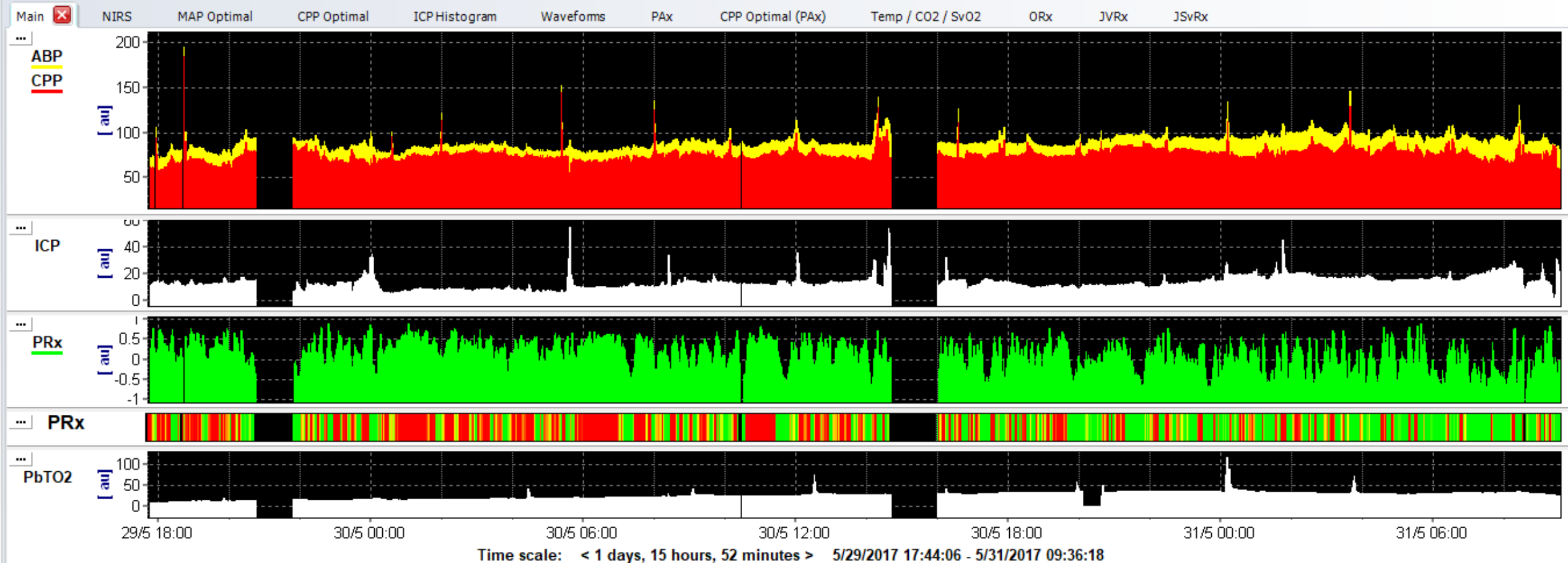
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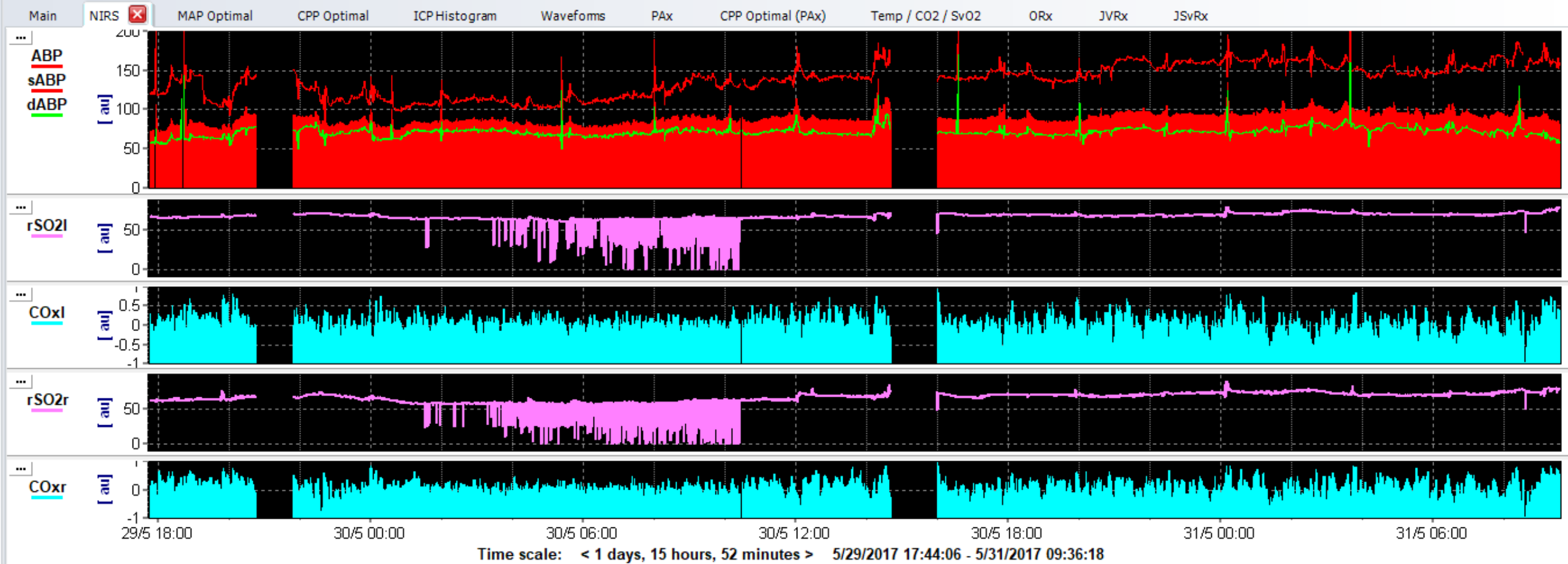
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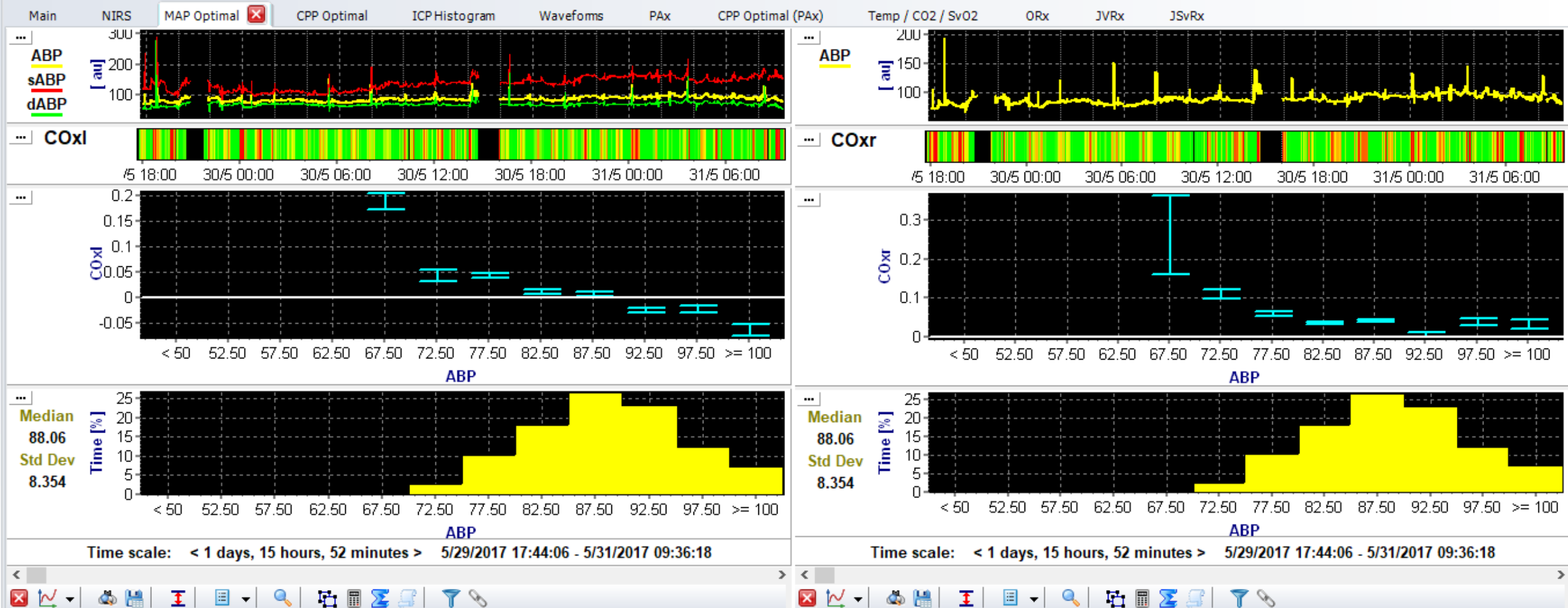
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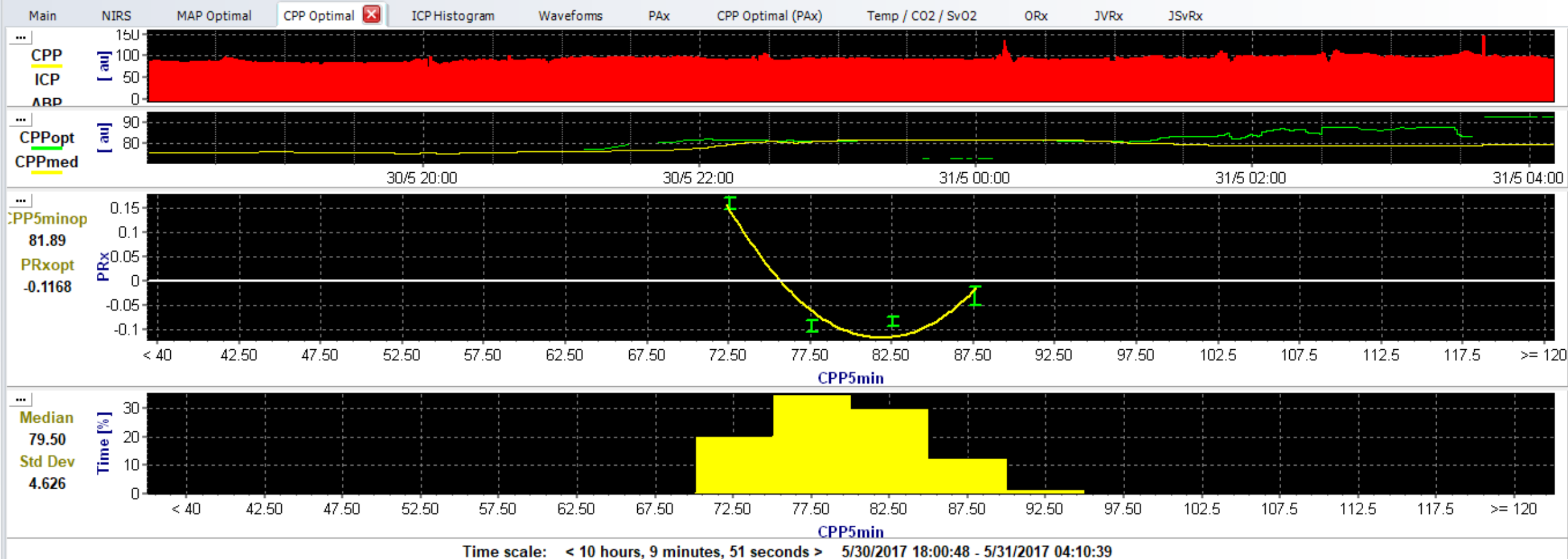
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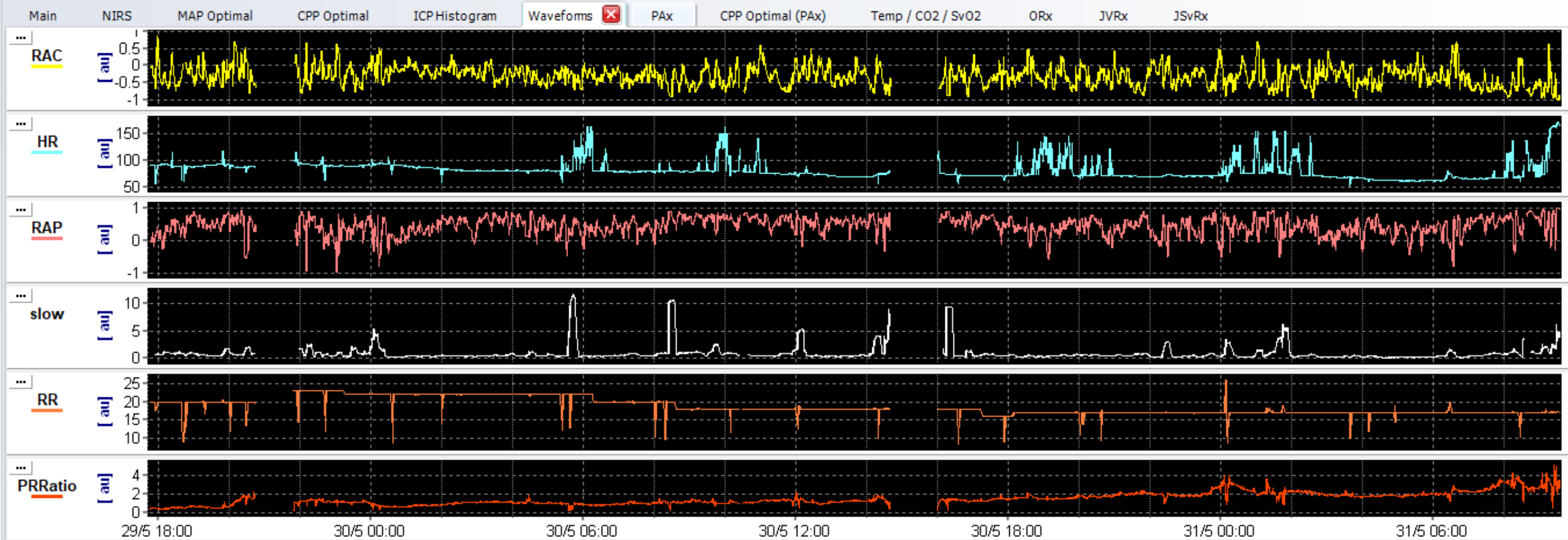
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Time scale: < 1 days, 15 hours, 52 minutes > 5/29/2017 17:44:06 - 5/31/2017 09:36:18



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Main

NIRS

MAP Optimal

CPP Optimal

ICP Histogram

Waveforms

Pax

CPP Optimal (Pax)

Temp / CO₂ / SvO₂

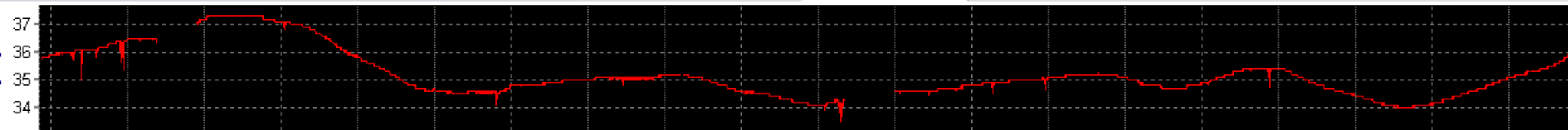
ORx

JVRx

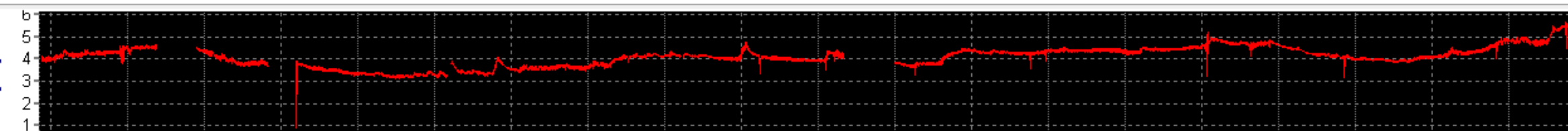
JSvRx

Temp

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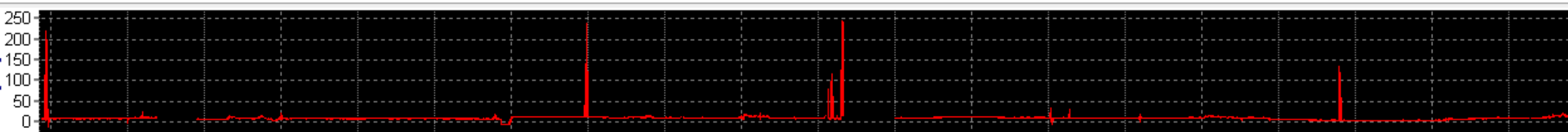
EtCO₂

[au]



Cvp

[au]

SvO₂

[au]



Time scale: < 1 days, 15 hours, 52 minutes > 5/29/2017 17:44:06 - 5/31/2017 09:36:18



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10:05 PM
9/8/2018

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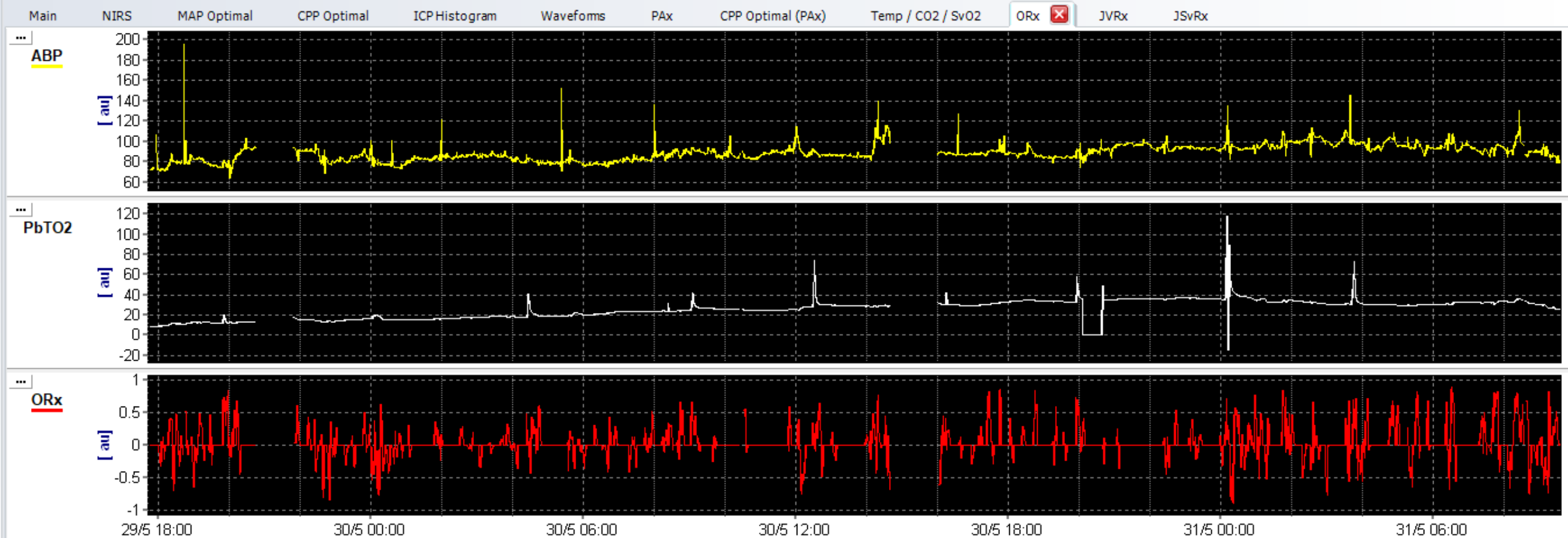
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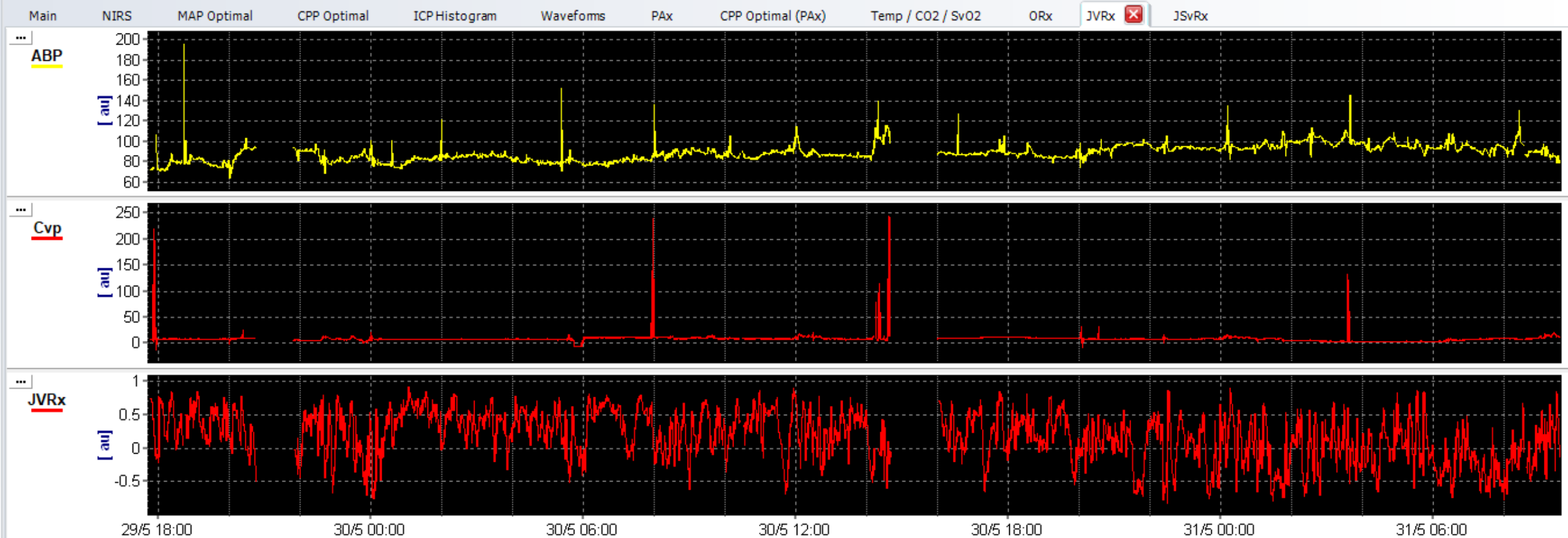
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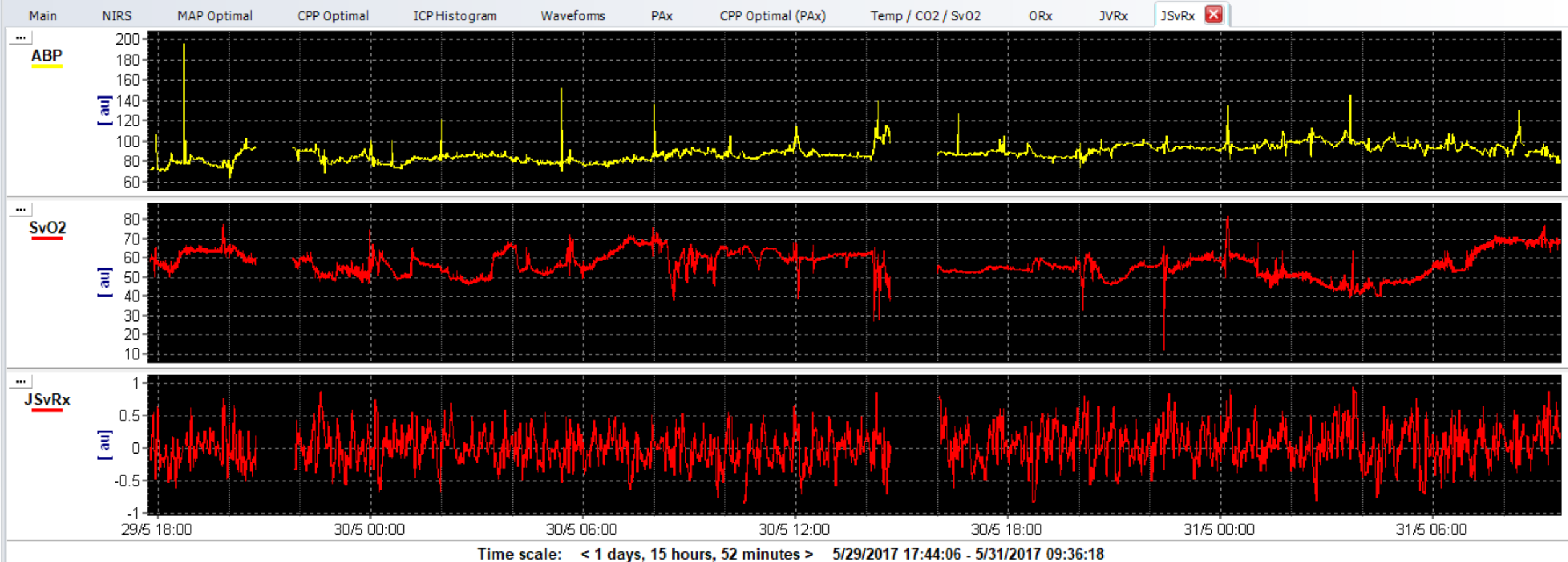


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Charts Layout

Series Clinical Notebook



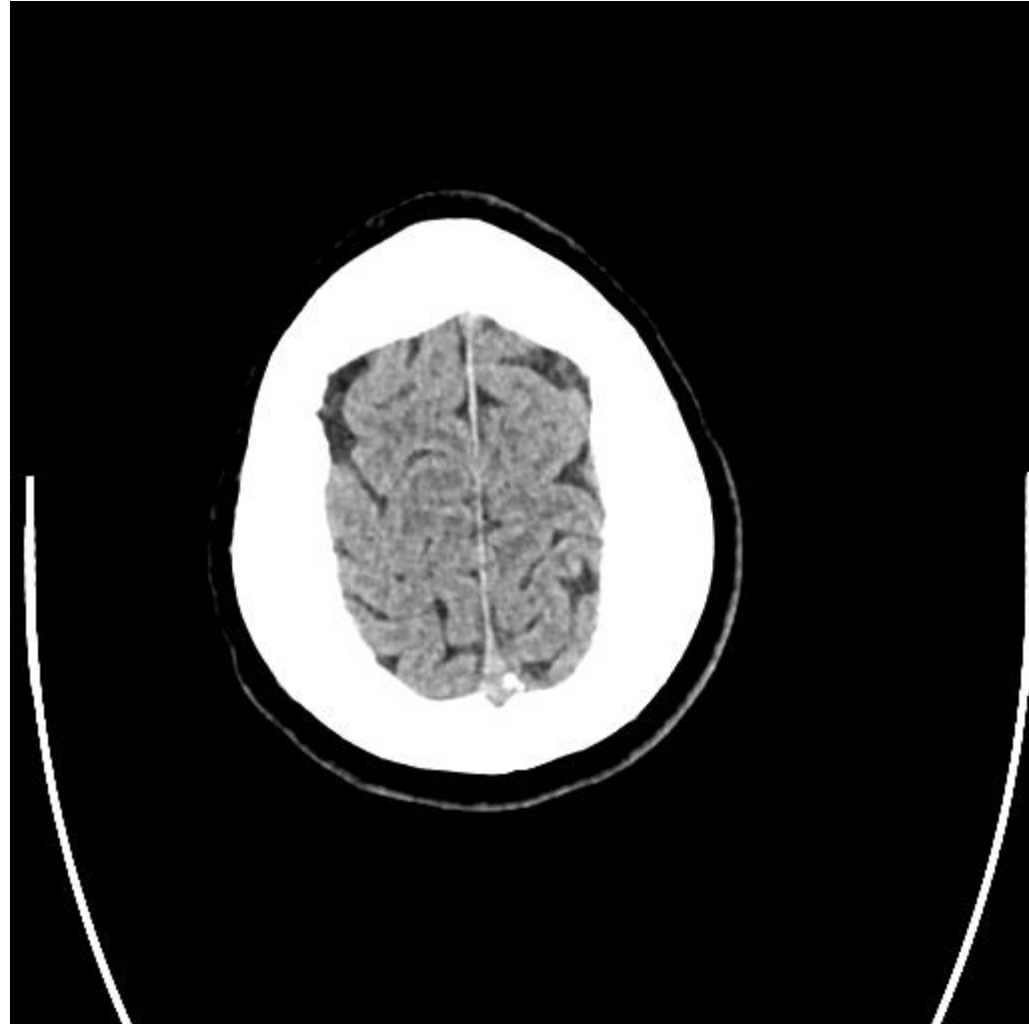
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Case

- 31 year old female
- Day 1
 - Pupils 3/3 and reactive
 - Sedated with Propofol and fentanyl
 - TTM – 36°C with surface cooling
 - MAP ~ 70's. Levophed 0 to 10mcg/min
 - Initial lactate 7.6mmol/L
 - ECG – No ischemic changes. Sinus tachycardia.
 - ECHO – low normal LV function. No regional wall motion abnormalities. No significant valvular disease.



Case



Case

- 31 year old female
- Day 2
 - Sedation withdrawn at ~ 30h post arrest
 - 14:00 – E1/VT/M1
- Day 3
 - 15:30 Pupils 8/8 and fixed
 - CT head...

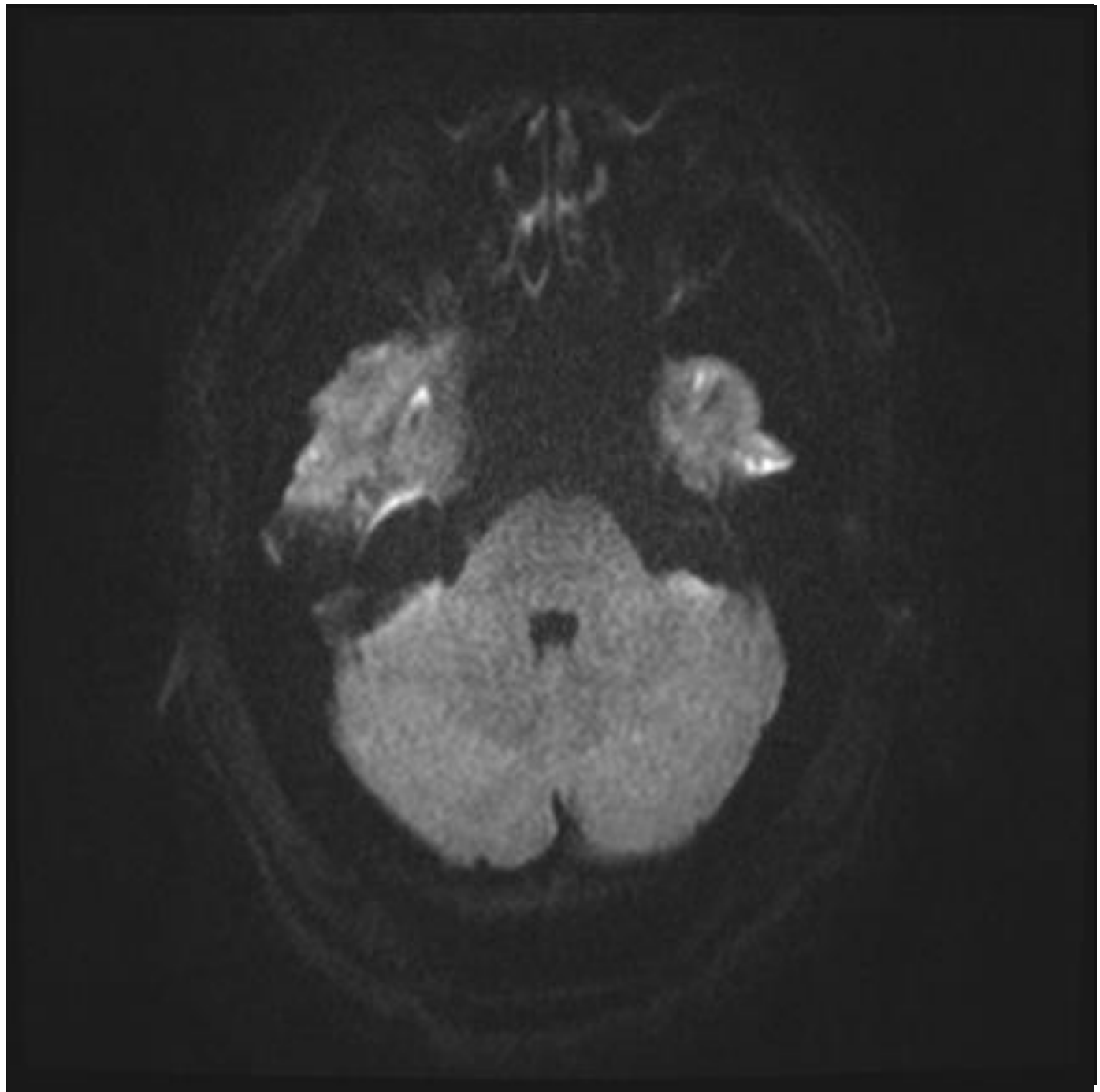




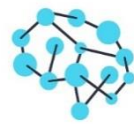
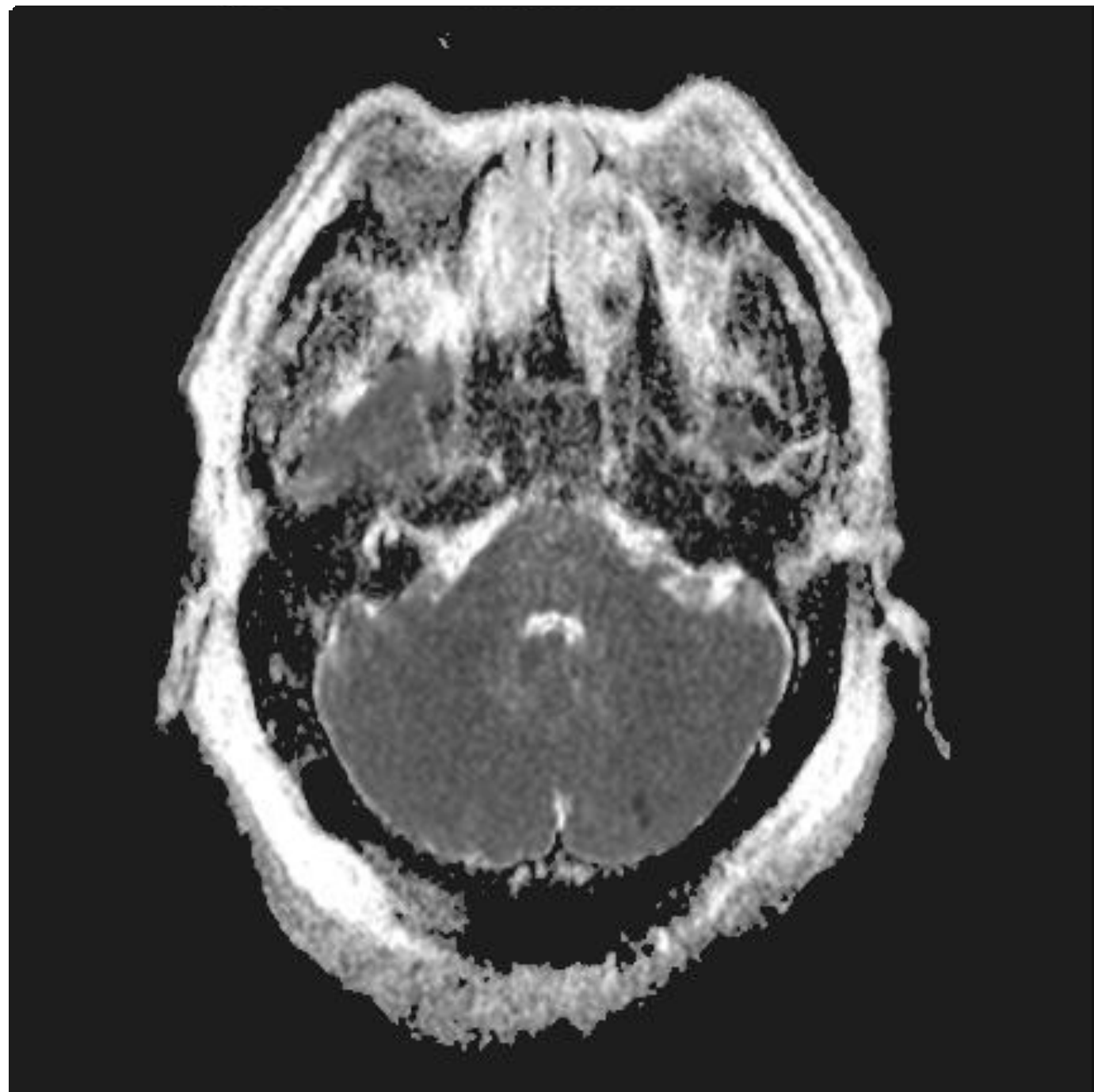
Case



Case



Case



Case

- 31 year old female
- Day 3
 - Transferred to ICU
 - 400ml 20% Mannitol and 150ml 5% Hypertonic saline
 - Pupils 6/6, sluggish
 - Role for invasive monitoring?

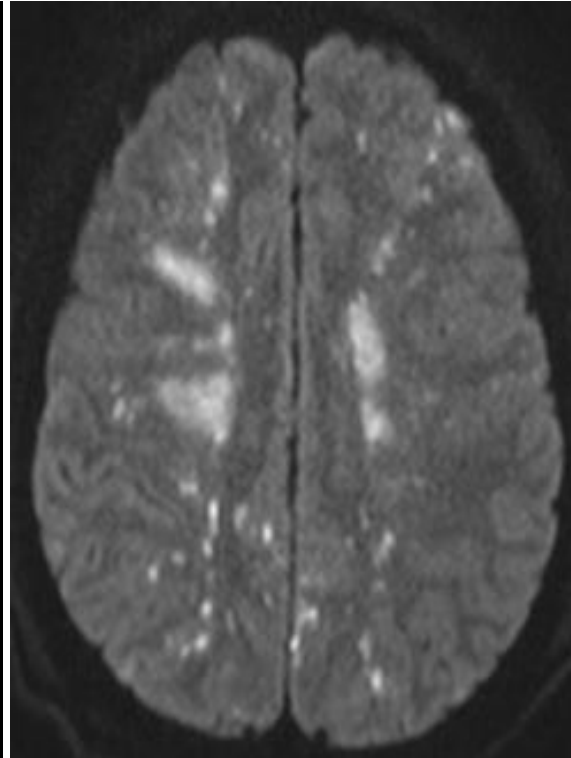


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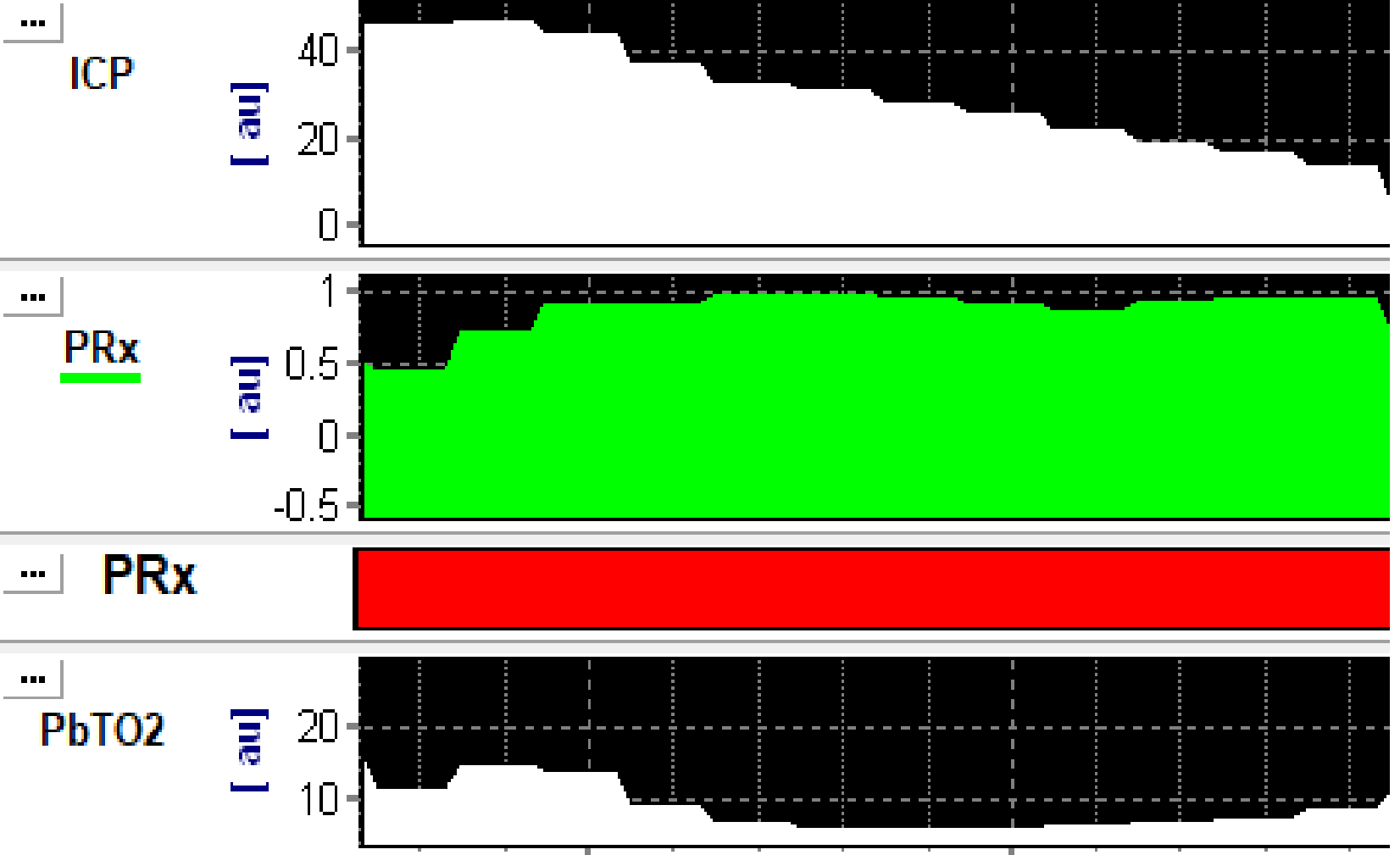


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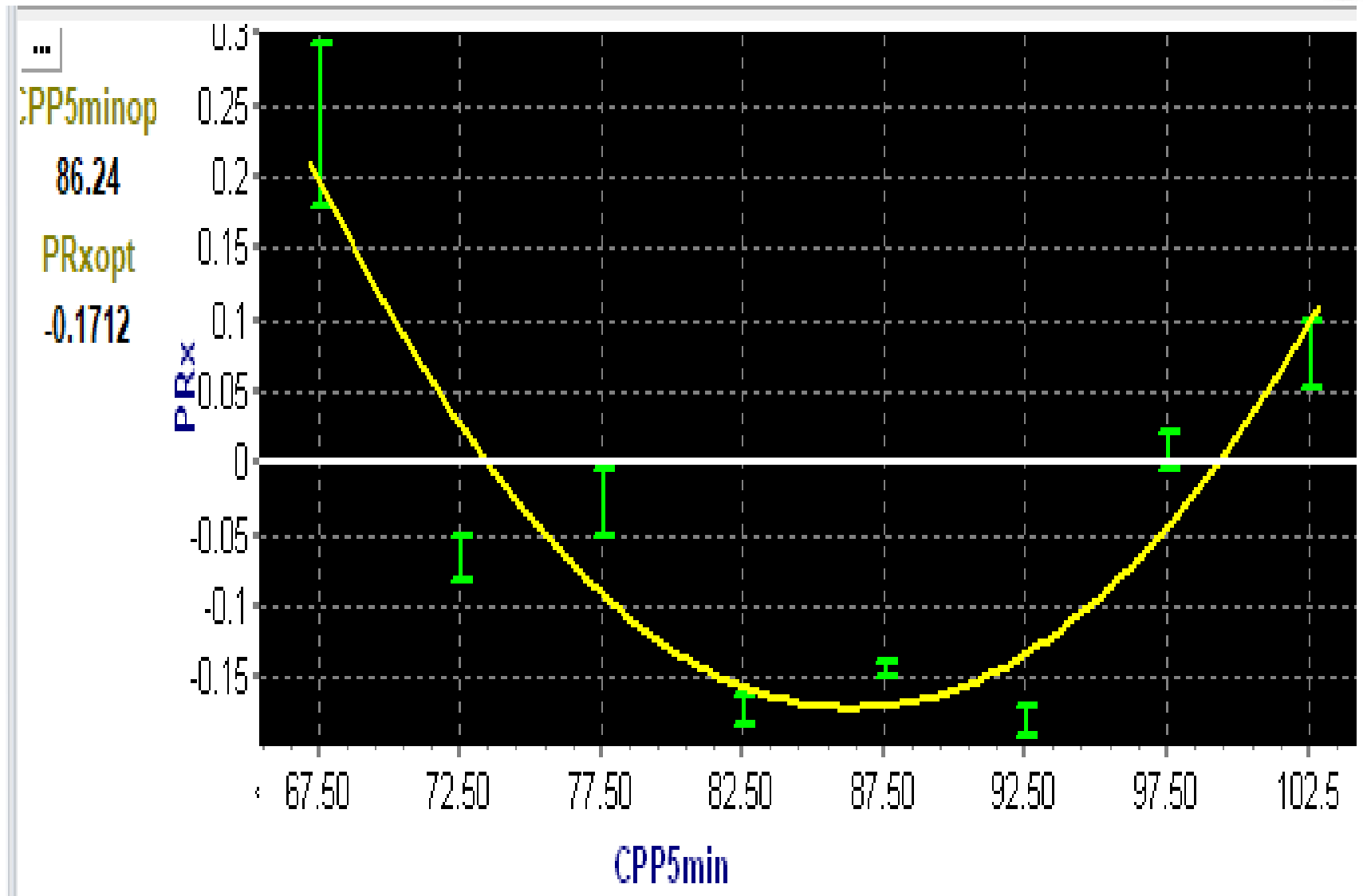


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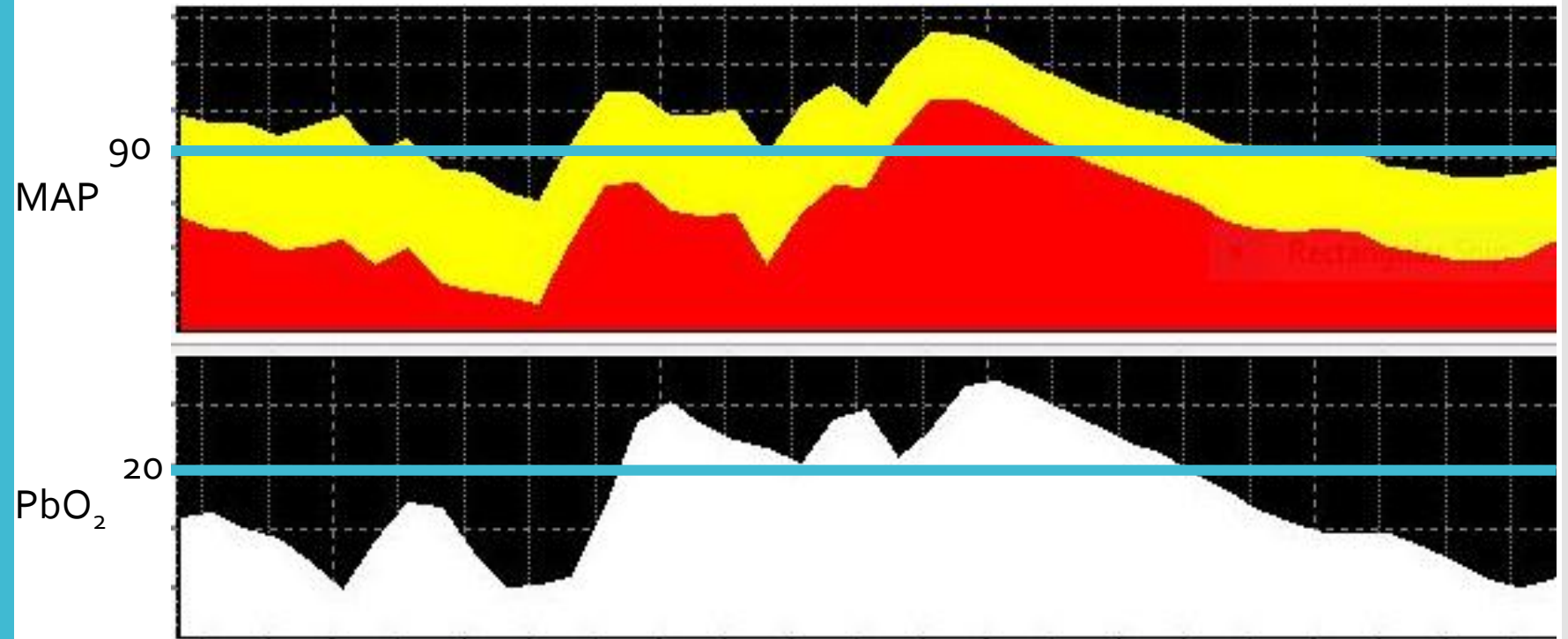


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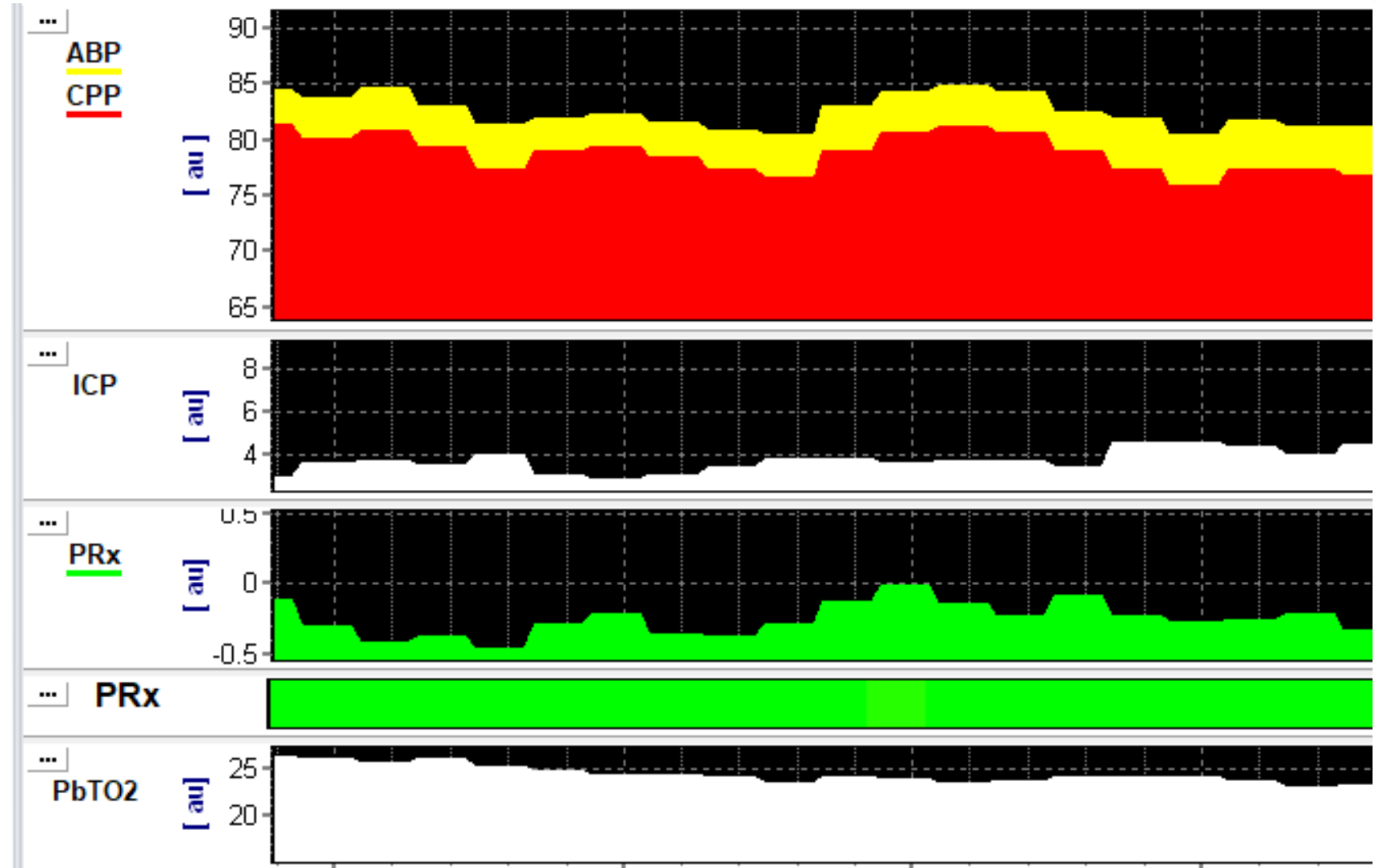
Case

Mean arterial pressure and parenchymal brain oxygenation





Case





Case



Case

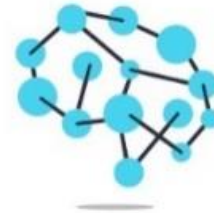
- 31 year old female
- Day 3 to 5
 - Managed with invasive neuromonitoring for 5 days
 - Sedation weaned on day 6 and monitoring removed
 - Day 6 – E1/VT/M1
 - Day 7 – E3/VT/M4
 - Day 9 – Obeying commands
 - Day 14 – Extubated
 - Day 27...



Case



Questions



VGH Neurocritical
Care

*Visitors
Welcome*



*Visitors
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Thank you!



Thank you

Come visit us!
www.vghneurocriticalcare.com

