Cerebral autoregulation
in pediatric ECMO :
2 centers experience

Nicolas Joram M.D.

ICM + User's Group meeting

Leuven

CHU de Nantes

Experience of 2 pediatric ECMO centers
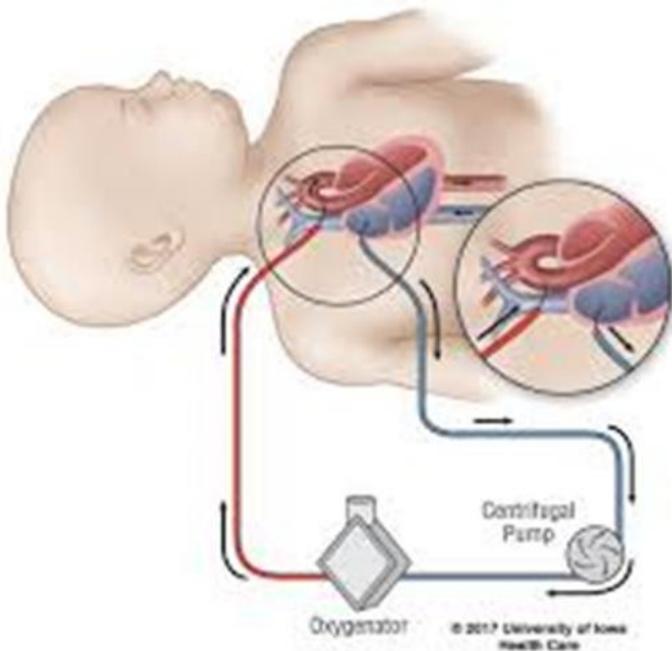

Nantes (France)

Genoa (Italy)
Dr Stefano Pezzato

- From january 2018
- 40 children
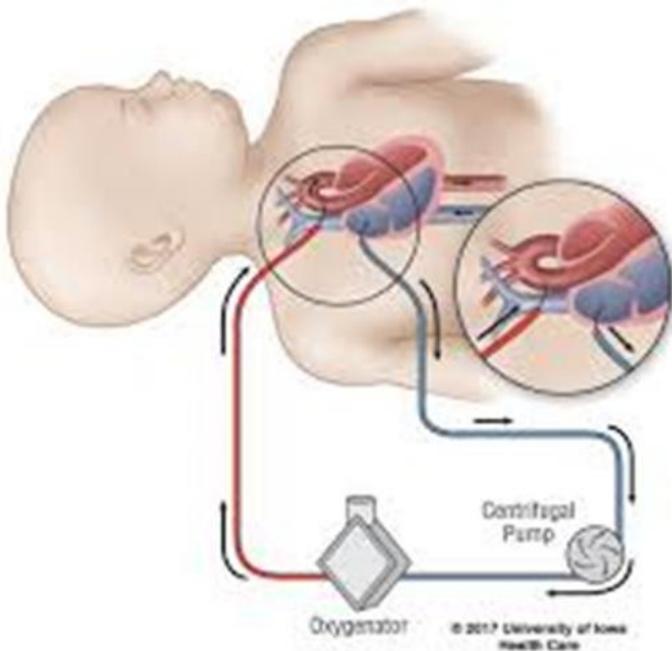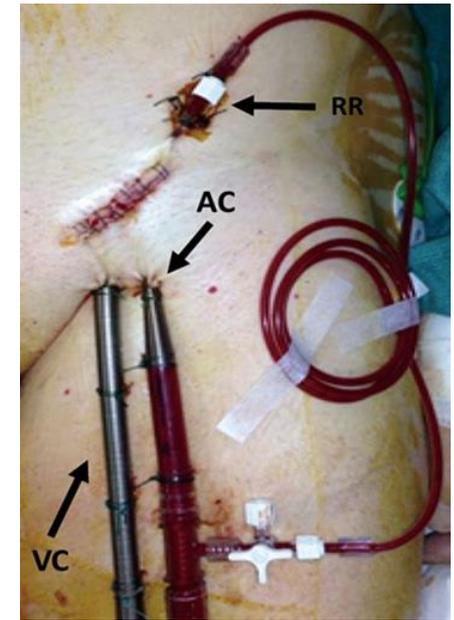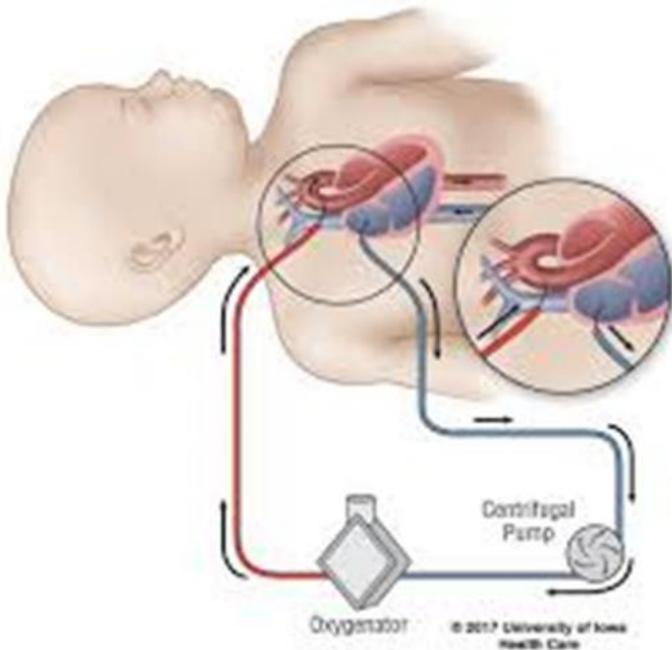- VA and VV ECMO
- 0 to 18 years

ECMO

- Hemodynamic failure
  - Cardiac surgery
  - Medical conditions
- Respiratory failure (ARDS)
- Cardio pulmonary rescucitation
  (ECPR)

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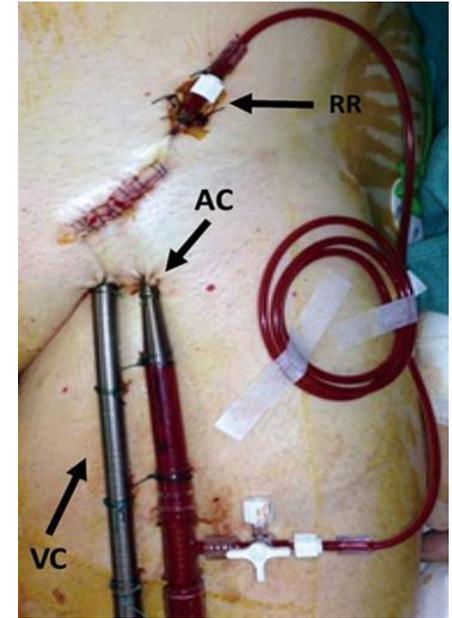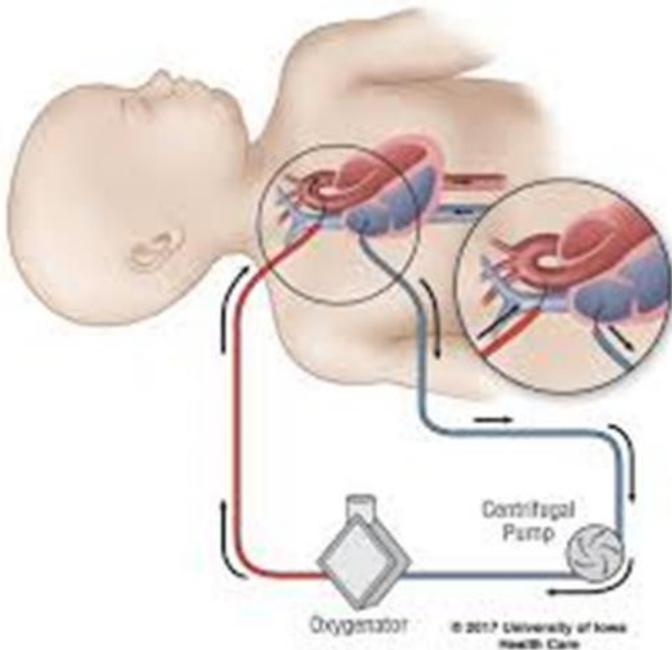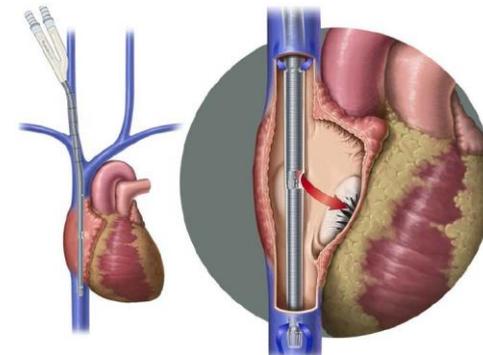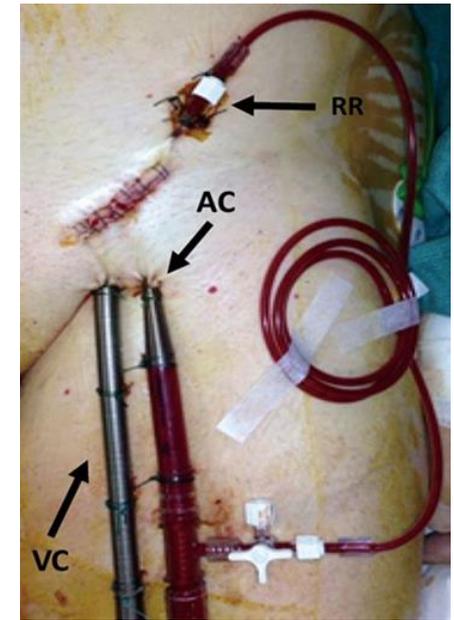- Cardio pulmonary rescucitation
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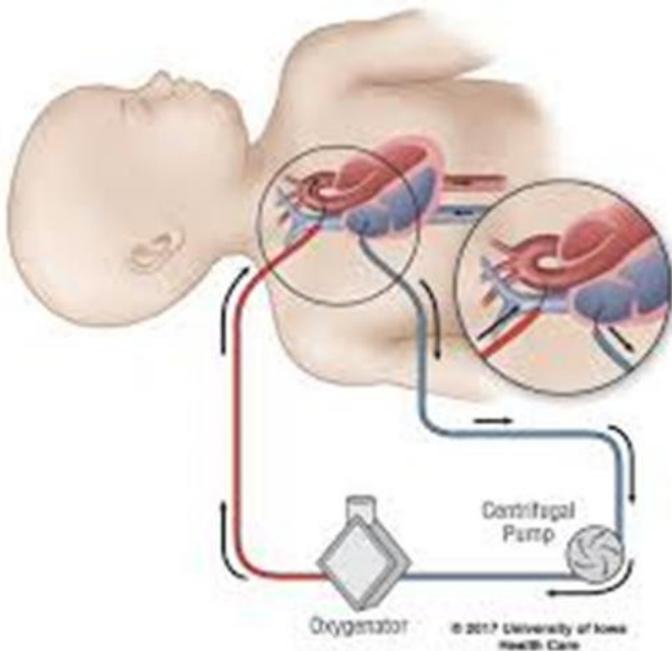- Cardio pulmonary rescucitation (ECPR)

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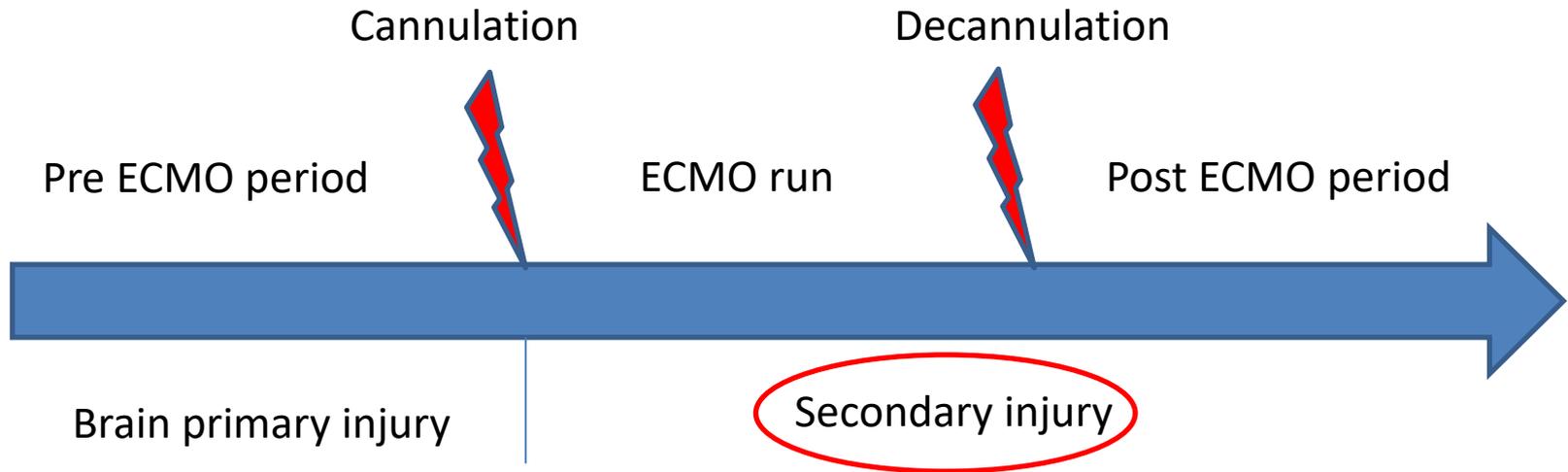- Respiratory failure (ARDS)
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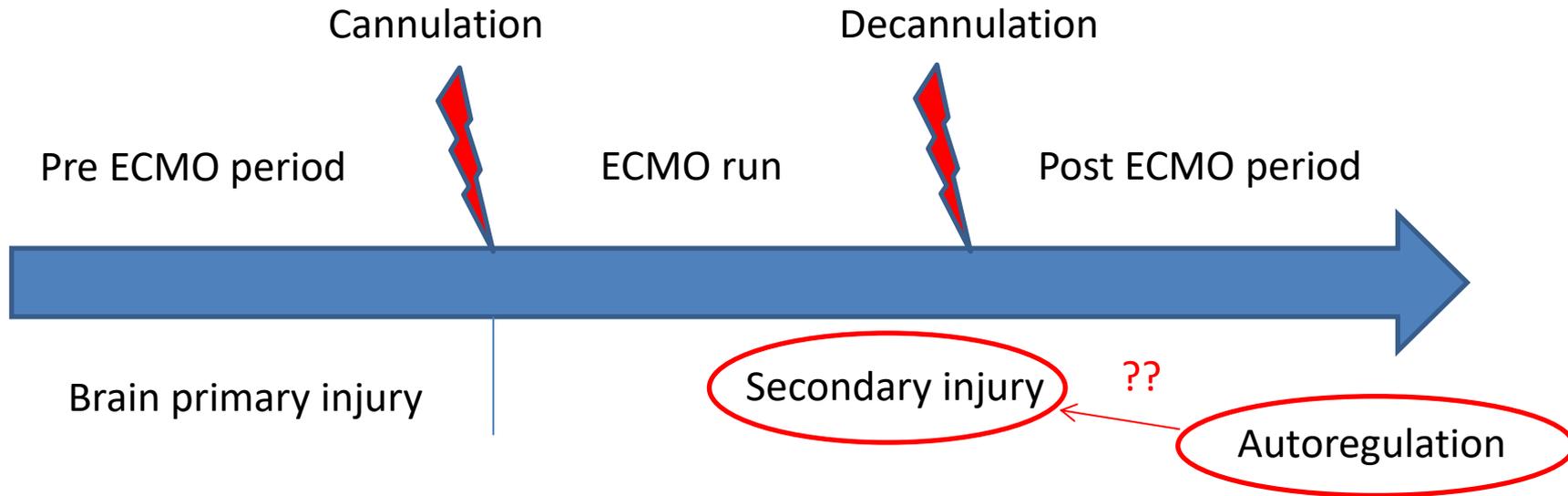
ECMO and neurological outcome

- 102 ECMO centers in the US
- From 1990 to 2009
- 31 335 ECMO patients < 18 years
- All indications

Complication	Incidence (%)	Patient Survival (%)
CNS hemorrhage	7.4	36
CNS infarction	5.7	48
clinically determined seizures	8.4	47
EEG-determined seizures	2.1	35

Hervey- Jumper. J Neurosurg Pediatrics 2011

Cerebral autoregulation and ECMO

Cannulation

Decannulation

Pre ECMO period

ECMO run

Post ECMO period

Brain primary injury

Secondary injury

Cerebral autoregulation and ECMO

Cerebral autoregulation and ECMO

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??
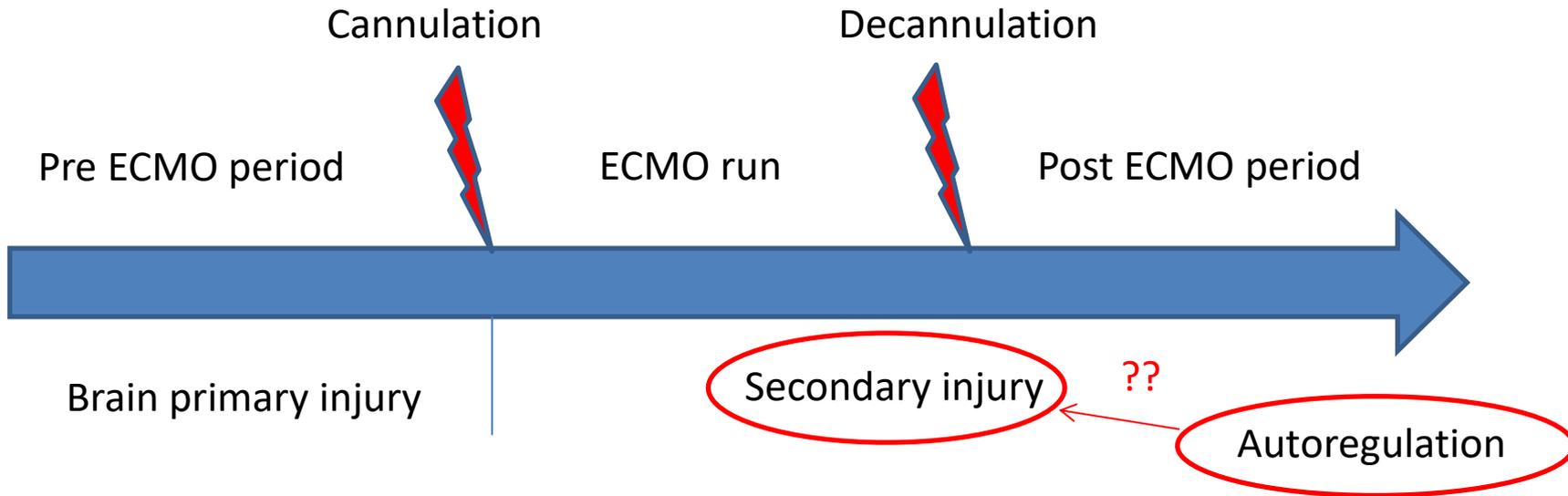
Autoregulation

- 14 healthy newborn lambs
- VA ECMO vs controls
- Progressive decrease of CPP

Controls

VA ECMO
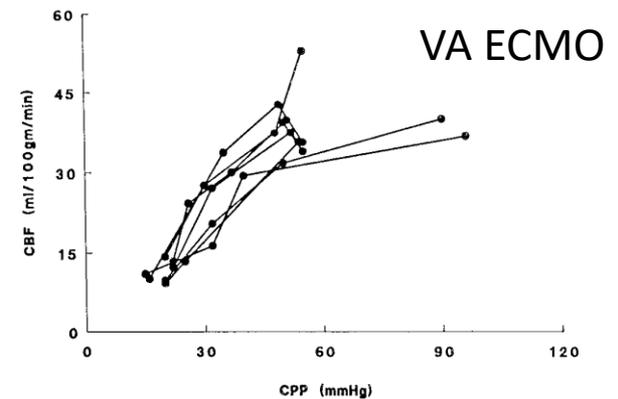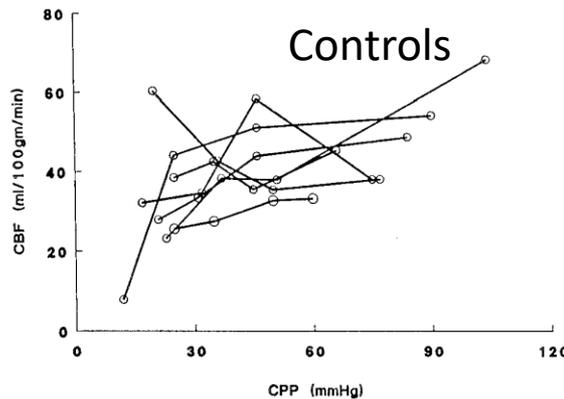
Supposed mechanism : loss of pulsatility

Short. Ped Res 1993

Questions

1. Can we monitor AR at bedside during ECMO ?

2. Clinical impact of cerebral autoregulation disorders?

3. Can we control them?

- Type of cannulation
- ECMO flow
- Optimal ABP
- Optimal PCO2
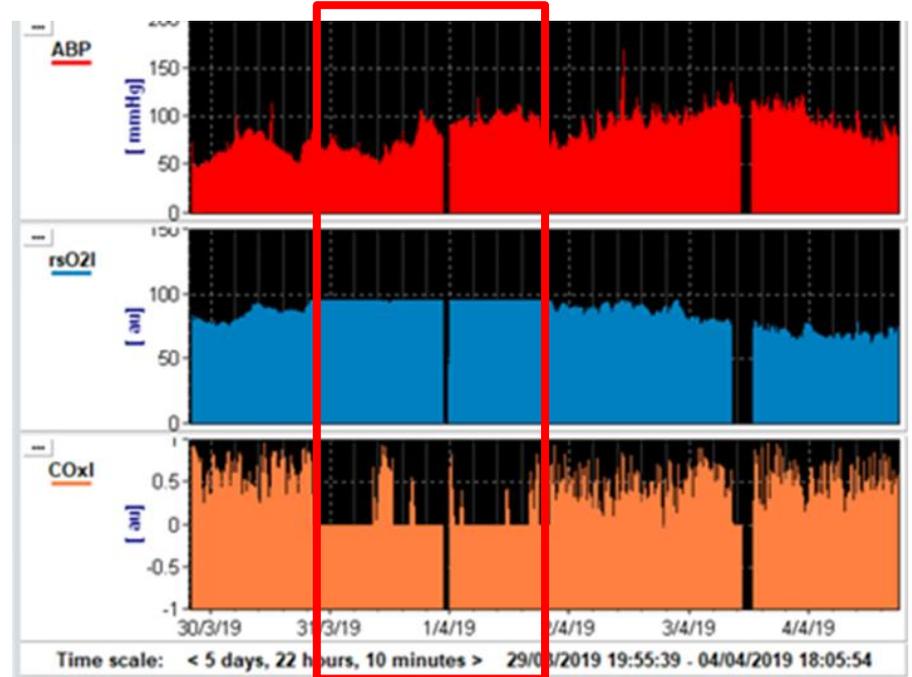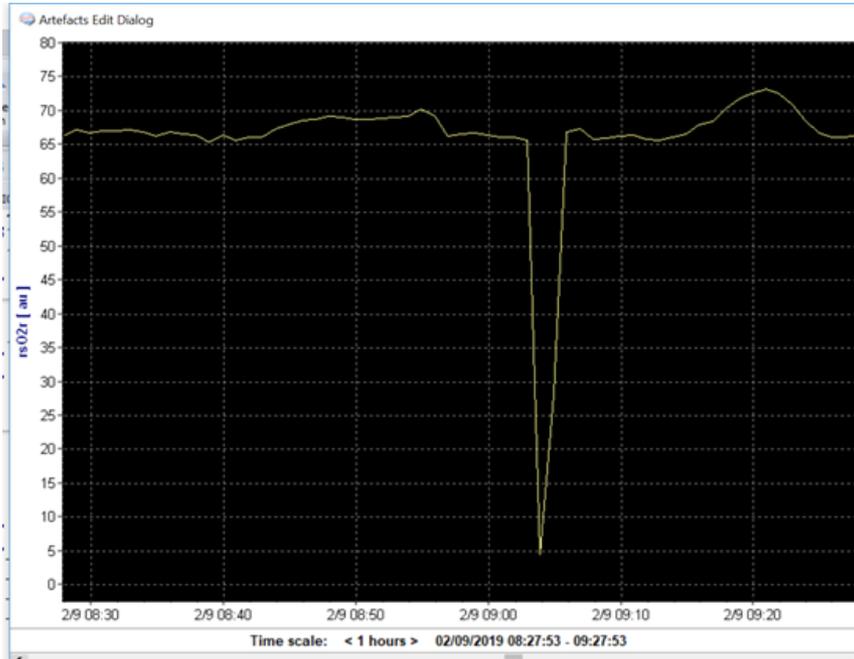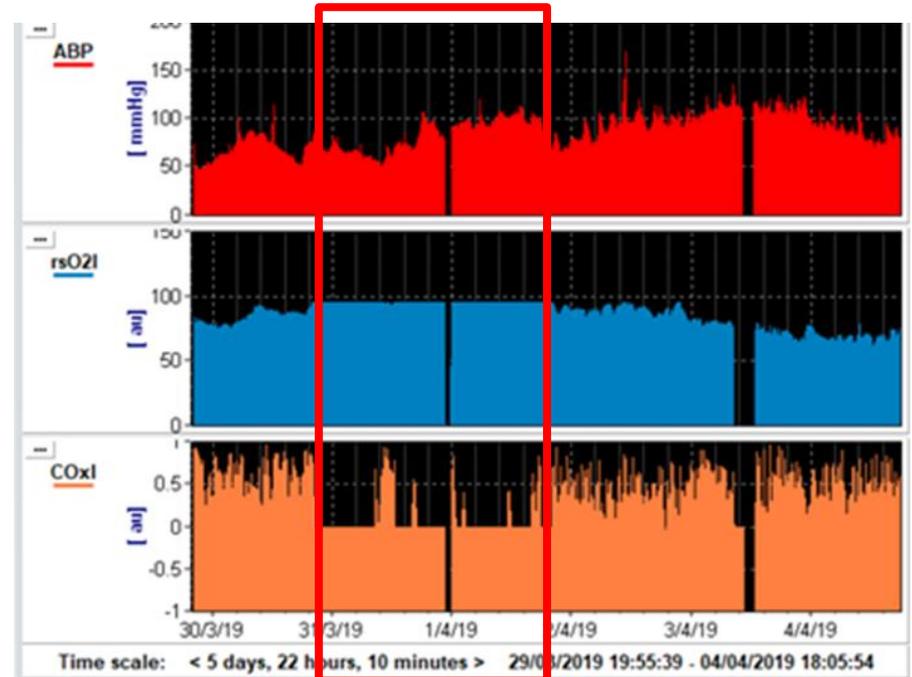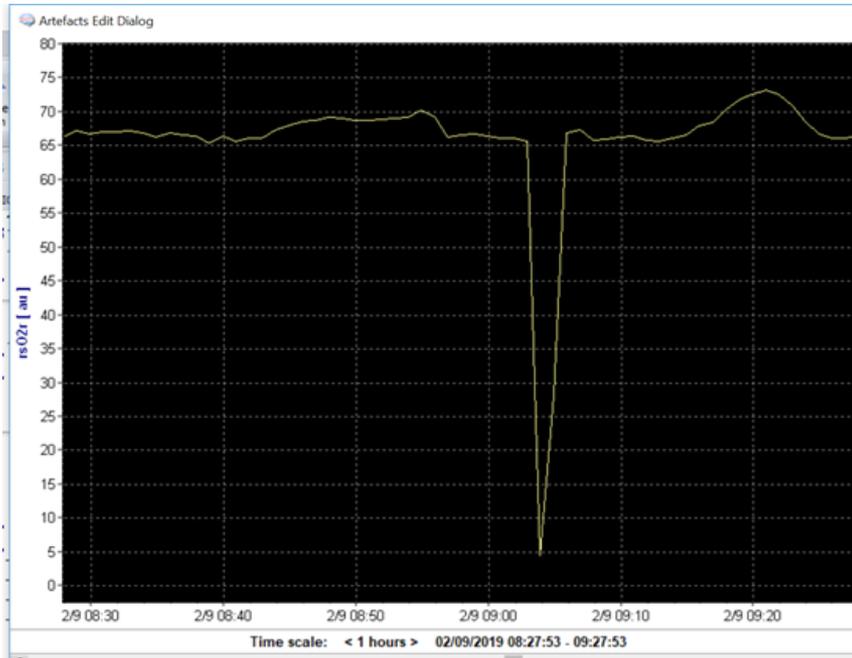- …

Which signals and index?

RSO2

ABP

ICM+

COx
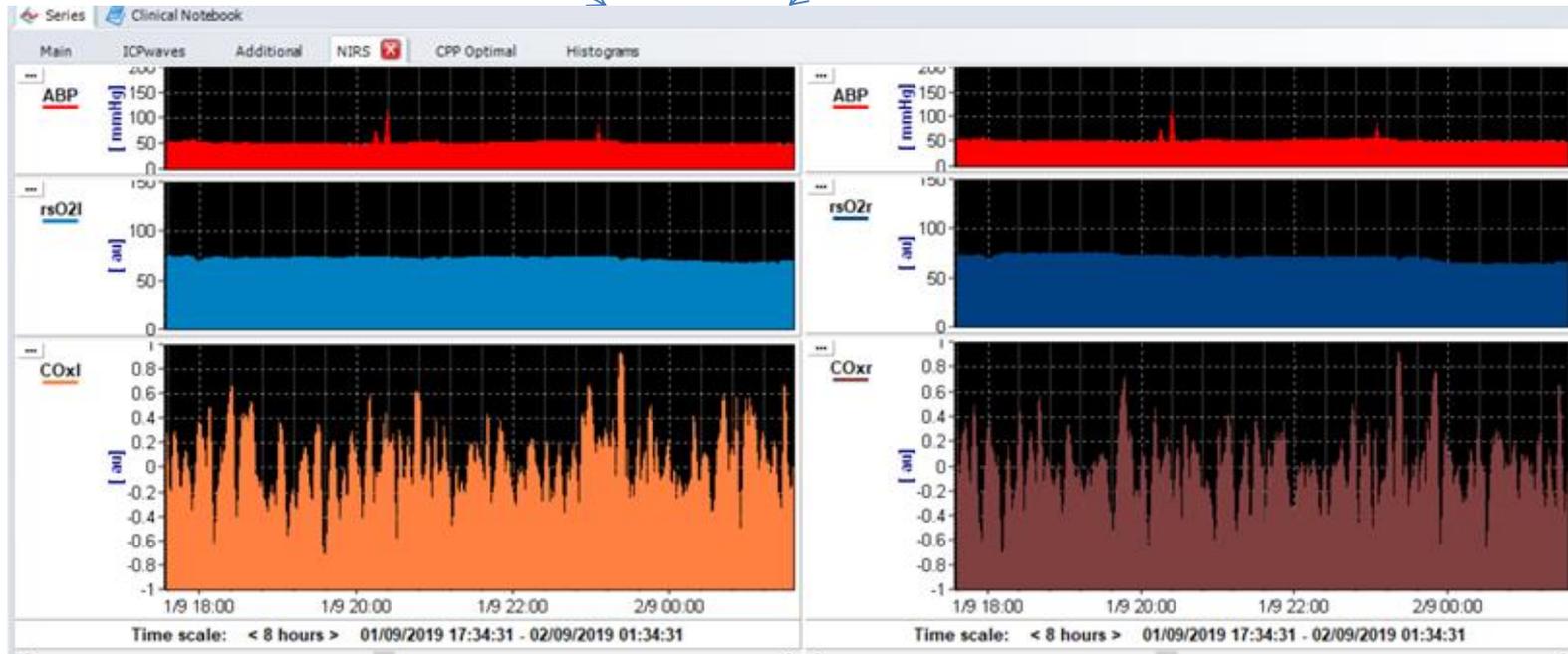
RSO2 artefacts
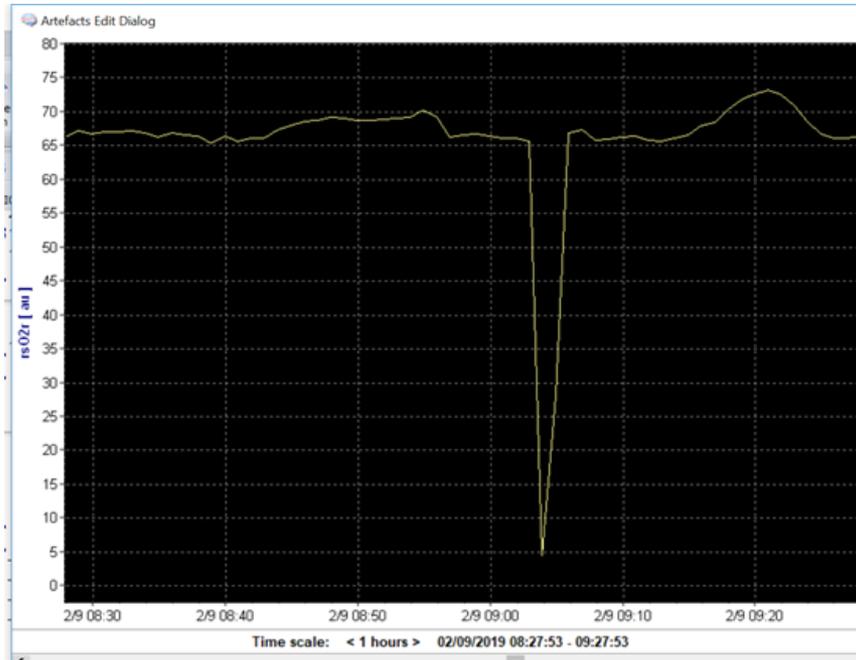
RSO2 artefacts

Values > 95%

RSO2 artefacts
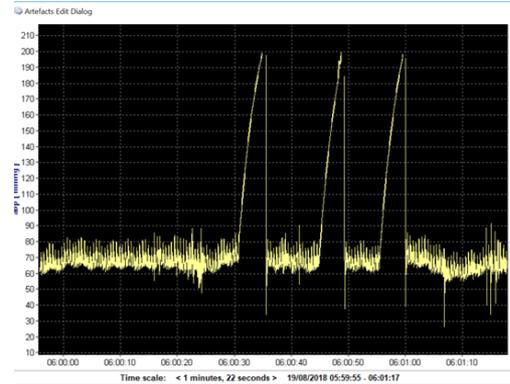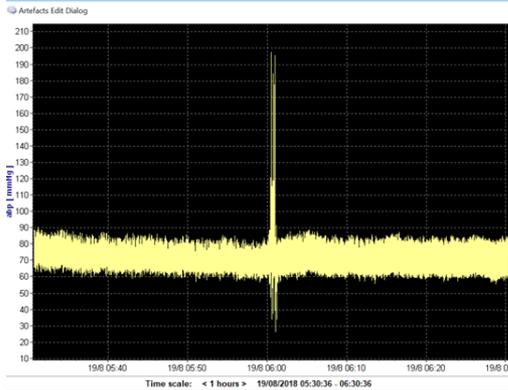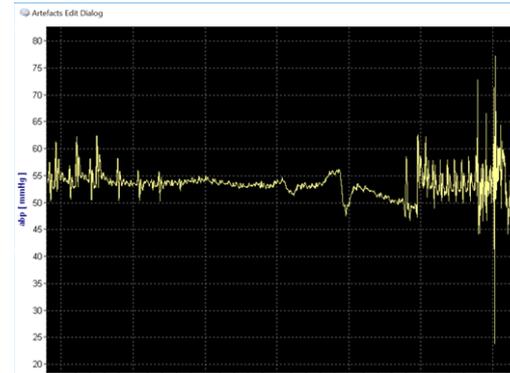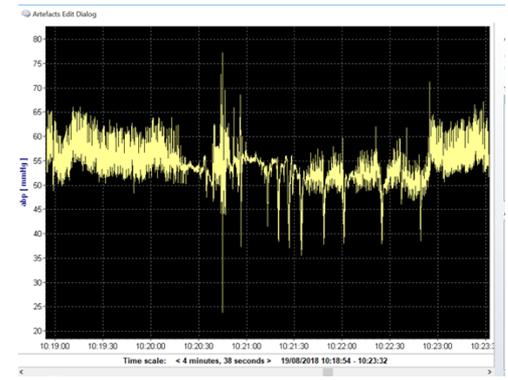

Values > 95%

- For the moment manually removed
- Need automatic funtion to be used at bedside

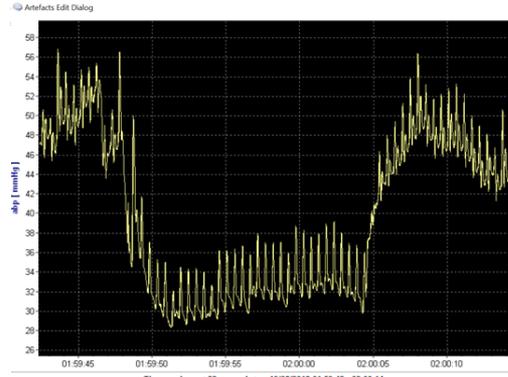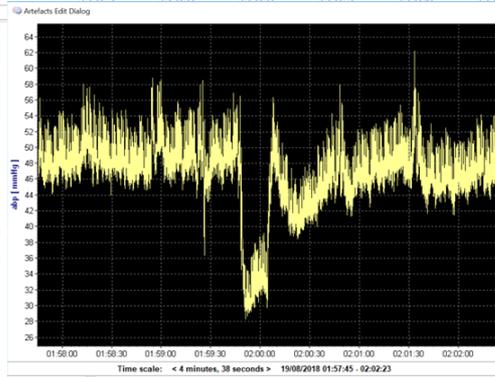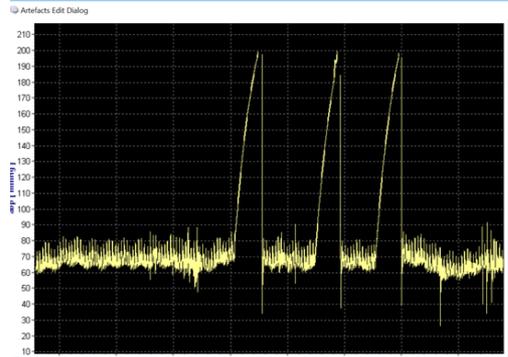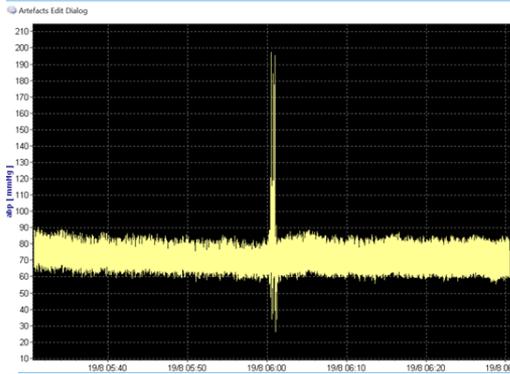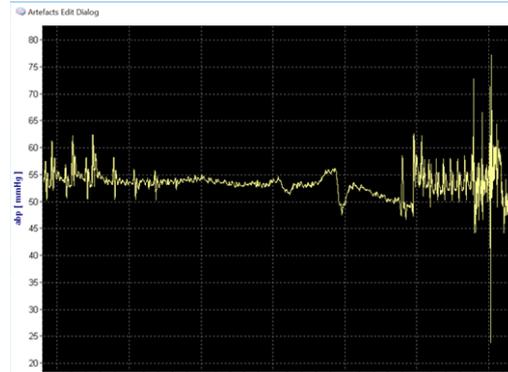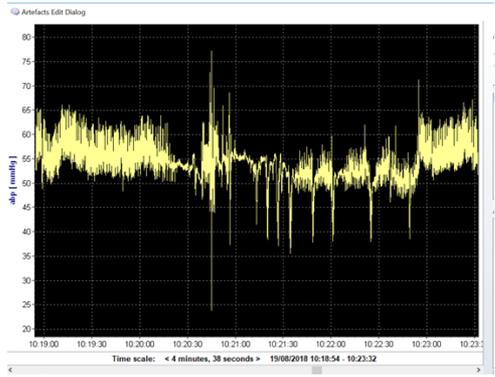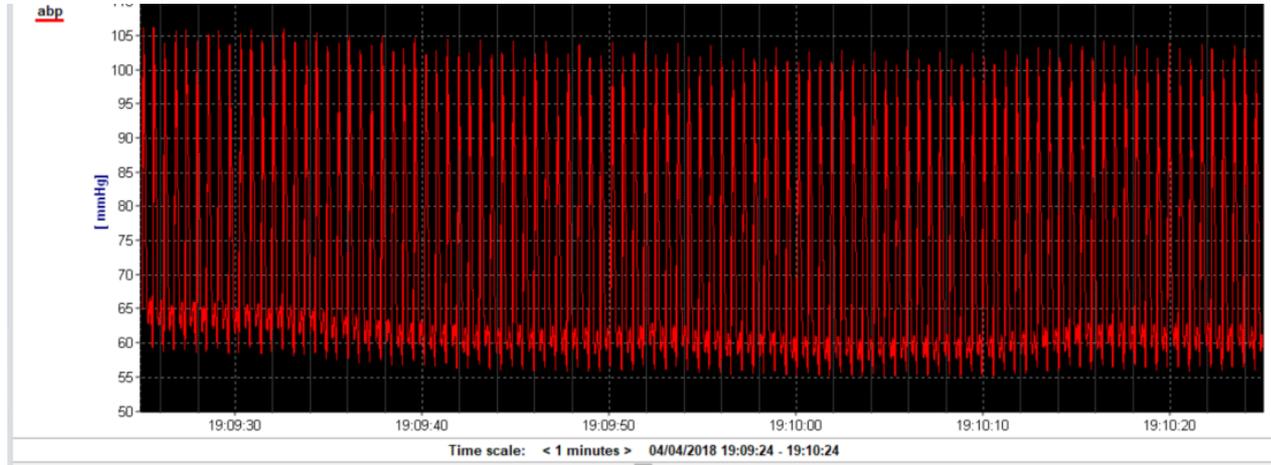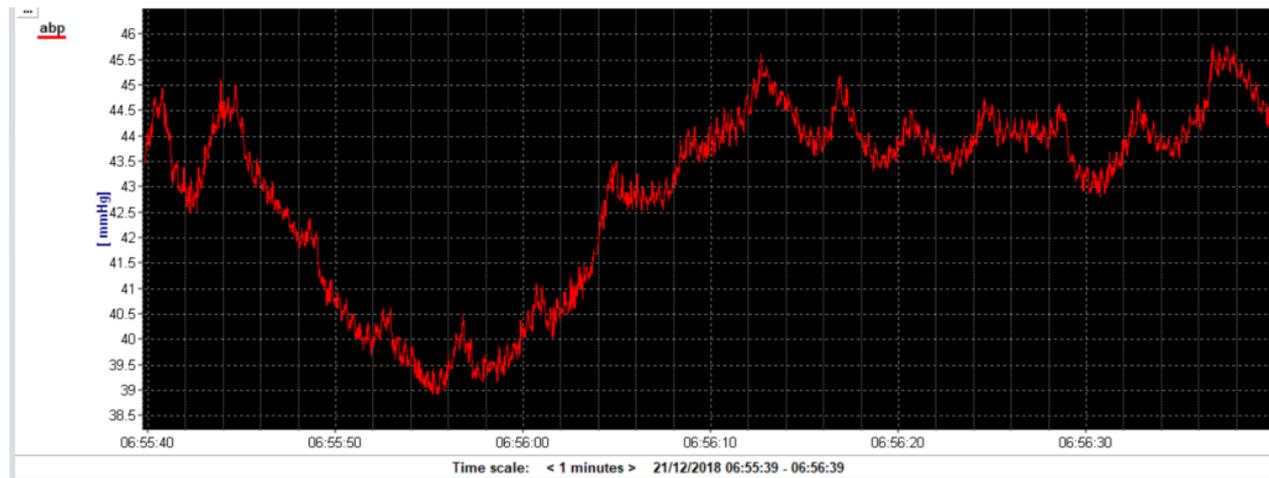# ABP artefacts
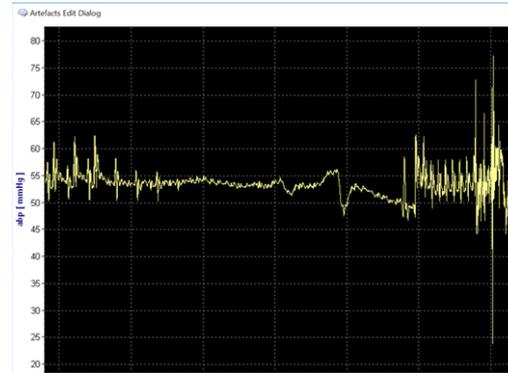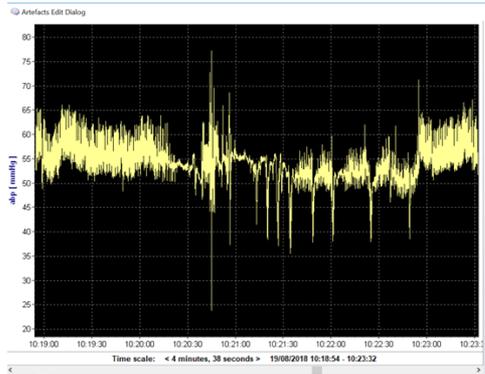
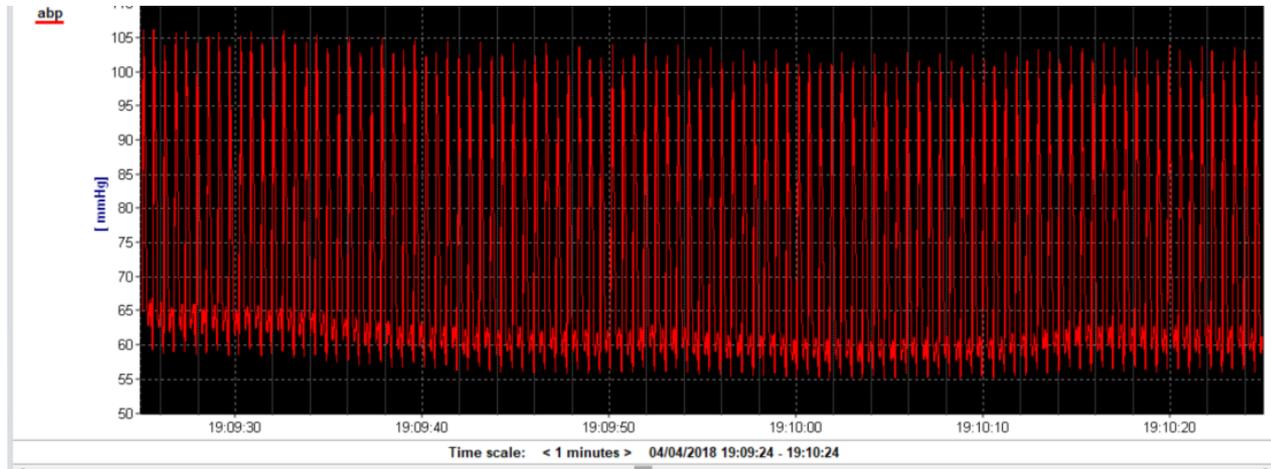# ABP artefacts

ABP artefacts

ABP artefacts removal : peak to peak filter ?

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Variables derived from COx

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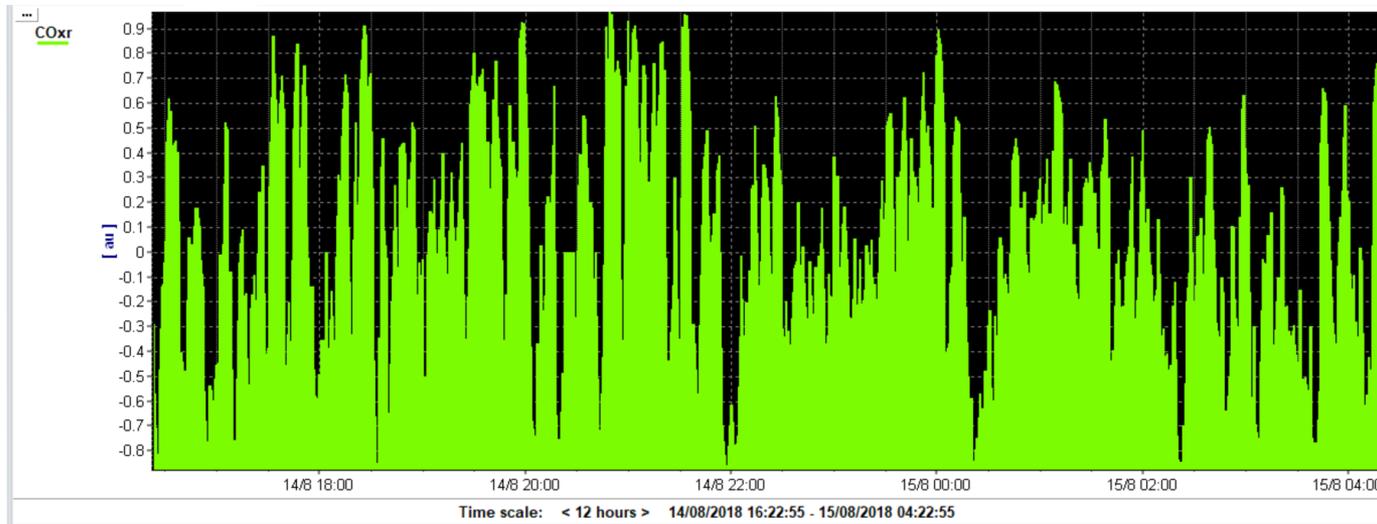
Variables derived from COx

« Critical » zone

% time with Cox > 0.3

Cox 0.3

Variables derived from COx

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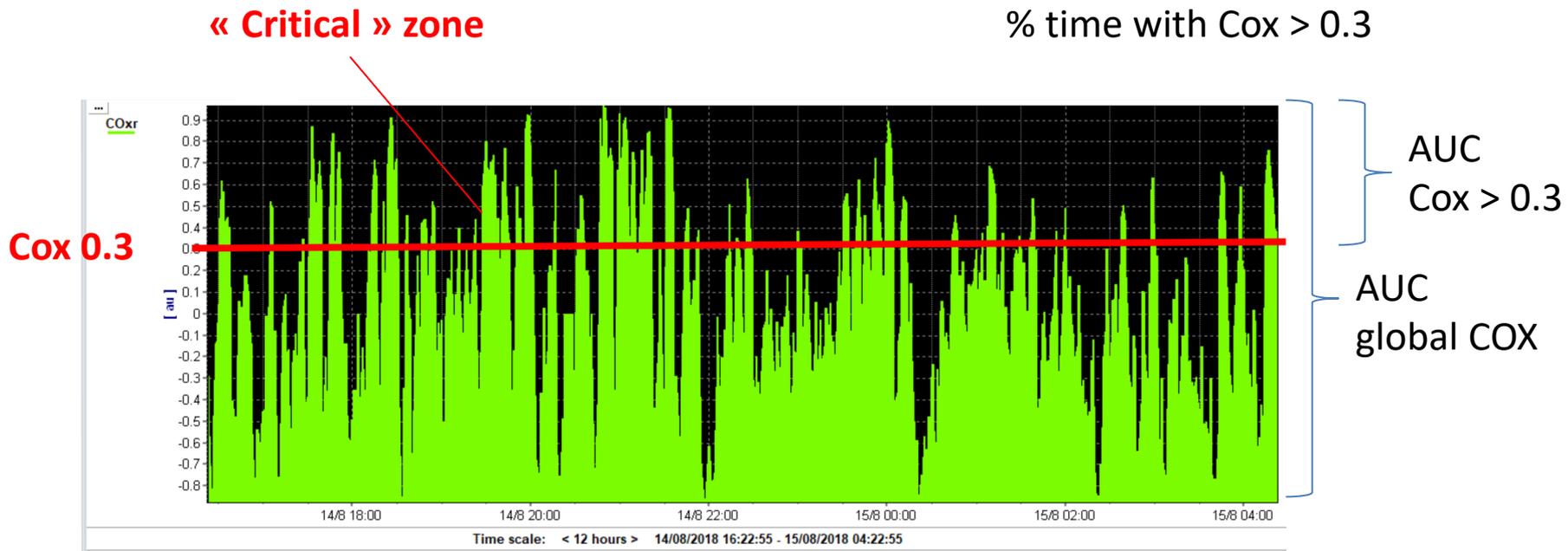
Cut off?

ABPopt, ULA, and LLA : single window approach
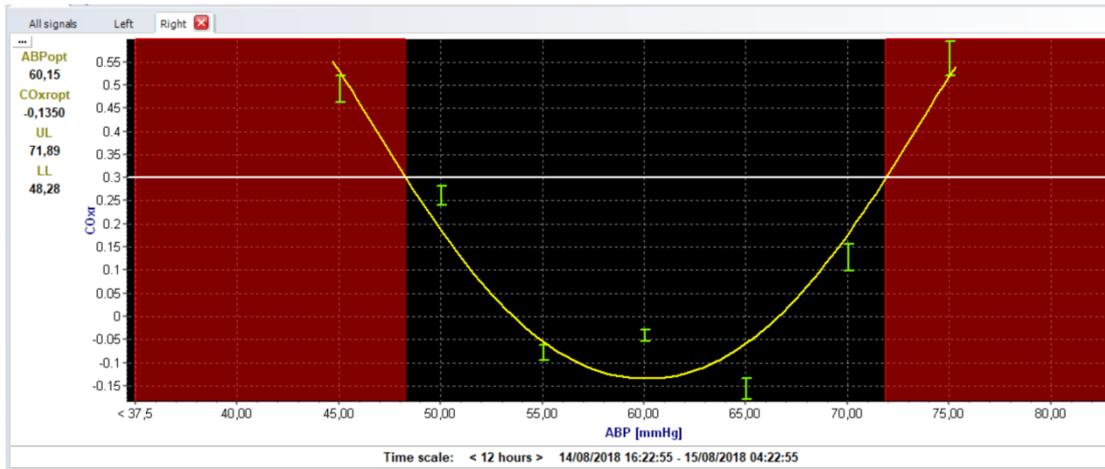
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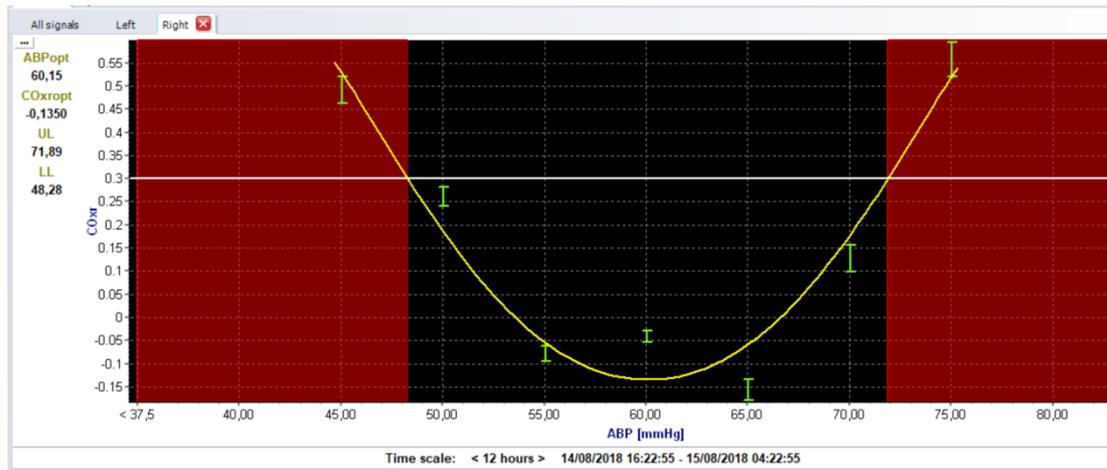
Periods of 4-6-8-12 hours ?
Bins of MAP of 2-3- 5mmHg width ?

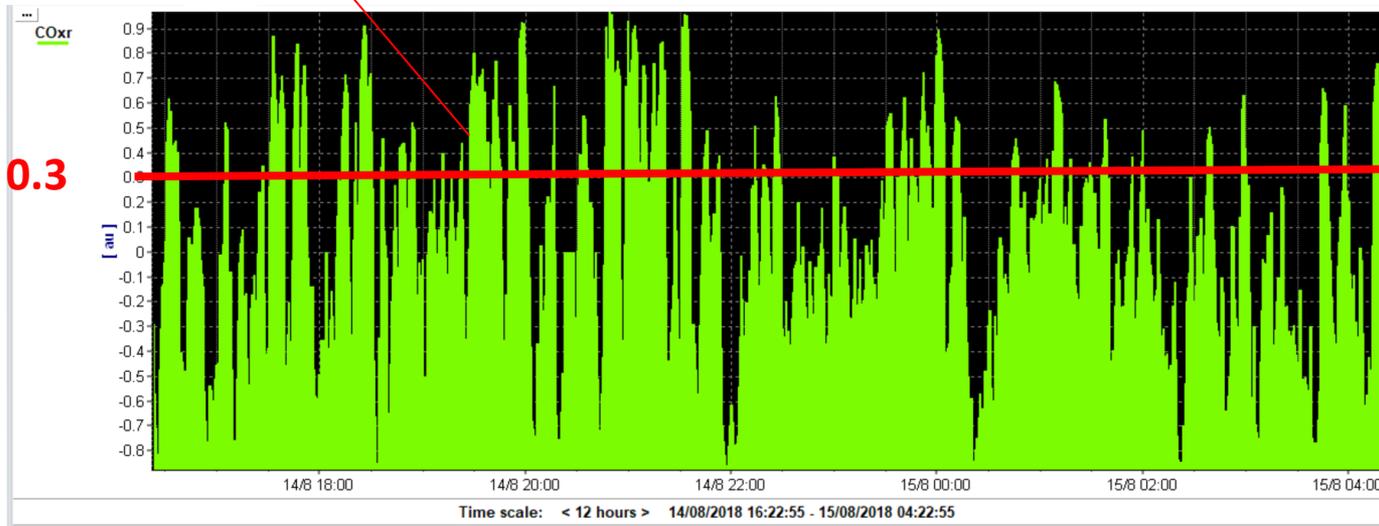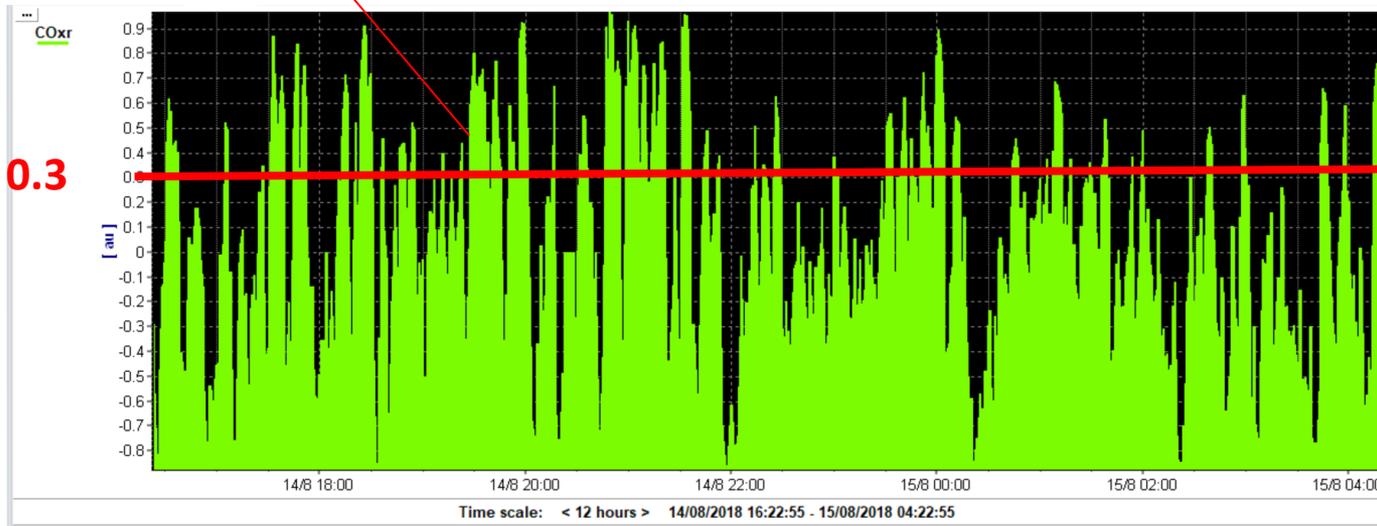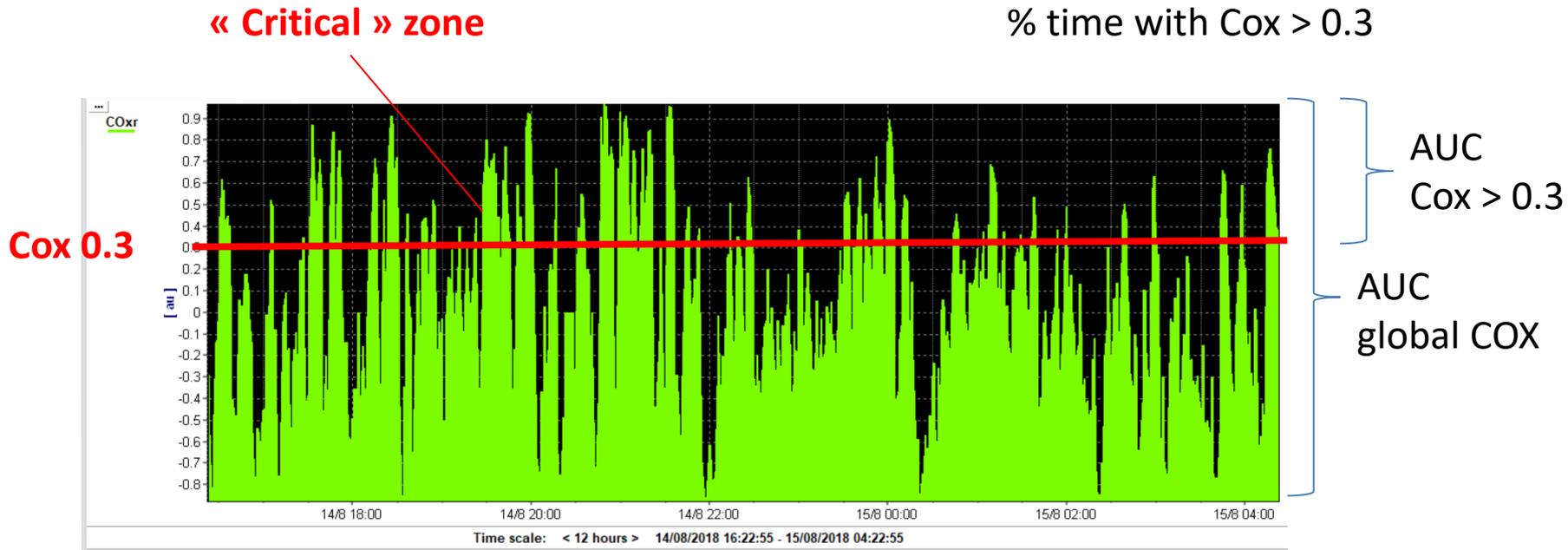# ABPopt, ULA, and LLA : single window approach

Periods of 4-6-8-12 hours ?
Bins of MAP of 2-3- 5mmHg width ?

1. How is ABP distributed?
2. How are the error bars distributed?
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4. How is the fitting of the curve?
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ABPopt, ULA, and LLA : single window approach

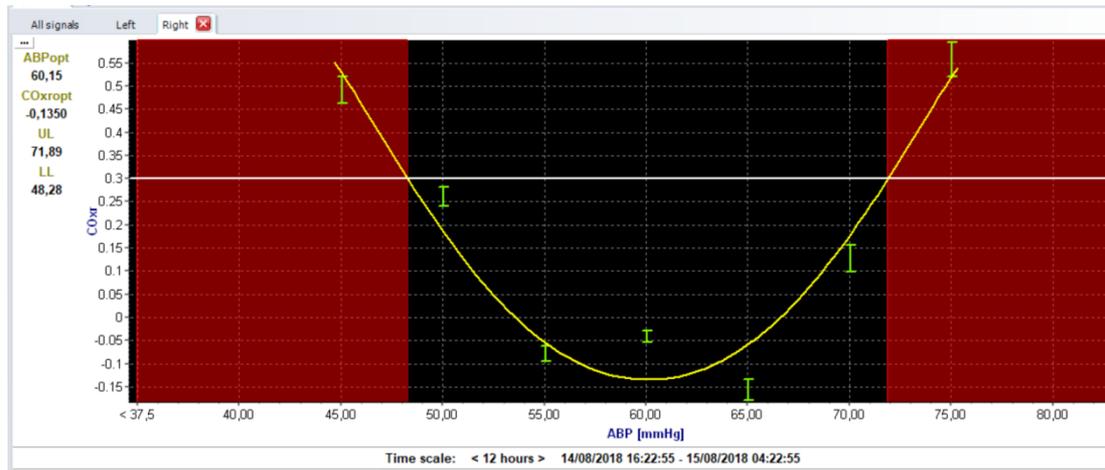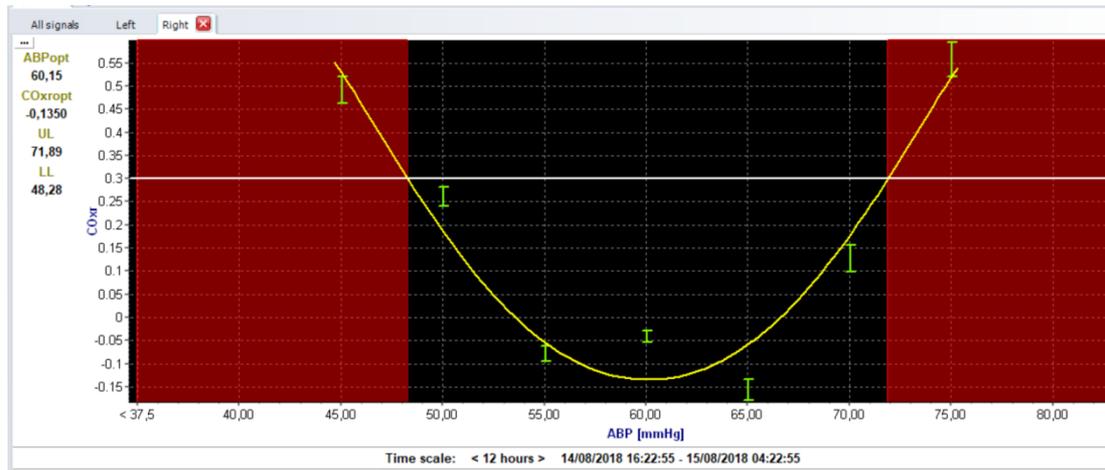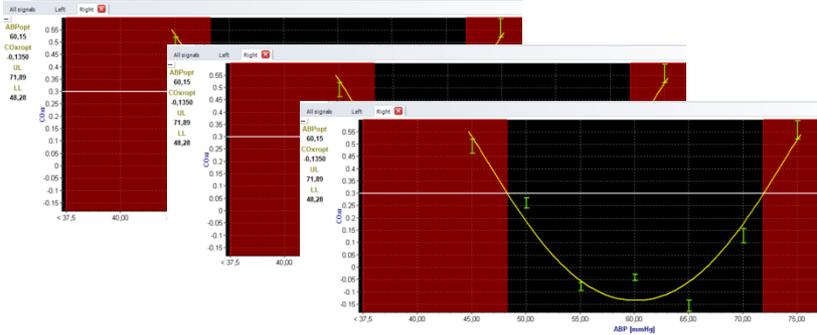Periods of 4-6-8-12 hours ?
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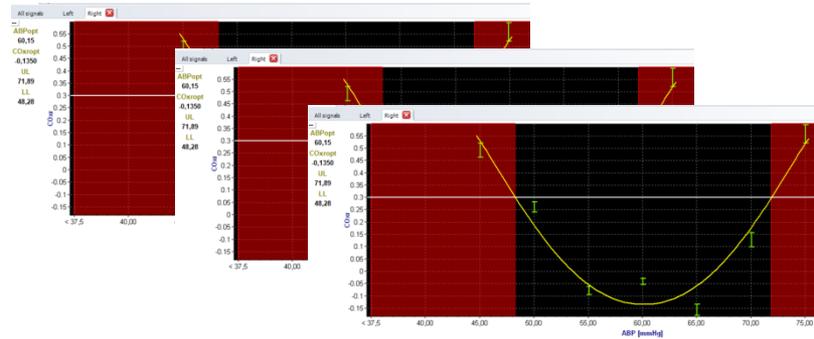
Periods of 8h
Bins of 2 mmHg

Multi-window ABPopt calculation with weighting

- Increase yield of the monitoring

- Multi-window approach

Multi-window ABPopt calculation with weighting

- Increase yield of the monitoring

- Multi-window approach

- Weighting algorithm
    - Length of the calculation window increasing from 2 to 8 hours
    - Application of a weight factor considering :
        - Period length
        - Size of the fit error
        - Obtention of a vertex

Liu. J of Neurotrauma 2017

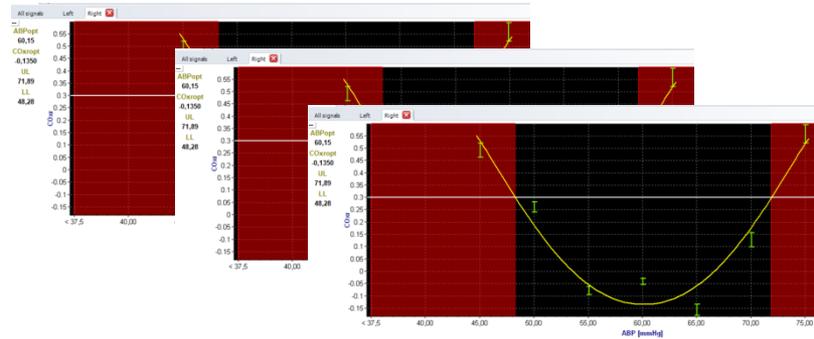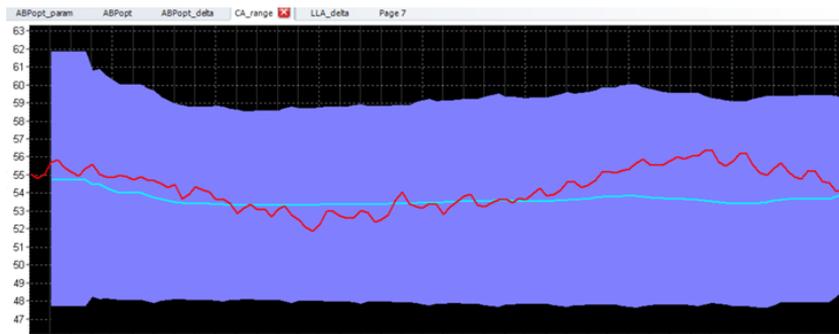# Multi-window ABPopt calculation with weighting

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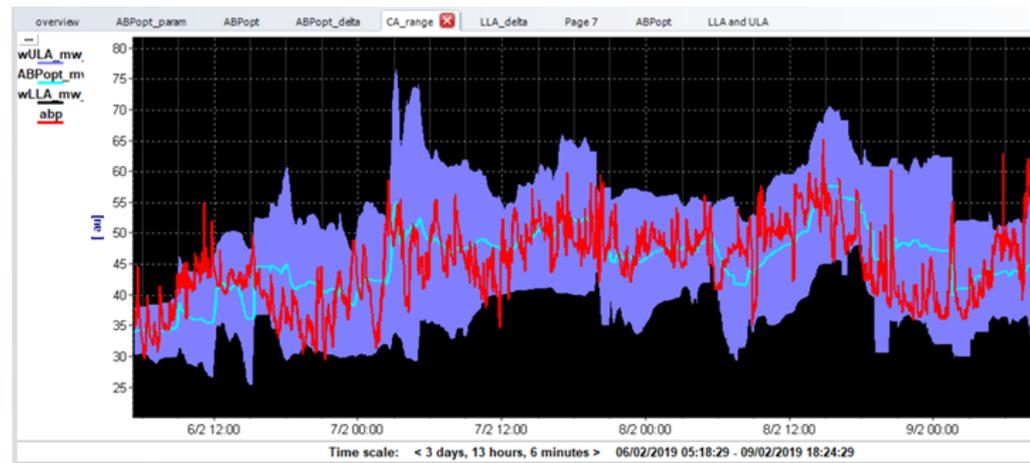**1 point/min**   ABP

ULA

ABPopt

LLA

Is this method applicable in our population ?

Yield : 89.8% time ABPopt available

Is this method applicable in our population ?

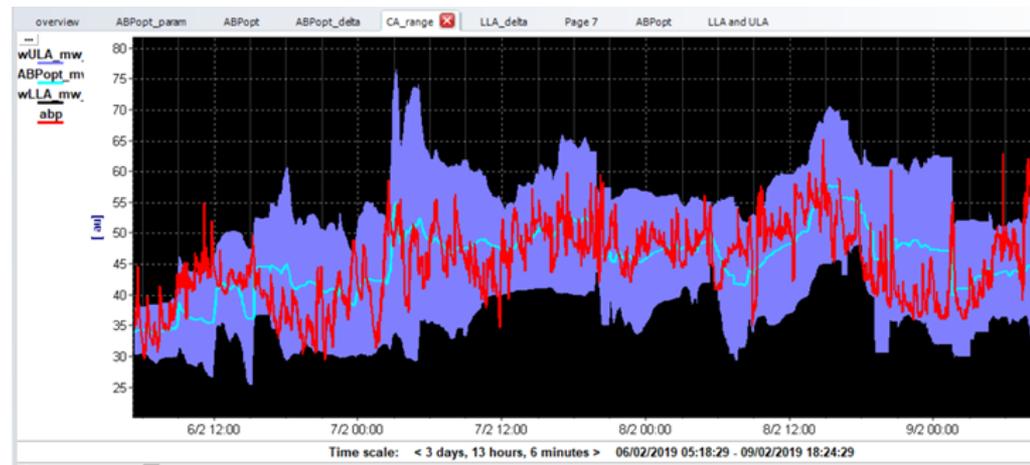Yield : 89.8% time ABPopt available
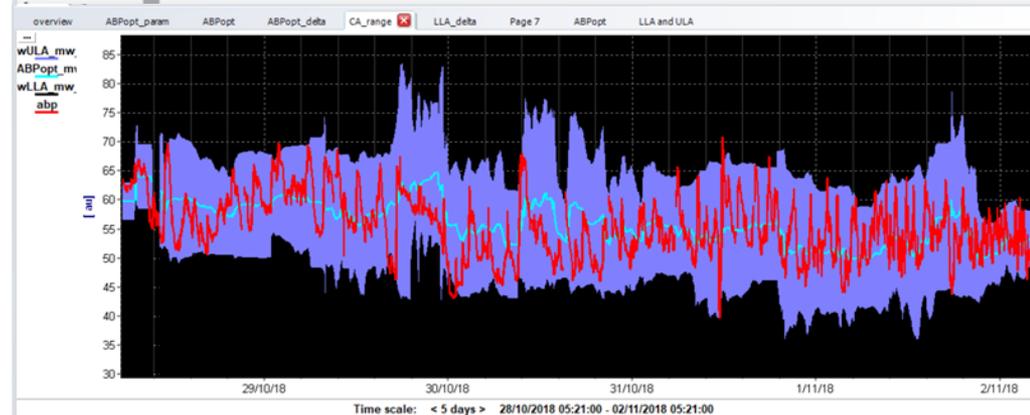
VA ECMO
1 month
Post operative

Is this method applicable in our population ?

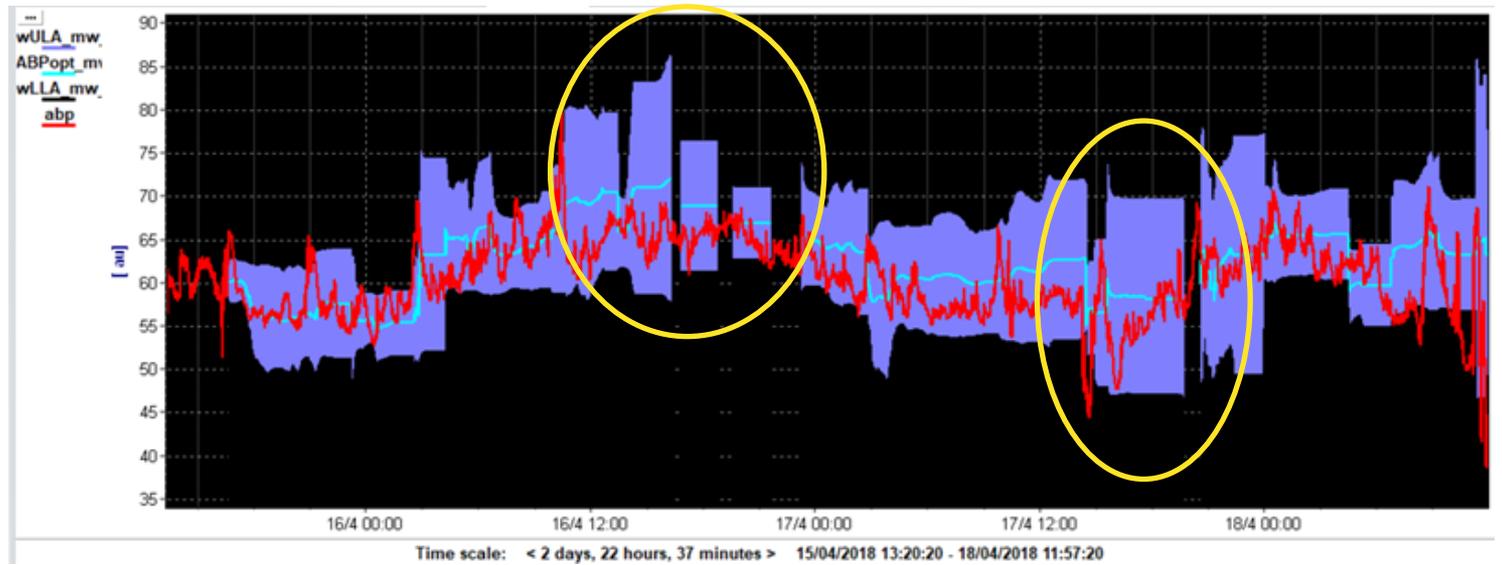Yield : 89.8% time ABPopt available
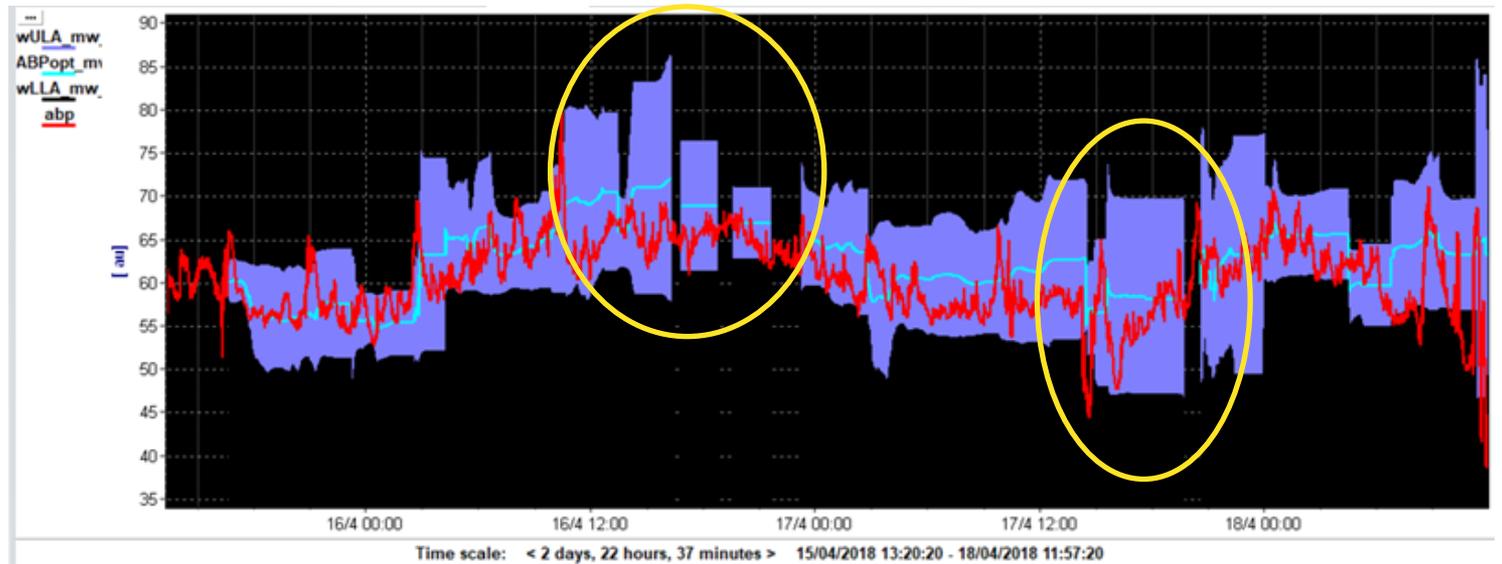
VA ECMO
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Post operative

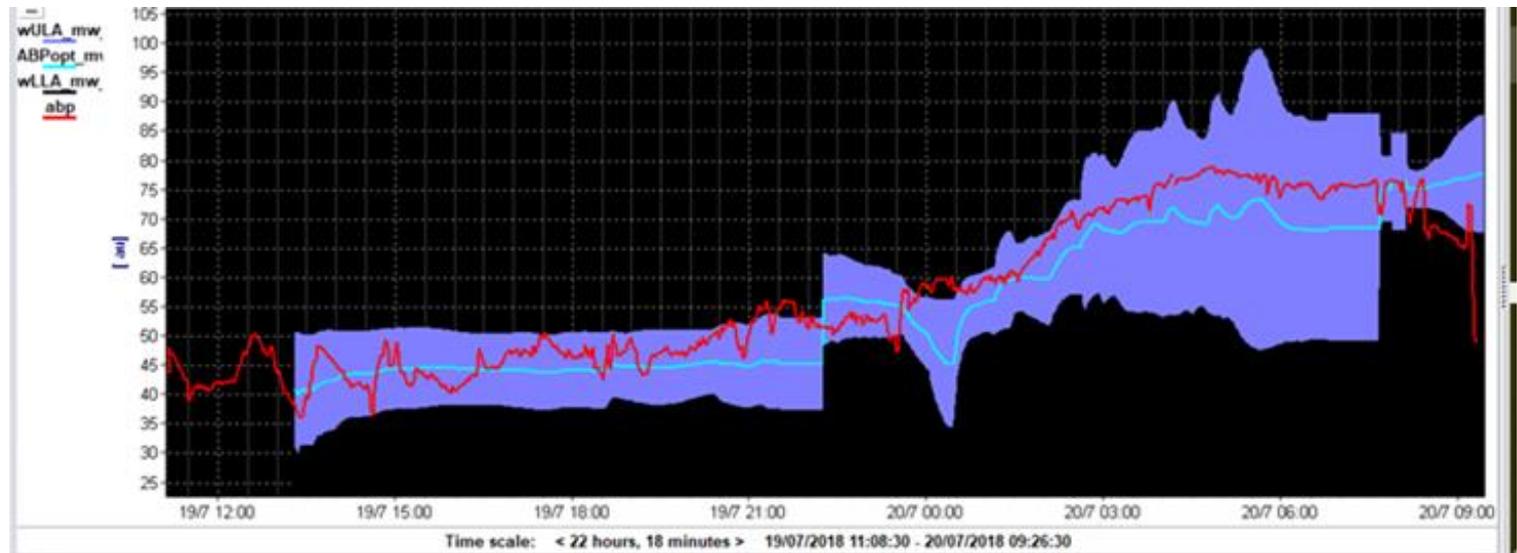VA ECMO
2 months
Post operative

VA ECMO
1 year
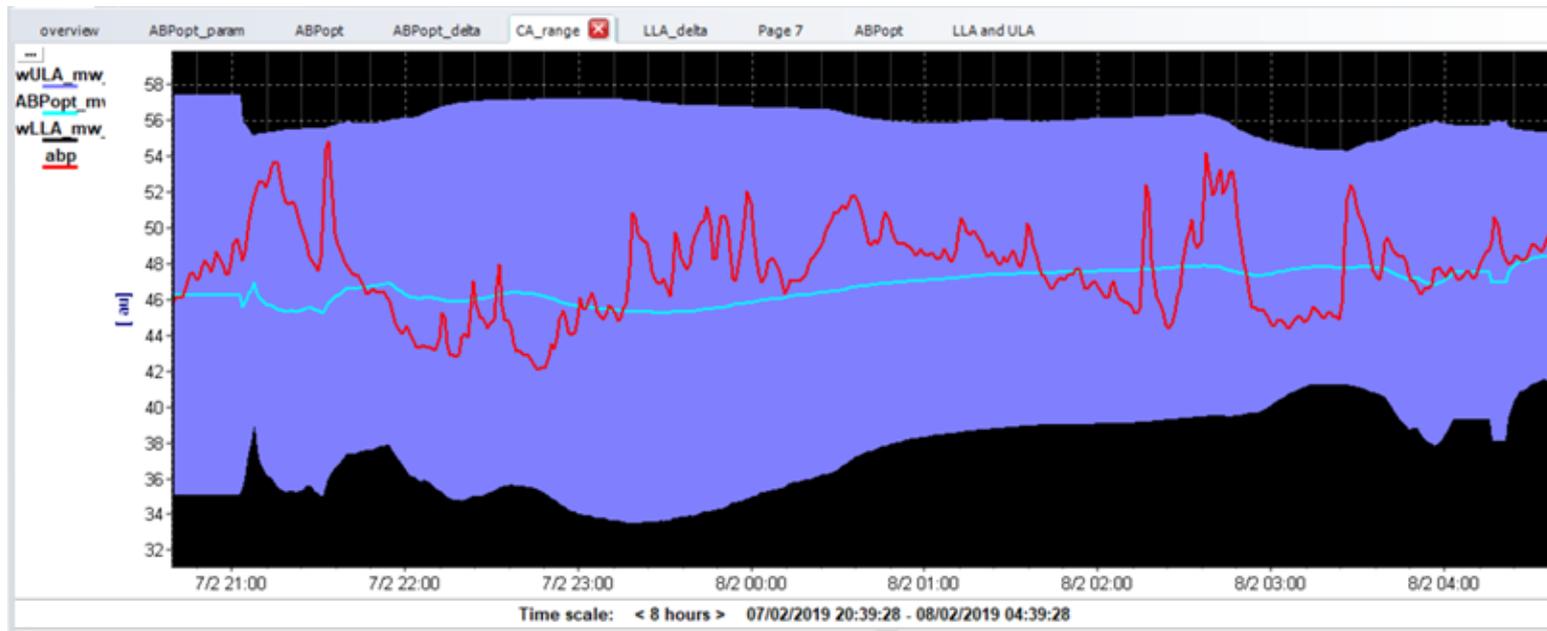Post operative

VA ECMO
1 year
Post operative

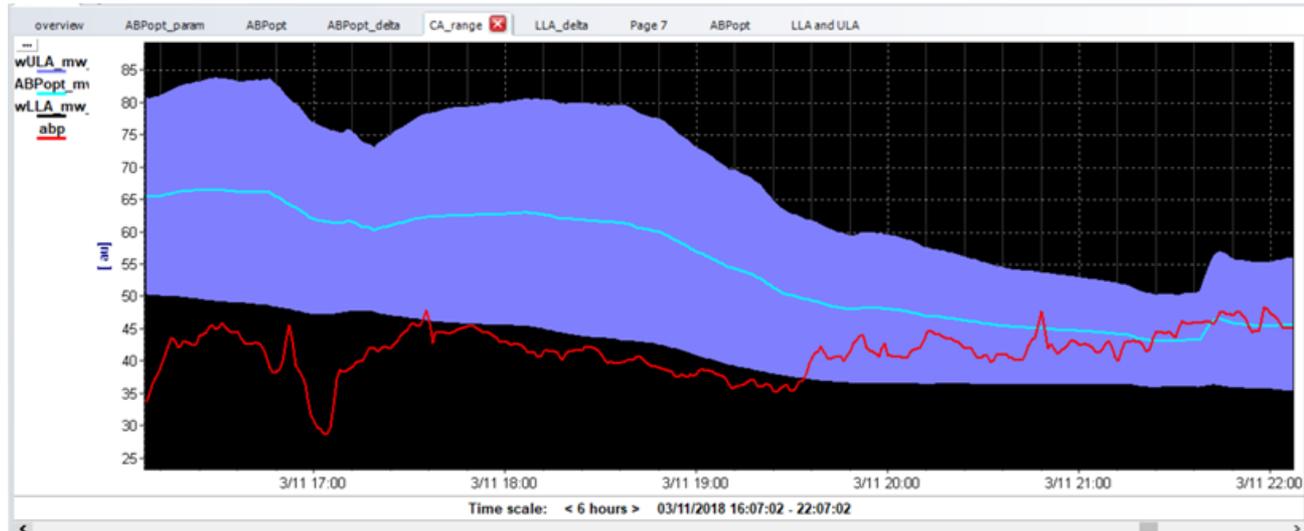VA ECMO
1 month
Post operative

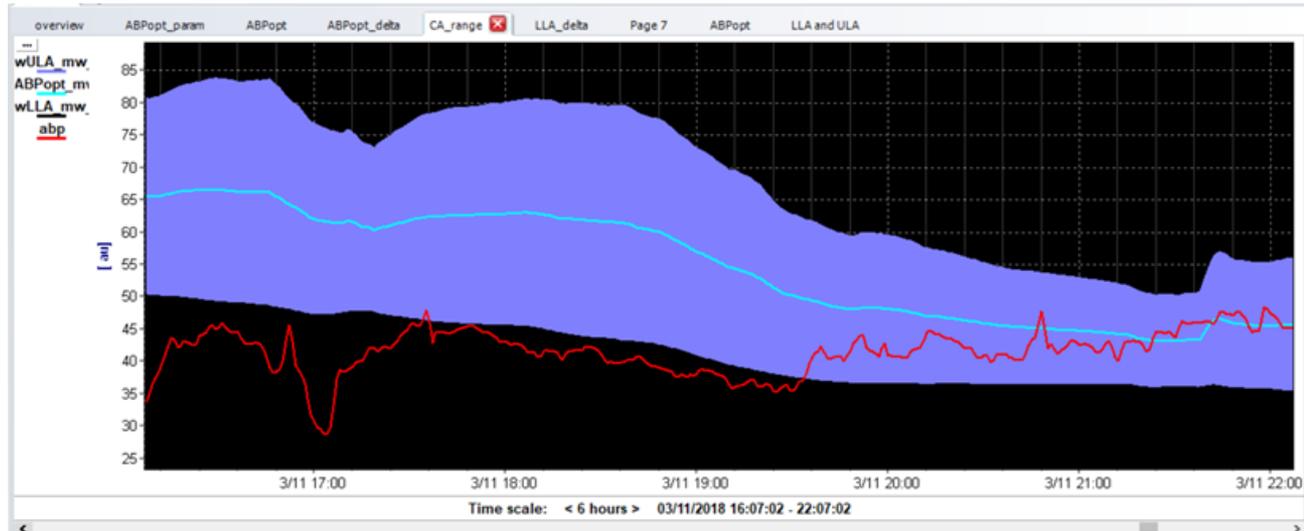# Stable period

VA ECMO
2 months
Post operative

Hypotension
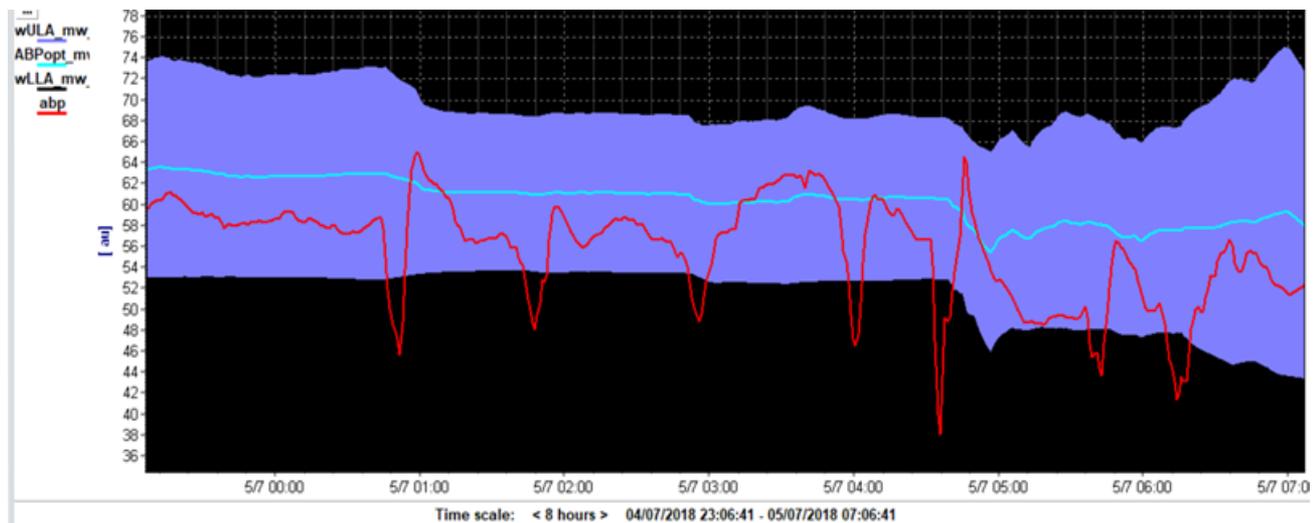
VA ECMO
2 months
Post operative
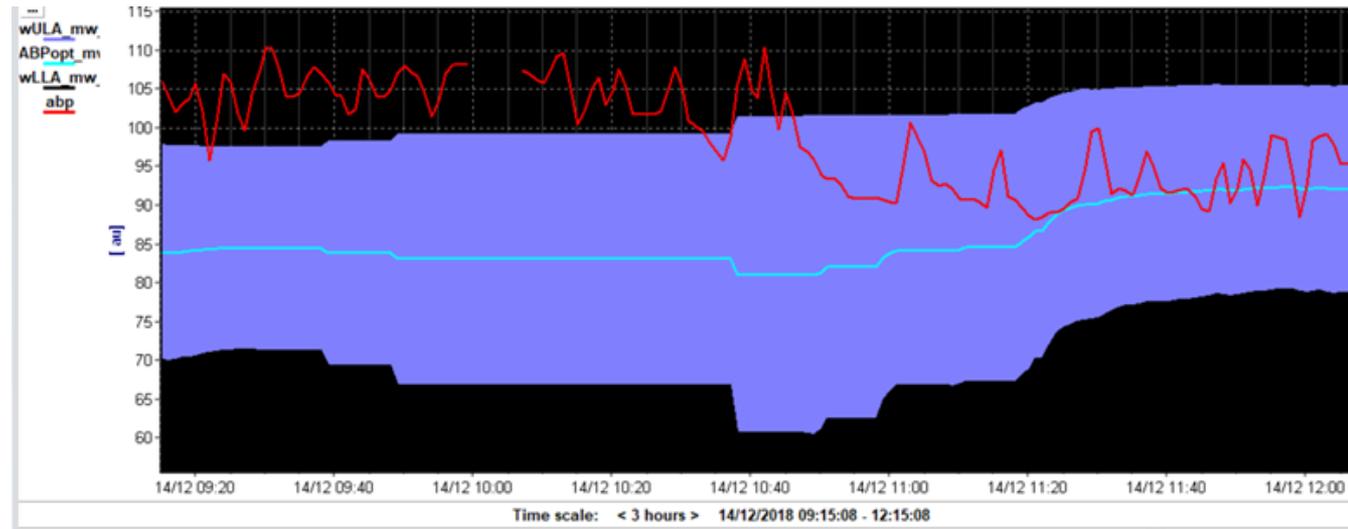
Hypotension

VA ECMO
2 months
Post operative

VA ECMO
3 months
Post operative
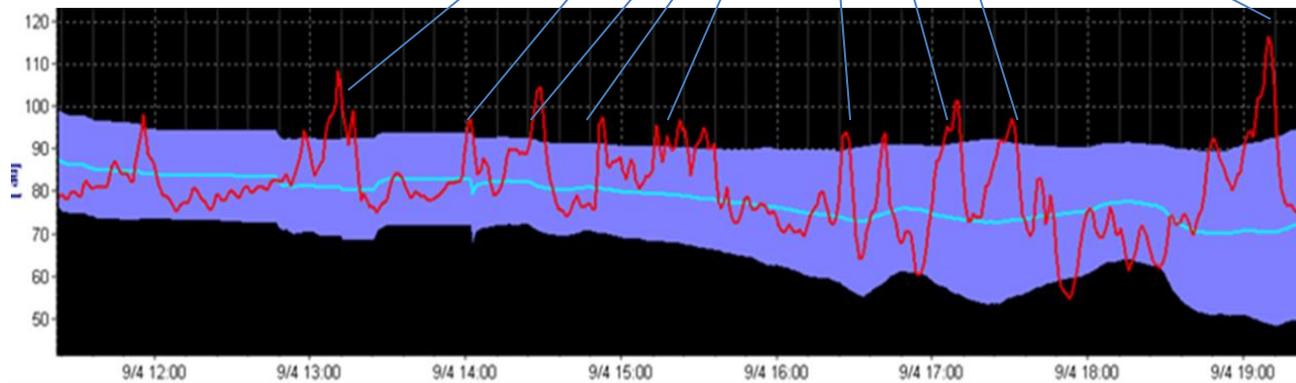
But also hypertension !!!

VA ECMO
5 years
Fulminant myocarditis
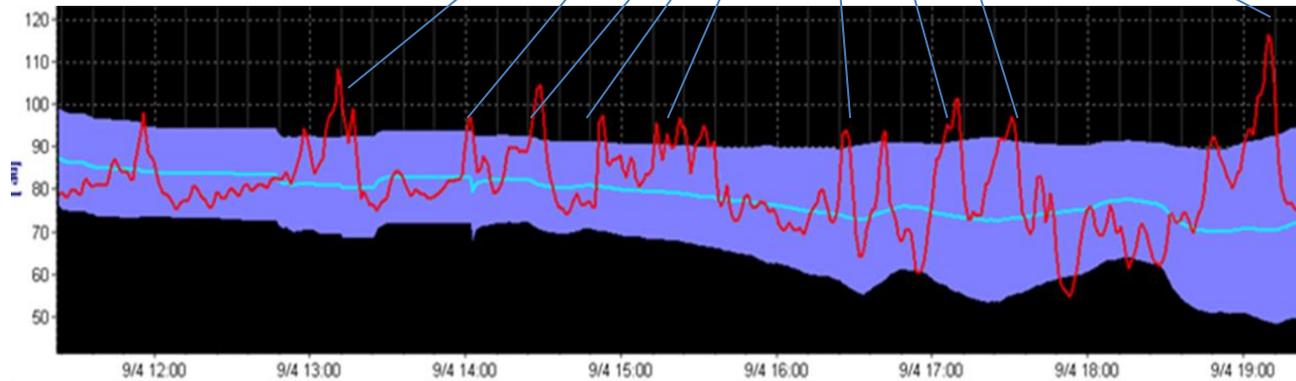
Variables

From ULA
- AUC MAP > ULA
- % time with ABP > ULA

Variables

From ULA
- AUC MAP > ULA
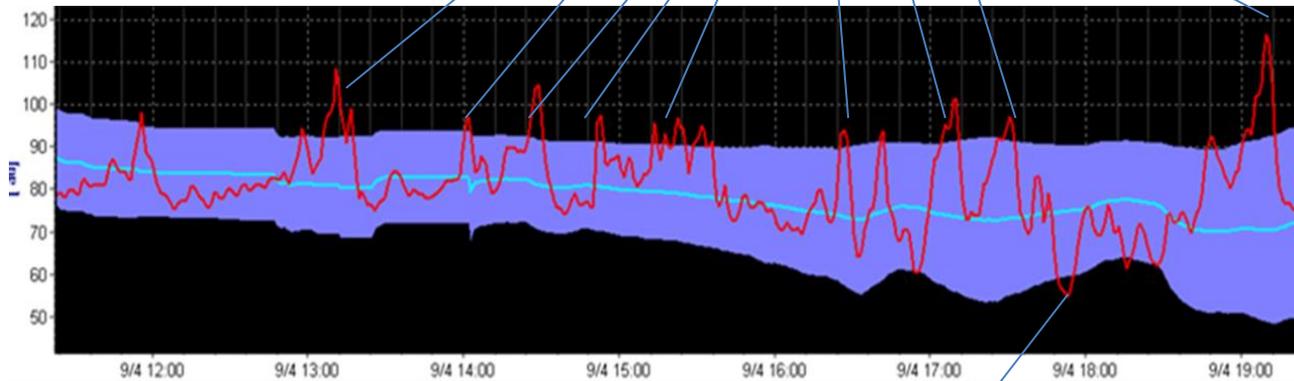- % time with ABP > ULA

From ABPopt
- Delta ABP-ABPopt
- % time +/- 5 mmHg

Variables

From ULA
- AUC MAP > ULA
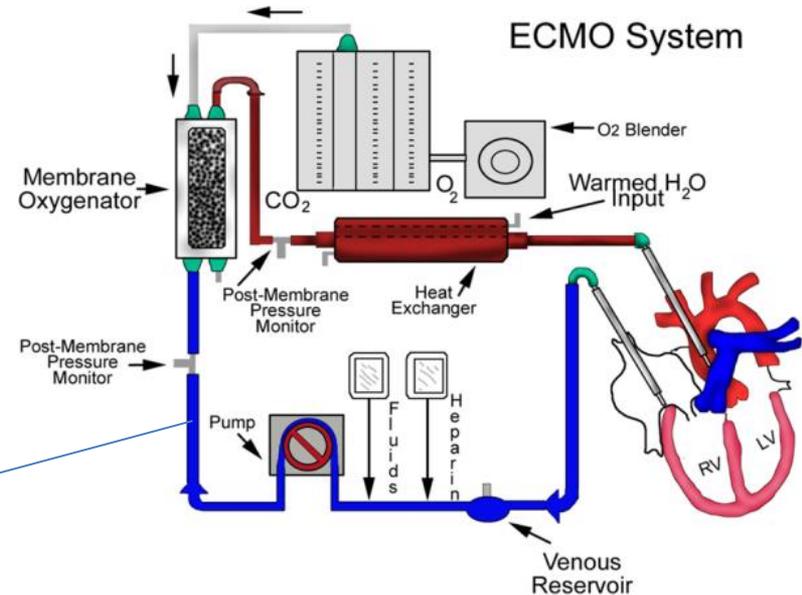- % time with ABP > ULA

From ABPopt
- Delta ABP-ABPopt
- % time +/- 5 mmHg

From LLA
- AUC ABP < LLA
- % time with ABP < LLA

Influence of PCO2

- Arterial PCO2 : only discontinuous values : 2 to 4/day
- Continuous veinous PCO2?

Conclusion

- AR monitoring in ECMO is feasible using routine devices
- Artefacts removal : manual for the moment
- Multi-window ABPopt calculation with weighting is feasible
- Inclusion of the influencing variables in the model in process
- Results of the association between AR impairment and neurological outcome in the CARNet meeting