

Data analysis with ICM+

Peter Smielewski, PhD Division of Neurosurgery, Department of Clinical Neursciences



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DISCLOSURE



Data examples

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Configs	^	Name	<u>.</u>	Date	modified	Туре
Data		confi	as	21/10)/2017 08:52	File folder
CPPopt meeting		work	folder	21/10)/2017 08:52	File folder
📕 Day 1		🔽 🔙 patie	ntl	11/10	0/2017 07:32	ICM+ data file
Patient_0		🗋 patie	nt1_r01.artf	17/05	9/2017 21:31	ARTE File
configs	1.0	📳 patie	nt1_r01	08/05	9/2009-00:05	ICM+ raw data file
work folder		🗋 patie	nt1_r02.artf	17/05	9/2017 21:32	ARTF File
Patient1 JD		📓 patie	nt1_r02	08/09	9/2009 07:22	ICM+ raw data file
Patient2 ID		🖳 patie	nt1_r03	08/05	3/2009 14:39	ICM+ raw data file
Deficient2.1D		関 patie	nt1_r04	08/05	9/2009 21:55	ICM+ raw data file
Patients_JD		📓 patie	nt1_r05	09/09	9/2009-05:13	ICM+ raw data file
Patient4_JD		🗋 patie	nt1_r06.artf	17/09	2/2017 21:34	ARTE File
Patient5_Refractory Hypertension		D patie	nt1_r06	09/09	3/2009 12:30	ICM+ raw data file
Day 2		Patie	nt1_r07	09/05	/2009 19:46	ICM+ raw data file
Patient_CrCP	~ «	-	1.055	- 1 (2)		
23 items 1 item selected 536 KB						





Open the data file







The main (summaries) file







Close the file







Open the raw data file





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Raw data loading period selection



Estimate of memory needed to load





Viewing the data







Viewing the data







Viewing the data







Open the file in 're-analysis' mode







Do NOT load any configuration yet



Analysis configuration editor



Add signals to be analysed

🌺 On Line Analy	sis Configuration Dia	ialog	
Virtual Signals P	rimary Analysis Final	I Apahreis	
		Virtual Signal Definition Editor	
Name	Formula	Name : Valid range for values	d
icp	icp	ABP Min Value : 0 ABP Enabled	
abp	abp	Formula:	
pto2	pto2	abp	
ecg	ecg	Clear Constants Operators	
		Variables: Functions Extended Functions	
		abp 7 8 9 + DelayFilter(,)	
		icp 4 5 6 - Differentiate() Filter(.)	
		pto2 1 2 3 * FIRFilter(,) fixAngle()	
		1 0 . / ifPresent(,,)	
		()) IIRFitter(,,)	
		Integrate() MedianFilter()	
		Sampling frequency conversion MovingAvgFilter(,)	
		Sampling Frq [Hz]: 200.0 SampleIdx()	
		Use Decimating Filter SamplingFrq()	
NO 11			
Modify	+ <u>A</u> dd	Cancel & Keyboard	
✓ OK	X Cancel	Save Load Advanced Sp Keyboard	





Add basic summaries







Adding more formulae

Virtual Signals Prin	nary Analysis Final Analysis				
Name	Formula	Calc. Window	Updated [s]	Min Ma	ax E
icp	Mean(icp)	10	10	0 0	Y
abp pto2	oose the calculation window siz	е	10	<u> </u>	× .
ecg	Name : Calculation Window Specification		Valid values range		
	CPP Calculation Period : 10	s	Max Value: 0		
	Enabled Vpdate Period : 10	s	Min Value : 0		
	K	Choose	the calcula	ation rate	
	Formula:				Function
	abs	A Inser	rt Function	Ser	Arguments ies 1 : icp
Modify	Tops Function: Option 7 8 9 + HRVstats Index Index Intercept IsNANFree	s:			abp icp pto2
ose Mean fur	Ction 3 * Kurtosis Length Max	Dou	uble click to	o choose	the variab
	Delete () MeanFW *				
	Function description:	uffer			

Adding PRx calculation

Calculatio	on window Final Analysis Configur	v size 5 min
Data Acquis	Name : PRx Units :	Calculation Window Specification Calculation Period: 300 s Max Value: 0 Update Period: 60 Calculation rate - every 1 minute
Name	Enabled 🔽	Brief description of the parameter
ICP pto2	Formula: Correl(abp,icp) abs	Double click 'abp' and then 'icp' Function Arguments: Series 1: abp Series 2: icp
Choose Correl function	Dn 7 8 9 + 4 5 6 - 1 2 3 * 0 . / Delete () Function descripti Function calculates F	AUC BaroIndex BaroIndexEx BaroSpidxEx Coherence Correl Correl ConseCorrel Consecorrel C





Final parameters

irtual Signals	Primary Analysis Fi	nal Analysis							
Data Acqu	isition Period [s] :	60.0		Adjust Calc. Period					
Name	Formula			Units	Calc. Windo	Updated [s]	Min	Max	En.
icp	Mean(icp)			1.1112	60	60	0	0	Y
abp	Mean(abp)				60	60	0	0	Y
pto2	Mean(pto2)				60	60	0	0	Y
CPP	Mean(CPP)				60	60	0	0	Y
PRx	Correl(abp.icp)				300	60	0	0	Y
Moo	lify + Add	<u> </u>	ete	Ciear Au	to <u>F</u> ill De	fault Period [s]:	60.0		





Start analysis





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Running the calculation





Resulting trends



Build the desired visualisation by adding more charts





Load preconfigured charts layout







Multipage view of the data







Histograms







Histograms









Visualising PRx against CPP







'Optimal CPP' curve







'Optimal CPP' curve







Limits of autoregulation







'LOW RES summaries 10s.dta' data file

To speed up further analysis we'll use pre-processed data source file (for the purpose of this workshop)





10s downsampled data file







Select the LOW RES data file for analysis







Configuring real time CPPopt calculation

Right click on the 'Final Analysis'

🌺 On Line An	alysis Configuration E)ialog	tab	_	_	_			_ D X
Virtual Signals Data Acqui	Primary Analysis Fin	al Analysis 60.0	Inser Add	t Extra Analysis Extra Analysis P	Page				
			Delet	e Current Analy	rsis Page				
Name	Formula	-		Units	Calc. Wind	lo Updated [s]	Min	Max	En.
іср	Mean(icp)				60	60	0	0	Y
abp	Mean(abp)				60	60	0	0	Y
pto2	Mean(pto2)				60	60	0	0	Y
CPP	Mean(CPP)				60	60	0	0	Y
PRx	Correl(abp,icp)				300	60	0	0	Y
Mod	lify <u>+ A</u> dd	<u>– D</u> e	lete	Clear	Auto <u>F</u> ill	Default Period [s]:	60.0 (4	
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Configuring real time CPPopt calculation

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	СР	Mean(ICP)				60	60	0	0	Y
	ABP	Mean(ABP)				60	60	0	0	Y
F	PtO2	Mean(PtO2)				60	60	0	0	Y
F	PRx	Mean(PRx)				60	60	0	0	Y
	CPP	Mean(CPP)				60	60	0	0	Y
						Popu	ate the	e me	an va	lues
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(🖹 Modi	ify <u>A</u> dd	<u> </u>	🙀 Clea <u>r</u>	Aut	o <u>F</u> ill	Default Period	[s]: 60.0		
	🖊 ок	X Cancel	😫 Save	\rm Load		Advanced		Keyboard		



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Configuring real time CPPopt calculation

	Final Analysis Configuration Editor	Function options	×	
	Name : Calculation Window Specificatio	Function: OptimalValue		
Vitu	Calculation Period : 1440	Missing Data Limit [%]	100.00	
D	Update Period : 60	Number of bins	16	
	Enabled V Optimal Cerebral Perfusion	Minimum bin value	40	the input variables
		Maximum bin value	120	
	OptimalValue(CPP,PRx,'BINS=16&MINVAL=40&MAXV	Minimum bin data count [%]	1.00	Function Y Arguments :
Choose Ontima	Value function	Minimum included data [%]	50.00	: СРР
Choose Optima		Minimum Y span	0.00	PRx Y
	9 + Min Moment	Concave		abp CPP
	4 5 MSEntropy OptimalValue	Need not include 'best'		icp PRx
	1 2 3 * OptimalValueFlex Percentile	Use error weighting		pto2
	0 . / PhaseShift Power	Enforce Y range		
	Delete () DuiseState	Enforce Y region - Min	0.00	
	Function description:	Enforce Y region - Max	0.00	
	fit a parabolic function to the resulting XY plot. Point of the	Optimal range threshold	NAN	alue.
	The function can also return:	Min value of lower breakpoint	0.00	
	- relative size of data included in the curve - span of the fitted curve, and	Max value of upper breakpoint	0.00	
	- the fit type: 0 - no fit possible,	Output value type	Optimal X 🔹	
		VOK X Cancel		
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Calculating lower limit of AR

ame :	Calculation Window Spec	ification			Valid va	Function options	-	2		
LA	Calculation Period :	14400		s	Max Va					
nits :	Update Period :	60		s	Min Val	Function: OptimalValue				
	Priof description of the	paramet	ar			Missing Data Limit [%]	100.00			
Enabled 🔽	Lower limit of autorem	ulation	er			Number of bins	16			
	20mol minicol datologi	ancaron				Minimum bin value	40			
ormula:						Maximum bin value	120			
OptimalValue(CI	PP,PRx,'BINS=16&MINVAL=40&	MAXVAL=	=120&TH	RSHLD=0.2&OUT	=LL')	Minimum bin data count [%]	1.00			
						Minimum included data [9/]	50.00			
abs 🔻 📋	Function :	Ор	otions:		Insert Fun	Minimum included data [%]	50.00			
7 8 9 4	OptimalValue	A MC	DLIM	Missing Data Li	mit [%] (0 - 1	Minimum Y span	0.00	6		
4 5 6 .	Percentile	BI	INS (AL	Number of bins	(1 - 1000)	Concave				
	PhaseShift	M	INVAL AXVAL	Maximum bin va Maximum bin va	alue	Need not include 'best'				
	PulseStats	M	INBIN	Minimum bin da	ta count [%]	Use error weighting				
	Range	- MI	INDATA INVSP	Minimum includ Minimum V sna	ed data [%] (n	Enforce Y range				
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Function descrip	tion: h. can be used to track 'Optimal C	DD' divide	ae V variat	lee valuee into hi	and calou	Enforce Y region - Max	0.00	8		
fit a parabolic funct	ion to the resulting XY plot. Point	of the min	nimum/max	imum of the funct	ion is returne	Optimal range threshold	0.2			
The function can a	et the function can return the lov so return:	ver and up	pper limit o	r the optimal range	ə.	Min value of lower breakpoint	0.00			
 relative size of da span of the fitted 	ta included in the curve fit, curve, and					Max value of upper breakpoint	0.00			
the fit type:	,					Output value or upper or eatpoint	Louis Ontlint	<u>ک</u>		
J - no fit possible,						Output value type	Lower Opt Limit	•		

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Analysis with CPPopt added

4	👷 On Line Ana	alysis Configuratio	on Dialog							_ 0	x
	Virtual Signals	Primary Analysis	Secondary Analysis 1	Final Analysis							
	Data Acqui	sition Period [s]	60.0	Adjust Calc. I	Period						
	Name	Formula		Units	C	alc. Windo	Updated [s]	Min	Max	En.	
	icp	Mean(icp)			6	0	60	0	0	Y	
	abp	Mean(abp)			6	0	60	0	0	Y	
	pto2	Mean(pto2)			6	0	60	0	0	Y	
L	CPP	Mean(CPP)			6	0	60	0	0	Y	
L	PRx	Mean(PRx)			6	0	60	0	0	Y	
	CPPopt	OptimalValue(CPP, PRx, 'BINS=16&MIN	/AL=40&MA	1	440	60	0	0	Y	
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	🗸 ок	X Cancel	Save	🖺 Load	Ad 🔊	vanced	🛞 Key	board			





Load the complete analysis configuration profile







Do not start analysis yet Lets examine the configuration first







View the analysis configuration





View the analysis config







Start the analysis







Running the calculation







Results - CPPopt trend page







Adding variables to the chart







Adding ULA and LLA to the chart







Modify the plot type to 'Area'







Modify the colours







Final presentation of the limits of autoregulation trend (the green band)







Time to explore other examples

Patient 1

Patient 2

Presentation: <u>19 year old</u> male GCS 7 diffuse axonal injury or Presentation: 20 yr male, Motor cyclist hit by a car. GC5 9, initial CT with left frontal contusions op CT shown).

Patient 3

Presentation <u>18 year-old</u> female RTA GCS 6, pupils reactive

On CT contusions with oe Decompression after 4 da





Monitoring shows goo

Good recovery at 6 m

Monitoring features – Disturbed PRx,

Patient died.

C. E

Before

Severe disability at 6 mor

Patient 4

Presentation

25 year-old male RTA (paedestrian hit by lorry). Both pupils reactive and GCS 3.

Initial CT: Left subdural, frontal contusions, skull fracture.



Monitoring features- 'solid red line' PRx, and high PbTO2 and then refractory high ICP.

Patient died.



