

Technical aspect of quantification and measurement of BRS



ONSE Medical Inc.

Seoul, South Korea

+82 2 508 0123

<http://www.onsemedical.co.kr>

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Finapres Products and Technologies

Non-invasive, Continuous, Beat-to-beat Blood pressure monitoring device



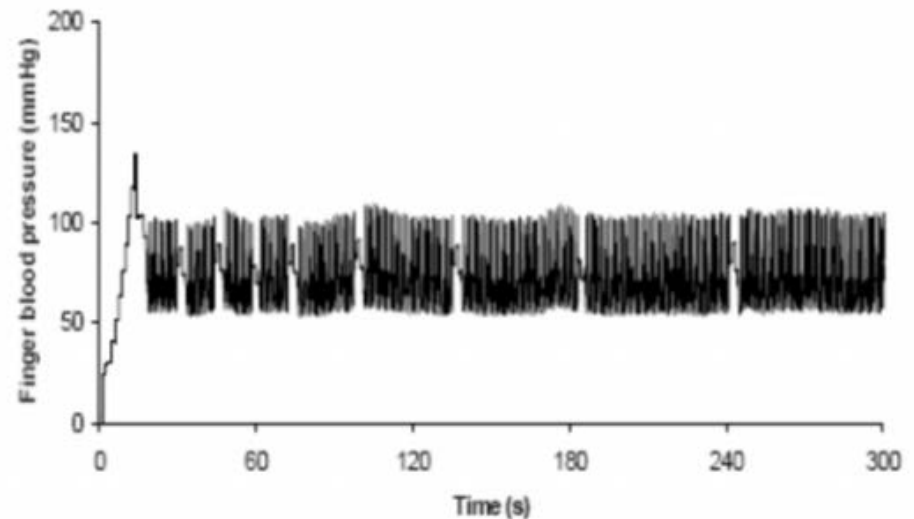
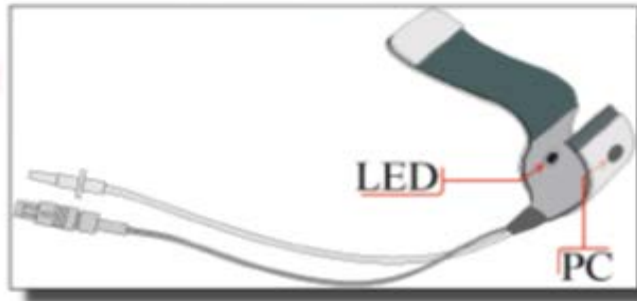
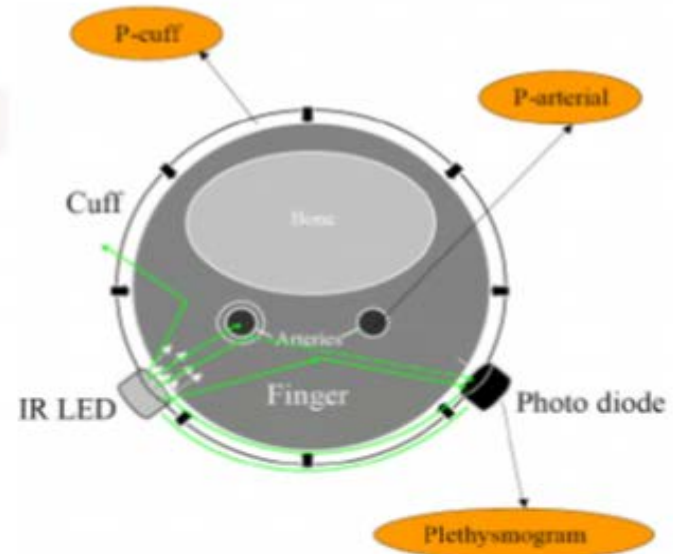
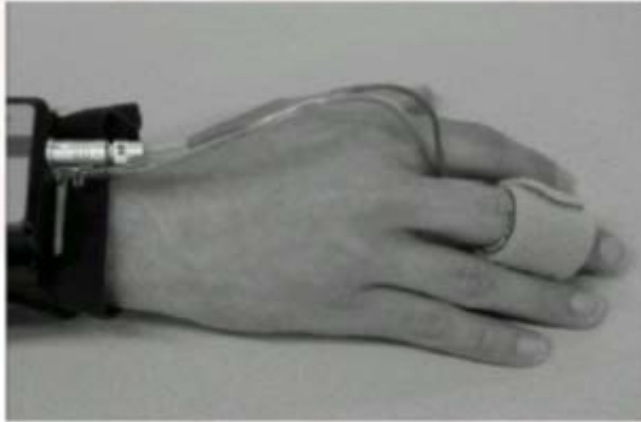
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FINAPRES®
TECHNOLOGY**

more than 30 years of proven reliability
attested by leading researchers and clinicians



Finapres Products and Technologies

Volume-clamp method



What BRS is.

■ Baroreflex

The baroreflex or baroreceptor reflex is one of the body's homeostatic mechanisms for maintaining blood pressure. It provides a negative feedback loop in which an elevated blood pressure reflexively causes heart rate to decrease therefore causing blood pressure to decrease; likewise, decreased blood pressure activates the baroreflex, causing heart rate to increase thus causing an increase in blood pressure. ¹⁾

■ Baroreflex Sensitivity

It is the amount of response in heart beat interval to a change in blood pressure, expressed in ms/mmHg. ²⁾

BRS measurement methods

■ Evoked BRS

; coined as a term for the regression of pulse interval on simultaneous blood pressure upon an injection of Phenylephrine (Vasoconstrictor). ³⁾

- (1) Injections of vasoconstrictor or vasodilator agents
- (2) Neck suction
- (3) Change from supine to standing

The results were obtained from **evoked, stimulus response** experiments.

However, blood pressure and pulse interval changes also occur **spontaneously**, thus methods were developed to estimate "BRS" from such spontaneous blood pressure - pulse interval variability. ²⁾

■ Spontaneous BRS

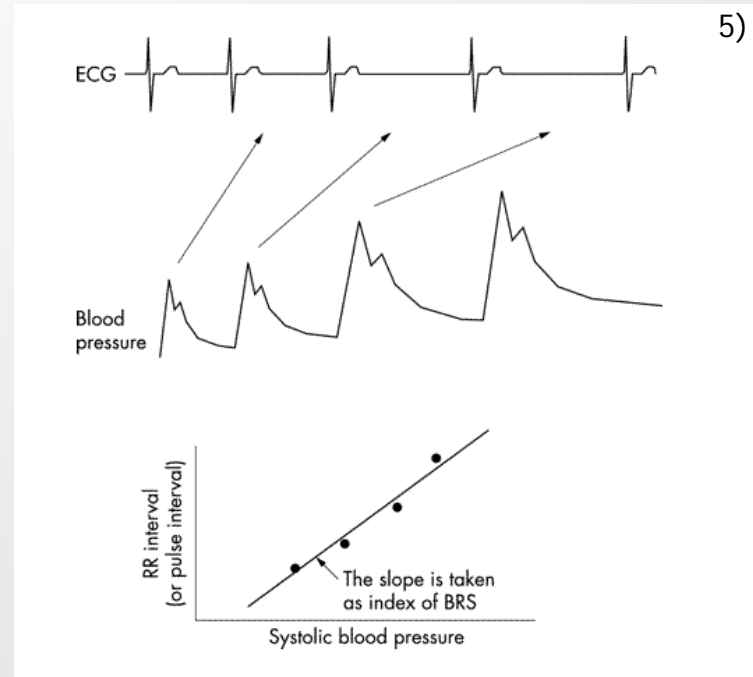
- (1) Time domain – Sequence method
- (2) Frequency domain – Spectral method
- (3) Cross-Correlation - xBRS**

BRS measurement methods

■ Spontaneous BRS

(1) Time domain, sequence method ⁴⁾

- 3 or more consecutive beats
- Progressive increases/decreases in systolic blood pressure
- progressive lengthening/shortening in RR interval.
- Systolic blood pressure change : 1mmHg in a sequence
- RR interval change : 6 ms in a sequence
- Computing the slope of the regression line relating changes in systolic pressure to changes in RR interval.
- All computed slopes are finally averaged to obtain the BRS.



BRS measurement methods

■ Spontaneous BRS

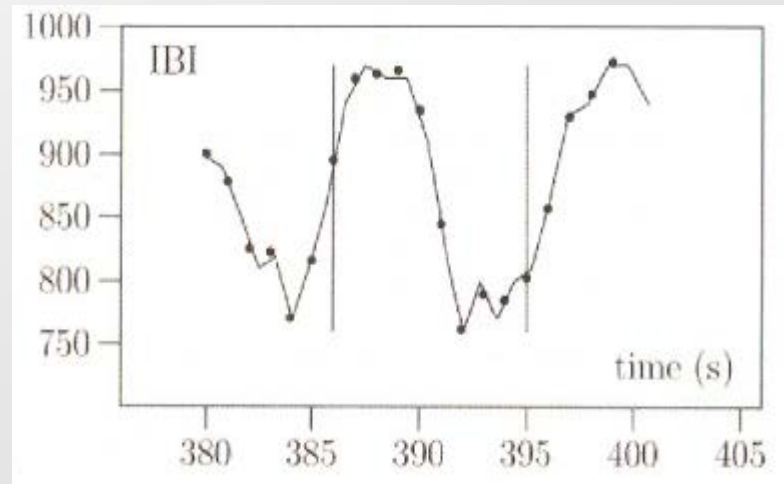
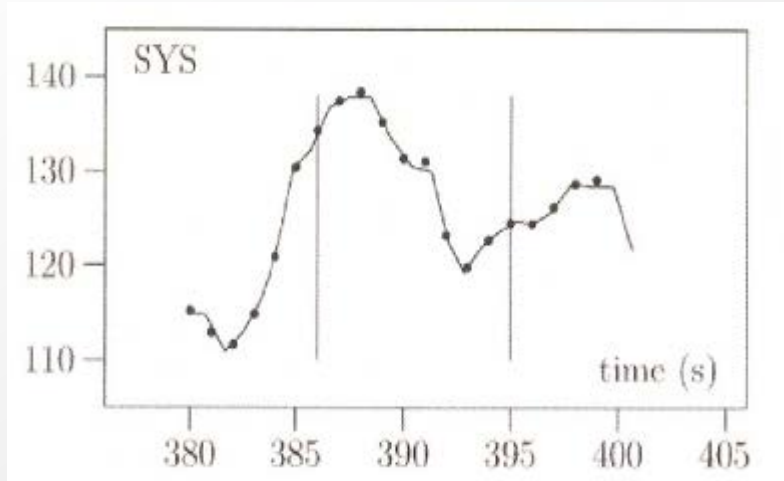
(2) Frequency domain, spectral method⁴⁾

- Each spontaneous oscillation in blood pressure elicits an oscillation at the same frequency in RR interval by the effect of arterial baroreflex activity.
- Two main oscillations are usually considered:
 - One centered around 0.1 Hz, within the low-frequency (LF) band (0.04 ÷ 0.15 Hz),
 - Associated with respiratory activity within the high-frequency (HF) band (0.15 ÷ 0.40 Hz).
- Therefore, these methods allow a clear definition of the oscillatory components that contribute to BRS measurement.

BRS measurement method in Finapres[®] devices

■ Cross-Correlation BRS (xBRS) ⁶⁾

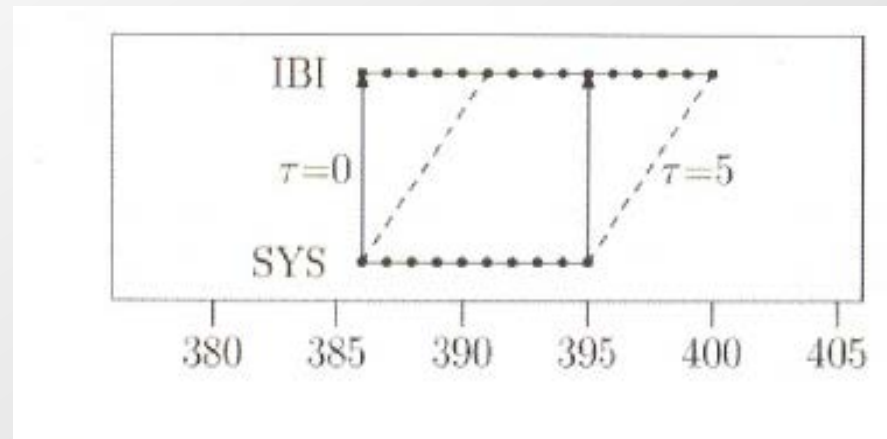
1. Take beat-to-beat pressure (p) and pulse interval (I).
2. 10s duration windows of simultaneous SYS and IBI are interpolated and resampled at 1s intervals.



BRS measurement method in Finapres[®] devices

■ Cross-Correlation BRS (xBRS)

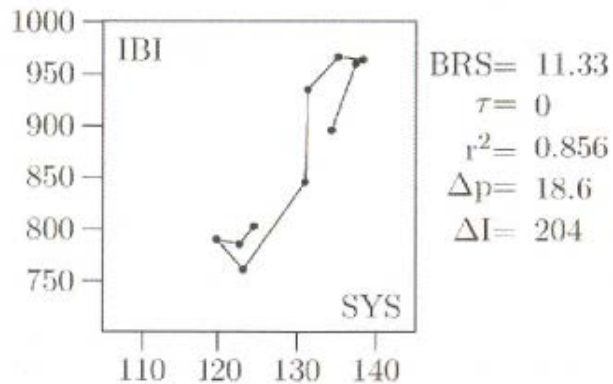
3. Assemble in 15s arrays.
4. Cross-correlate p [1...10] with I [1...10]. ($\tau=0$)
5. Repeat this for p [1...10] and I [2...11] and so forth.
6. Until p [1...10] and I [6...15] is reached. ($\tau=5$)



BRS measurement method in Finapres® devices

■ Cross-Correlation BRS (xBRS)

7. Select result with highest coefficient of determination, r^2



8. If $P < 0.01$ store BRS/r of this result.

9. Timed at instant of middle position.

10. Increment time by 1s,

11. Repeat.

BRS measurement method in Finapres® devices

Time-domain cross-correlation baroreflex sensitivity : performance on the EUROBAVAR data set

Stand	EUROBAVAR			sBRS	N-est	xBRS	N-est
	seq	α -L	α -H				
mean		6.7		6.8	76	6.2	213
SD				3.9	78	3.9	106
min				1.2	1	0.8	11
max				15.7	279	16.3	423
N-sbj		(20)		21	21	21	21

BRS in stand position.

The BAVAR study pools the results of the sequential and the two spectral versions, (20) in all, since they are similar.

xBRS versus other time-sequential methods:

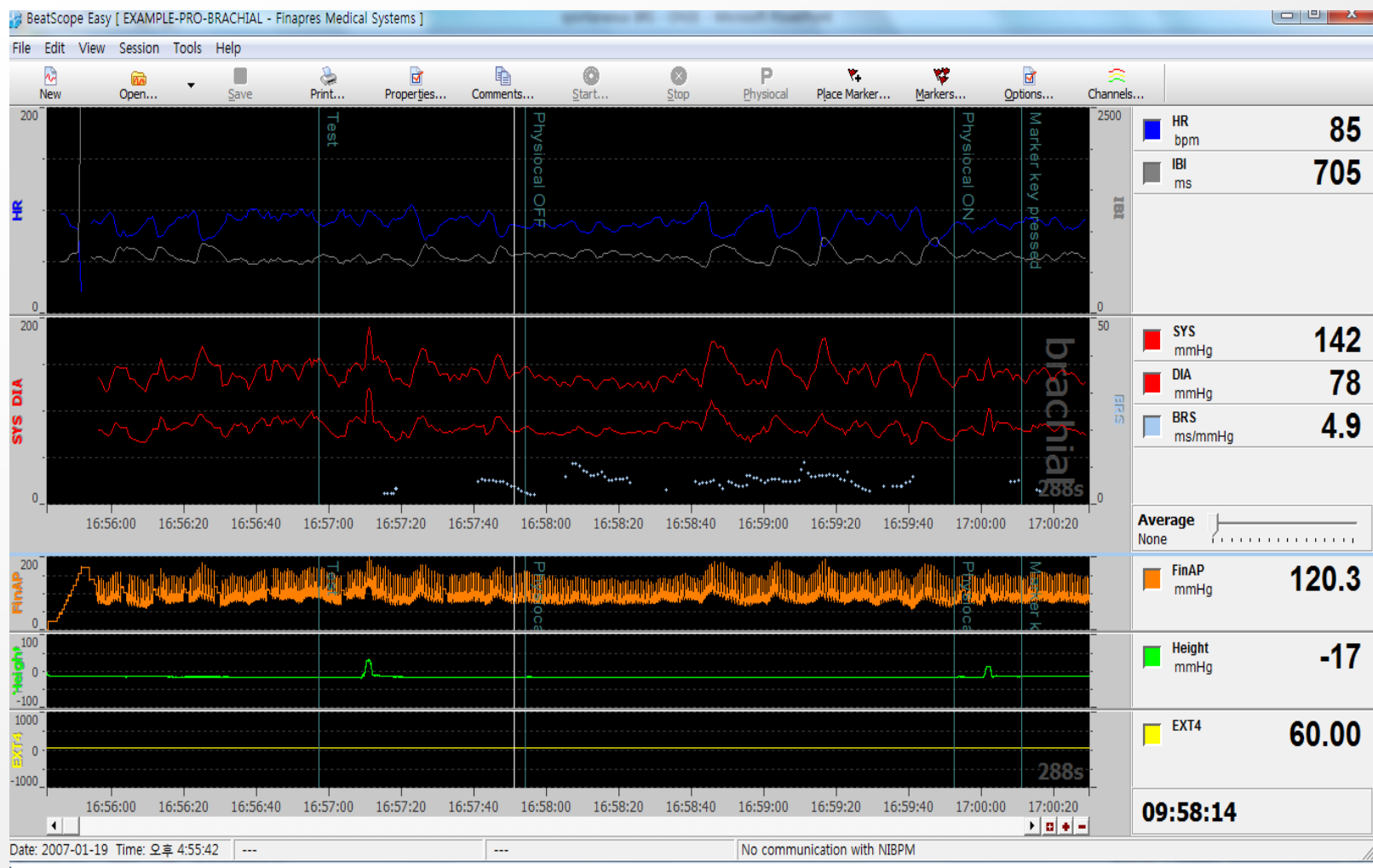
- Variance reduced by 50%
- More measurements per unit of time
- More equally distributed over time
- No thresholds present or needed

Patient	sBRS		xBRS	
	m(s)	N-est	m(s)	N-est
b005s	1.2	1	0.8(0.3)	46
b005l	2.1(0.6)	2	2.3(0.8)	83
b010s	2.5	1	1.3(0.4)	11
b010l	2.2(0.7)	3	2.0(1.8)	18

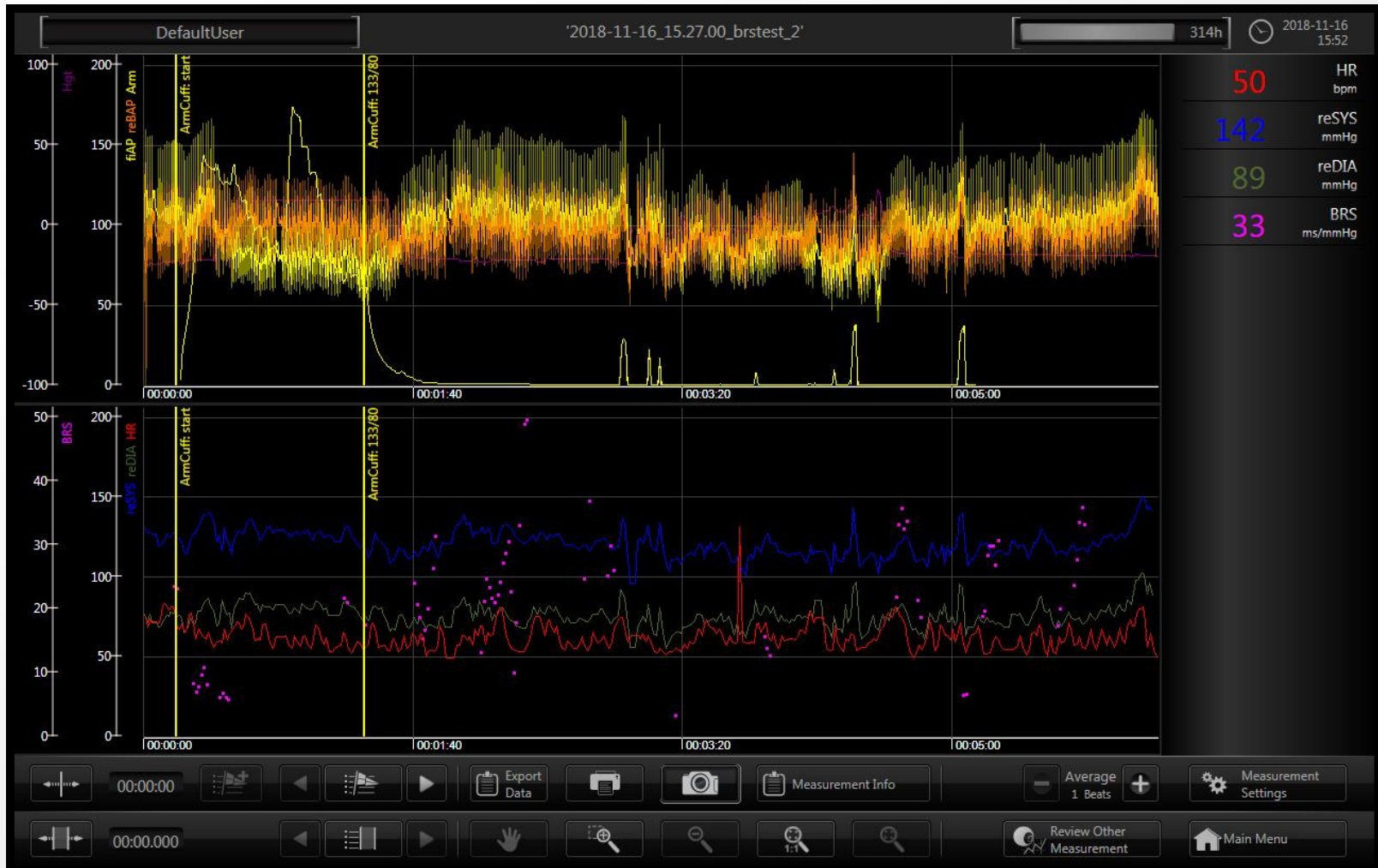
BRS on two patients with impaired baroreflex.

Patient b010 with a recent heart transplant and b005 with diabetic autonomic neuropathy exhibit very small values for BRS.

BRS measurement method in Finapres® devices



BRS measurement method in Finapres[®] devices



BRS measurement method in Finapres® devices

EXAMPLE-PRO-BRACHIAL_2007-01-19_16.55.42_BRS.txt - 메모장

파일(F) 편집(E) 서식(O) 보기(V) 도움말(H)

BeatScope Easy - v02.10 build 004

Identification:Identification;Age (yrs);Height (cm);Weight (kg);Gender;Procedure;Model number
 EXAMPLE-PRO-BRACHIAL;Finapres Medical Systems;33;189;105;Male;example brachial;9715

Reconstructed pressure level:
 brachial

Time(s)	BRS (ms/mmHg)	MP (mmHg)	MI (ms)	tau (s)	R ²	dP (mmHg)	dI (ms)
16:57:15.360;	2.82;	155.40;	656;	5;	0.6787;	53.20;	136;
16:57:16.360;	3.00;	153.73;	649;	5;	0.7368;	55.71;	144;
16:57:17.360;	2.91;	152.86;	645;	5;	0.8105;	55.71;	144;
16:57:17.860;	2.76;	149.93;	645;	4;	0.7310;	58.20;	144;
16:57:18.360;	4.02;	143.80;	645;	3;	0.8104;	30.57;	144;
16:57:18.860;	4.05;	140.51;	645;	2;	0.7729;	32.69;	144;
16:57:41.360;	6.05;	139.01;	665;	1;	0.8594;	17.62;	127;
16:57:42.360;	6.75;	141.50;	681;	1;	0.9315;	29.43;	204;
16:57:43.360;	6.46;	143.57;	697;	1;	0.9669;	29.86;	204;
16:57:44.360;	6.49;	144.80;	705;	1;	0.9670;	29.86;	204;
16:57:45.360;	6.31;	143.97;	705;	1;	0.9511;	29.86;	204;
16:57:46.360;	6.21;	143.17;	705;	1;	0.9235;	29.86;	204;
16:57:47.360;	6.13;	142.93;	708;	1;	0.9442;	29.86;	204;
16:57:48.360;	6.02;	143.52;	715;	1;	0.9301;	29.86;	204;
16:57:49.360;	5.37;	144.88;	726;	1;	0.9419;	27.66;	174;
16:57:50.360;	4.78;	146.47;	736;	1;	0.9491;	22.87;	113;
16:57:51.360;	4.86;	146.32;	733;	1;	0.9180;	22.87;	113;
16:57:52.360;	4.29;	144.23;	722;	1;	0.9139;	22.87;	100;
16:57:53.360;	3.37;	141.95;	712;	1;	0.7931;	13.57;	49;
16:57:54.360;	3.18;	140.73;	708;	1;	0.6848;	11.18;	37;
16:57:54.860;	2.84;	140.35;	708;	0;	0.7153;	13.99;	37;
16:57:55.860;	2.54;	139.93;	708;	0;	0.6980;	15.31;	37;
16:57:56.860;	2.54;	139.55;	710;	0;	0.6032;	15.31;	37;
16:58:05.360;	7.48;	132.15;	712;	1;	0.7326;	9.68;	92;
16:58:07.360;	10.78;	131.85;	721;	1;	0.5923;	9.68;	111;
16:58:08.360;	10.90;	131.65;	722;	1;	0.6459;	9.68;	111;
16:58:09.360;	10.15;	131.36;	720;	1;	0.6779;	12.58;	111;
16:58:10.360;	9.05;	130.89;	718;	1;	0.6643;	12.77;	111;
16:58:11.360;	8.69;	130.85;	722;	1;	0.7404;	12.77;	111;
16:58:12.360;	7.72;	131.41;	729;	1;	0.7638;	12.77;	100;

<

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Published by Finapres Medical Systems B.V. The Netherlands