CNAP® HD (NIBP100D-HD) IN RESEARCH

Benefits in Research
20.10.2015, V3.2
One finger sensor providing complete cardiovascular responses to tests – continuous & non invasive

SETUP & PARAMETERS

Unique combination of noninvasive continuous…

- Pulse Rate
- Blood Pressure
- Cardiac Output, Stroke Volume
- Systemic Vascular Resistance

CNAP® HD sold as NIBP100D/NIBP100D-HD
Blood pressure, cardiac output and vascular resistance are used to differentiate between psychophysiological states.

**WHY CONTINUOUS BP, CO & SVR IN RESEARCH?**

- Assessment of cardiovascular response to (psycho)physiological states
  - Reactions of the human body to *challenge and threat* (positive and negative stress) \[1,2\]
  - Quantification of *emotional response* \[3\]

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Full hemodynamics and simple setup brings huge benefits for scientific studies

FEATURES & BENEFITS OF CNAP® HD IN RESEARCH

- **SIMPLE AND QUICK SET-UP**
  - One finger sensor provides all parameters noninvasively – no placing of catheters or additional electrodes.

- **QUICK RECORDING**
  - Signals displayed only shortly after startup
  - Enables accurate & immediate feedback on arterial BP, cardiac output, fluid and hemodynamic status, etc.

- **CLINICALLY PROVEN AND VALIDATED**
  - Combination of finger sensor with NBP calibration provides high accuracy BP signal
  - Continuity, accuracy & waveform dynamics are equivalent to intra-arterial measurement.
  - Proven solution for consistent, repeatable results

- **SIMPLE DATA TRANSFER AND ANALYSIS**
  - Up to 4 analog output channels (BP waveform, MAP, CO*, PPV*)
  - Plug & play integration into all common data acquisition systems (e.g. MP150: AcqKnowledge ) and subject monitors.

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*CE approval granted; FDA approval pending;
CNAP® HD provides easy setup for cardiac output from the same finger sensor

WAYS TO MEASURE CO IN RESEARCH

**CNAP® HD**

- Quick & simple setup
- Using a reusable finger sensor

**Standard Impedance Cardiography**

- Complex and time-consuming setup requires to undress upper body
- Placing of disposable electrodes
CNAP® HD combines three core technologies

HOW DOES CNAP® HD WORK?

COMBINATION OF 3 TECHNOLOGIES/METHODS:

1. **Vascular unloading principle**
   - Blood pressure, pulse rate from finger sensor

2. **Standard upper arm cuff for calibration (NBP)**
   - Reference BP value at heart level for automatic scaling

3. **Pulse Contour Analysis (PCA)**
   - SV, CO, SVR
Integrated pressure chambers measure blood pressure continuously

CONTINUOUS BLOOD PRESSURE

1. Infrared light sensors pick up blood volume and flow.

2. In- and deflating pressure chambers follow blood pulsation and keep blood flow constant. The resulting pressure in the finger sensor corresponds to the real arterial pressure.¹

3. The pressure system is controlled by multiple digital feedback loops and the “VERIFI-algorithm” for high fidelity signal processing and artifact rejection.²

¹ Jan Penaz, Brno, Czech Republic 1973
Interaction of fingersensor with NBP provides high accuracy BP signal – equivalent to invasive arterial line

**CALIBRATION TO CLINICAL GOLD STANDARD**

1. Obtaining a first un-calibrated finger measurement

2. Obtaining a NBP measurement

3. Applying NBP pulse pressure to the finger signal

4. Calibrating the finger curve to sys- and diastolic NBP pressure

All consecutive BP values are calculated from changed calibrated finger blood pressure signal

CNAP® HD sold as NIBP100D/NIBP100D-HD
Cardiac output measure obtained from accurate blood pressure waveform using well-known pulse contour analysis

**CNAP® HEMODYNAMICS**

- Applying Ohm’s Law to Hemodynamics

Voltage = Current x Resistance

\[ \text{MAP} - \text{CVP} = \text{CO} \times \text{SVR} \]

\[ \text{MAP} \approx \text{CO} \times \text{SVR} \]

- MAP … mean arterial pressure
- CVP … central venous pressure*
- CO … cardiac output
- SVR … systemic vascular resistance

* CVP ≈ 7 [mmHg] and can be neglected

- MAP derived from accurate blood pressure waveform provided by Vascular unloading
- CO is calculated from pulse contour analysis (PCA)
- SVR results from CO and MAP
- SVI, CI, SVRI absolute values can be indexed to body surface area

**CNAP® HD sold as NIBP100D/NIBP100D-HD**
CNAP® arterial pressure is comparable with an invasive arterial line, even during general anesthesia

CLINICAL VALIDATION: CNAP® BLOOD PRESSURE

Erlangen, Germany[1]:

- 88 Patients (Neuro, Abdominal, Cardiac Surgery)
- Bland-Altman Plot for MAP:
  - Bias (SD) = -1.6 (11.0) mmHg
- Precision (trending):
  - CNAP® as accurate as invasive BP (3.2 mmHg for MAP)
- 82.1% fast blood pressure changes detected simultaneously by CNAP® and IBP

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CO with CNAP® HD is inter-changeable with clinical standards and tracks changes reliably

**CLINICAL VALIDATION: CARDIAC OUTPUT WITH CNAP® HD**

- **HIGH ACCURACY** of non-invasive CO with CNAP® HD compared to invasive transpulmonary thermodilution¹. Bland-Altman plots show:
  - Small bias (0.2 l/min) and narrow limits of agreement (LoA: -1.7 to 2.2)
  - Percentage error: 25% (according to strict Critchley standard of ≤30%²,³)

- **HIGH TRENDING ABILITY** of non-invasive CO with CNAP® HD compared to invasive clinical standards
  - Concordance rates ≥90%⁴ (according to standard⁵)


⁴ CNAP® HD validation data for CE mark and prepared for publication in peer-reviewed journal – data available upon request

CNAP® is used in a variety of applications & scientific studies

### RESEARCH EXAMPLES WITH CNAP®

#### Psychophysiology: Challenge & Threat
Cornick, Blascovich et al. from the University of California in Santa Barbara investigated the cardiovascular consequences of exercise in obese subjects in a stressful environment. Cardiovascular and self-report measures were recorded. Findings indicated that those who are more self-aware showed cardiovascular response patterns indicative of threat.¹

#### Psychophysiology: Emotional Response
At Pitzer College, California, Noble et al. performed a study to assess the effects of mainstream media on women's physiological and psychological functioning.²

The Naval Aerospace Medical Research Laboratory studied the detection of deception by use of continuous blood pressure³.

Sanchez-Gonzalez et al. evaluated the cardiovascular reactivity to anxiety in young and middle-aged individuals⁴.

#### Psychophysiology: Interaction Hemodynamics & Brain
The Institute for Knowledge Discovery from Graz, Austria studied the influence of slow blood pressure oscillations on self-paced movements. "Free will" is not only brain directed but also a matter of blood pressure.⁵

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RESEARCH EXAMPLES WITH CNAP®

**Physiology**
Hurr et al. from the Department of Kinesiology and Health Education (The University of Texas at Austin; USA) determined whether there is a difference in cerebral vasodilatory capacity in response to rebreathing-induced hypercapnia between African Americans and Caucasian Americans.6

**Sports**
Telles et al. assessed heart rate variability, non-invasive arterial BP, and respiration rate, during alternate nostril yoga breathing and breath awareness sessions.7

**Gerontology**
Pereira et al. from Marquette University, USA, investigated the steadiness of muscle contractions in young and old adults during high and low cognitive demand tasks.8

Contact us for a complete bibliography of CNAP® / NIBP100D studies

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