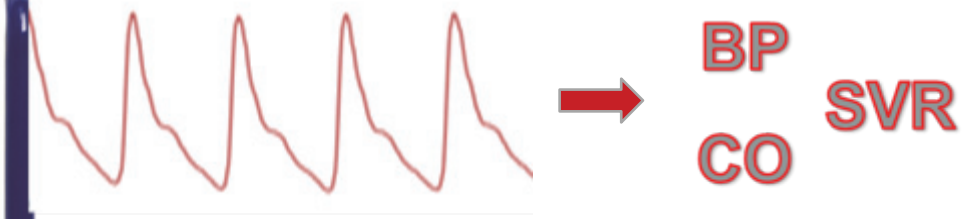
CNAP®-HD IN RESEARCH

SETUP & PARAMETERS

One finger sensor providing complete cardiovascular responses to tests – continuous & noninvasive



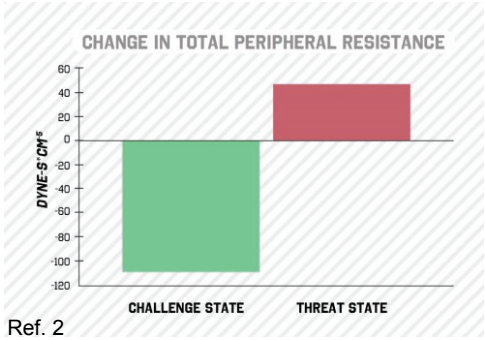
Unique combination of continuous:

- pulse rate
- blood pressure
- cardiac output, stroke volume
- systemic vascular resistance

Blood pressure, cardiac output and vascular resistance are used to differentiate between challenge and threat states.

WHY USE CONTINUOUS BP, CO & SVR IN RESEARCH ?

- Examination of cardiovascular response to (psycho)physiolog. stress
  - Reactions of the human body to **challenge and threat** (positive and negative stress) [10,11]
  - Quantification of emotional response [12]



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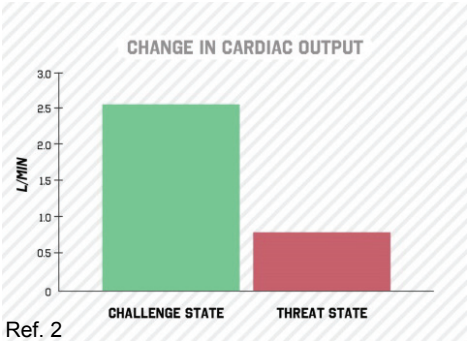


Ref. 2

[10] Kirby, L. D., & Wright, R. A. (2003). Cardiovascular correlates of challenge and threat appraisals: A critical examination of the Biopsychosocial Analysis. *Personality and Social Psychology Bulletin*, 7, 216-233.

[11] Tomaka, J., Blascovich, J., Kelsey, R. M., & Leitten, C. L. (1993). Subjective, physiological, and behavioral effects of threat and challenge appraisal. *Journal of Personality and Social Psychology*, 65, 248-260.

[12] Lackner, H. K., Weiss, E. M., Schulter, G., Hinghofer-Szalkay, H., Samson, A. C., & Papousek, I. (2013). I got it! Transient Cardiovascular Response to the Perception of Humor. *Biological Psychology*, *93*, 33–40.

Full hemodynamics and simple setup brings huge benefits for scientific studies

FEATURES & BENEFITS OF CNAP®-HD IN RESEARCH

- Full hemodynamics from only one device
- Simple and quick setup
  - One finger sensor provides all parameters
  - No placing of additional electrodes on subjects
- Quick recording
  - Parameter values in less than 15 heart beats (available end of 2014)
- Well validated parameters & system[1,2]
  - Interchangeability with clinical standards according to international criteria
- 4 analog output channels (BP waveform, mBP, CO, PPV)

[1] Jeleazcov et al.(2010). Precision and accuracy of a new device (CNAP) for continuous noninvasive arterial pressure monitoring: assessment during general anaesthesia. *British Journal of Anaesthesia, 105*(3):264–72.
[2] Clinical Evaluation Report Cardiac Output (according to Meddev 2.7.1. Rev. 3), CNSystems. 2014.

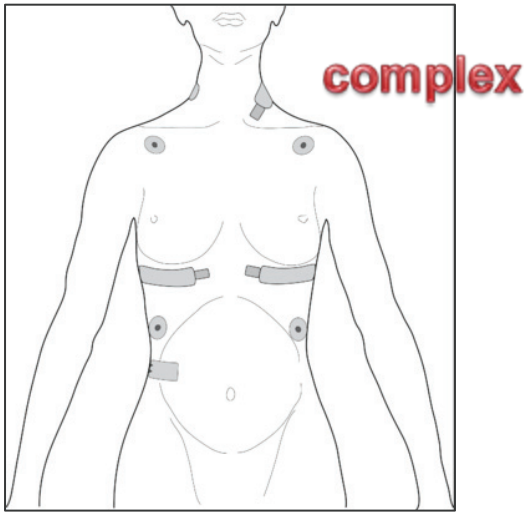
CNAP®-HD provides easy setup for cardiac output from the same finger sensor

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?

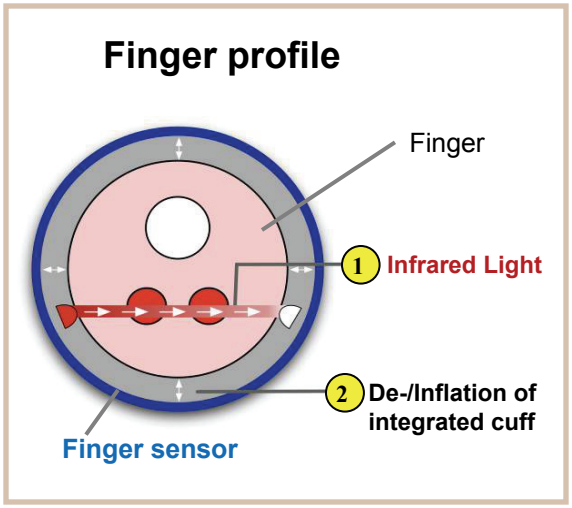
- Combination of 3 technologies/methods:
  1. Vascular unloading principle
     - → Blood pressure, pulse rate
  2. Standard upper arm cuff for calibration (NBP)
  3. Pulse contour analysis (CNCO®)
     - → SV, CO, SVR

Integrated pressure cuff measures blood pressure continuously

CONTINUOUS BLOOD PRESSURE

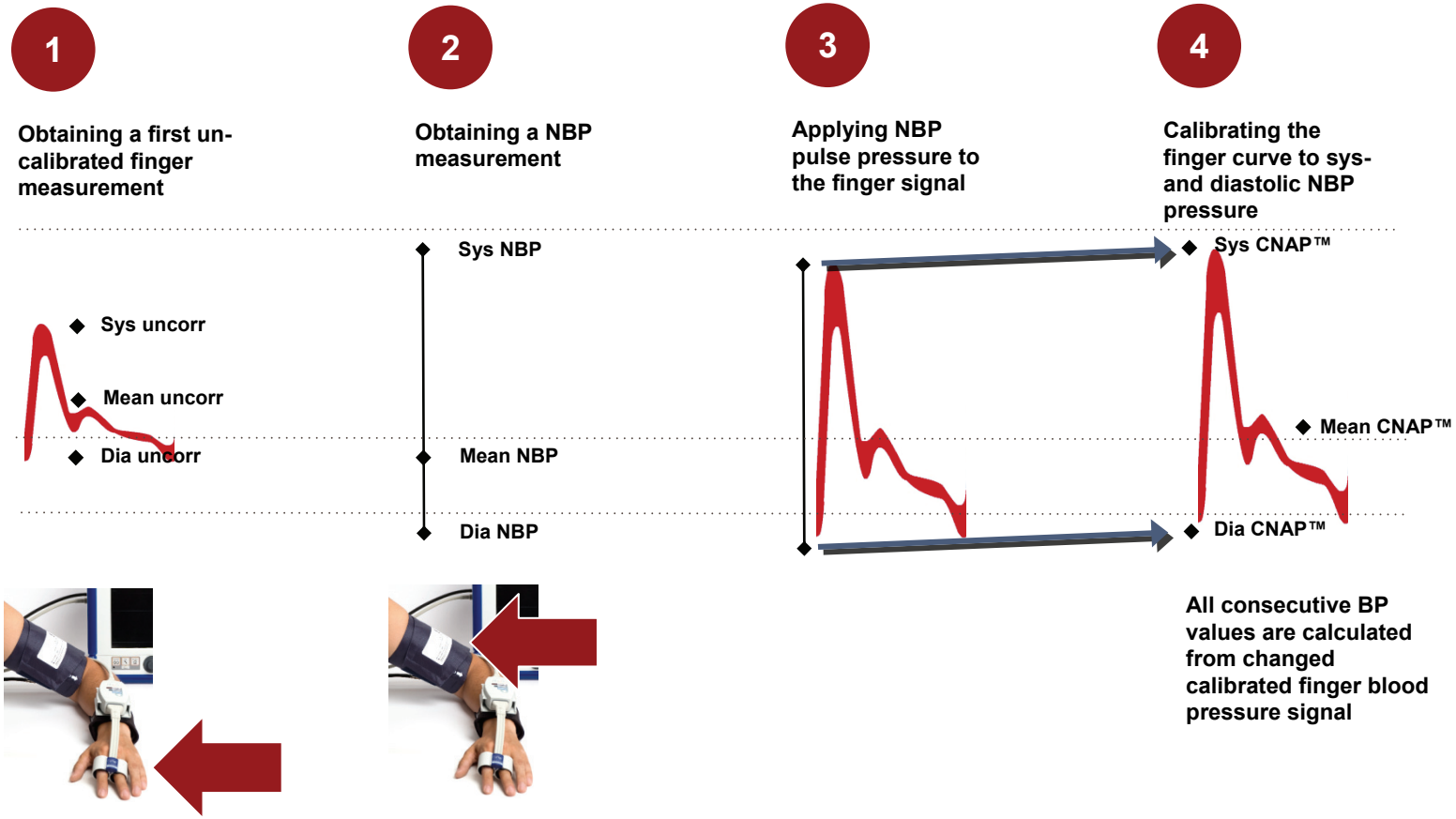
Vascular unloading principle:

1. **Infrared light** is sent through the finger to measure blood volume
2. The **integrated cuff** in the finger sensor inflates & deflates to **keep the blood volume constant** (actio = reactio)
3. Pressure from the finger cuff equals the blood pressure → BP waveform



Combination of finger sensor with NBP provides high accuracy BP signal – equivalent to invasive arterial line

CALIBRATION TO CLINICAL GOLD STANDARD



Cardiac output measure obtained from accurate blood pressure waveform using well-known pulse contour analysis

CNAP® HEMODYNAMICS

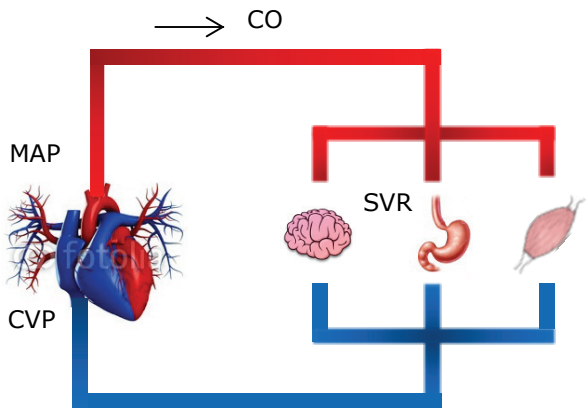
- Applying Ohm's Law to Hemodynamics

  Voltage = Current · Resistance

  ↳ MAP - CVP = CO · SVR

MAP ≈ CO • SVR

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

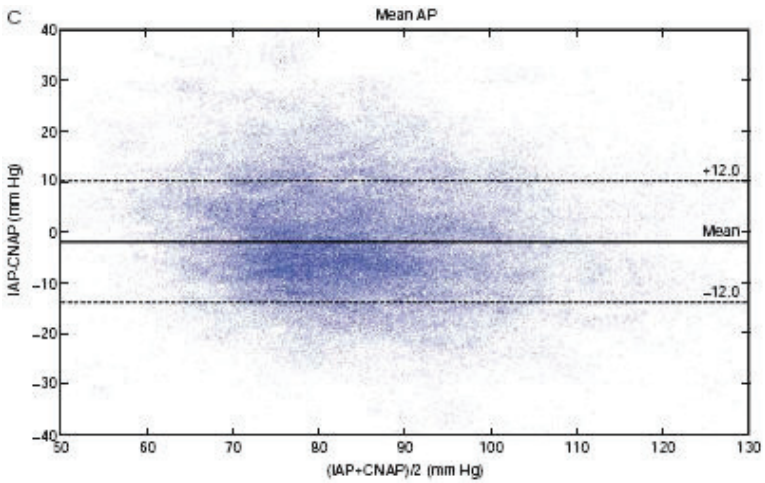


1. **Vascular unloading** provides accurate blood pressure waveform and MAP
2. **CO** is calculated from pulse contour analysis
3. **SVR** results from CO and MAP
4. Absolute values can be **indexed** to body surface area (SVI, CI, SVRI)

* CVP ≈ 7 [mmHg] and can be neglected

CNAP® arterial pressure is comparable with an invasive arterial line, even during general anesthesia

CLINICAL VALIDATION: CNAP®



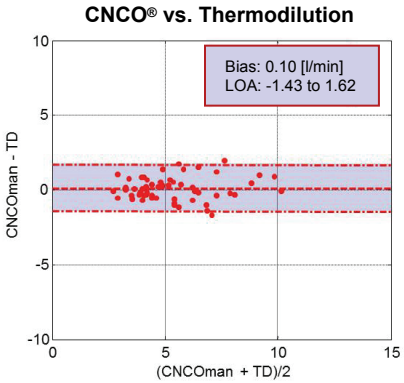
- Erlangen, Germany[3]:
  - 88 Patients (Neuro, Abdominal, Cardiac Surgery)
- Bland-Altman Plot for mean BP:
  - Bias (SD) = -1.6 (11.0) mmHg
- **Precision of CNAP®** (trending) not different from invasive BP (3,2mmHg for mean BP)
- CNAP® and IBP detected simultaneously 82.1% fast blood pressure changes

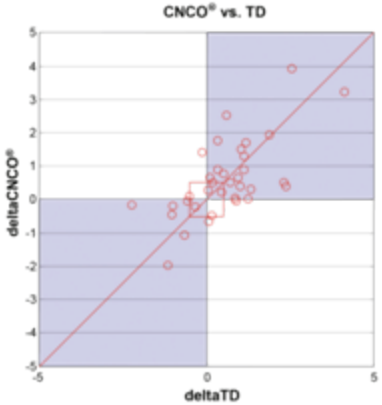
[3] Jeleazcov et al. Precision and accuracy of a new device (CNAP) for continuous non-invasive arterial blood pressure monitoring: assessment during general anesthesia. British Journal of Anesthesia 2010 vol. 105 (3) pp. 264-72

CNCO® is inter-changeable with clinical standards and tracks changes reliably

VALIDATION OF CARDIAC OUTPUT (CNCO®)

- High accuracy of non-invasive CNCO® compared to invasive clinical standards: Bland-Altman plots
  - Small bias and narrow limits of agreement
  - Percentage errors ≤ 30% (according to strict Critchley standard[4,5])
- High trending ability of non-invasive CNCO® compared to invasive clinical standards
  - Concordance rates ≥ 90% (according to standard[6])





[4] Critchley, L. A., & Critchley, J. A. (1999). A meta-analysis of studies using bias and precision statistics to compare cardiac output measurement techniques. *Journal of clinical monitoring and computing, 15(2), 85–91*

[5] Peyton PJ, Chong SW: Minimally invasive measurement of cardiac output during surgery and critical care. Anesthesiology 2010; 113:1220-35.

[6] Critchley LA, Lee A, Ho AMH: A critical review of the ability of continuous cardiac output monitors to measure trends in cardiac output. Anesth Analg 2010; 111:1180-92.

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

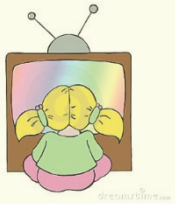
RESEARCH EXAMPLES WITH CNAP®

The Naval Aerospace Medical Research Laboratory studied the **detection of deception** by use of continuous blood pressure [7].

BIOPAC Customer

At Pitzer College, California, a study was performed to assess the **effects of mainstream media** on women's physiological and psychological functioning [8].

- Reactions to commercials of Victoria's Secret and Chrysler automobile



BIOPAC Customer

The Institute for Knowledge Discovery in Graz, Austria studied the influence of slow blood pressure oscillations on self-paced movements[9].

Contact us for a complete bibliography of CNAP® studies → info@biopac.com

[7] Taylor, M. K., Horning, D. S., Chandler, J. F., Phillips, J. B., Khosravi, J. Y., Bennett, J. E., … Gao, H. (2011). A Comparison of Approaches To Detect Deception. *Technical Report, Naval Aerospace Medical Research Laboratory*, (11).

[8] Noble, M. L. (2012). The Effect of Mainstream Media on Body Image and Stress Reactivity in Latina Females. *Pitzer Senior Theses*.

[9] Pfurtscheller, G., Ortner, R., Bauernfeind, G., Linortner, P., & Neuper, C. (2010). Does conscious intention to perform a motor act depend on slow cardiovascular rhythms? *Neuroscience Letters*, *468*(1), 46–50.