

Publications with CNSystems products in Blood Pressure Monitoring and Hemodynamic Management

Noninvasive continuous blood pressure (BP) monitoring as well as hemodynamic optimization is getting more and more important, particularly in cases, where an arterial line (AL) is not indicated or cannot be placed due to the associated complications or the minimal invasiveness of the surgical procedure. Selected papers are gathered in fields of applications.

Cardiac Surgery

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Grudev et. al	2010	Grudev, G., & Hanss, R. (2010). Continuous Blood Pressure Readings in Intensive Care Patients, Comparison of a Continuous Non-Invasive Pressure Device and Invasive Recording by means of an Arterial Line. Poster.	97 critically ill patients (ASA III or IV) admitted	CNAP® showed acceptable agreement and adequate precision compared to intra-arterial blood pressure (IAP) measurement in intensive care patients. Interchangeability criteria defined by the PE were met for mean AP.
Jagadeesh et. al	2012	Jagadeesh, a M., Singh, N. G., & Mahankali, S. (2012). A comparison of a continuous noninvasive arterial pressure (CNAP™) monitor with an invasive arterial blood pressure monitor in the cardiac surgical ICU. Annals of cardiac anaesthesia, 15(3), 180–4. doi:10.4103/0971-9784.97973	30 patients in cardiac surgery ICU	CNAP® is a reliable noninvasive, continuous blood pressure monitor that provides real-time estimates of arterial pressure comparable to those generated by an invasive arterial catheter system. CNAP® can be used as an alternative to IAP.
Schramm et. al.	2011	Schramm, C., Baat, L., & Plaschke, K. (2011). Continuous noninvasive arterial pressure: assessment in older and high-risk patients under analgesic sedation. Blood pressure monitoring, (May), 1–7. doi:10.1097/MBP.0b013e32834d777f	29 patients with aortic valve replacement	CNAP® recognizes fast changes in arterial blood pressure and sudden arrests of the circulatory system with acceptable accuracy to the arterial line (AL). Rapid pacing intervals showed a significant difference in systolic measurements; whereas the differences between CNAP® and IAP for diastolic and mean AP were minimal.

Cesarean Section

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Sia et al.	2009	Sia, a T. H., Tan, H. S., & Sng, B. L. (2012). Closed-loop double-vasopressor automated system to treat hypotension during spinal anaesthesia for caesarean section: a preliminary study. Anaesthesia, 1–8. doi:10.1111/anae.12000	55 patients	Noninvasive BP monitoring with an automated closed-loop feedback computer-controlled system with phenylephrine and ephedrine has been shown to be clinically effective in maintaining BP during caesarean section under spinal anesthesia
Illies et al.	2012	Illies, C., Kiskalt, H., Siedenhans, D., Meybohm, P., Steinfath, M., Bein, B., & Hanss, R. (2012). Detection of hypotension during Caesarean section with continuous non-invasive arterial pressure device or intermittent oscillometric arterial pressure measurement. British Journal of Anaesthesia, 3–9. doi:10.1093/bja/aes224	65 patients	The CNAP® device detected more hypotensive episodes after SPA and significantly lower AP compared with NIAP. Hypotension was detected in 91% of the patients based on CNAP® and in 55% based on NIAP. Arterial pressure (AP) monitoring based on CNAP® may improve hemodynamic management in this patient population with potential benefit for the fetus.
Hanss et al.	2009	Hanss, R., Illies, C., Missalla, H., Steinfath, M., Bein, B., & Siedenhans, D. (2009). CONTINUOUS NONINVASIVE BLOOD PRESSURE MONITORING DURING SPINAL ANESTHESIA FOR CESAREAN SECTION. Poster (p. 1).	50 patients	Comparison of NIBP with continuous BP measurement using CNAP® detecting hypotensive episodes during SPA. More hypotensive episodes detected by CNAP® (458 of 1196 measurements) in comparison to NIBP (112 of 1196 measurements).

Emergency Department/Transport

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Reifferscheid et. al	2012	Reifferscheid, F., Ilies, C., & Hanss, R. (2012). Evaluation der nicht - invasiven kontinuierlichen Blutdruckmessung mittels CNAP unter Transportbedingungen in der präklinischen Notfallmedizin. Presentation, 1–9.	11 patients	Mean arterial pressure (MAP) by CNAP® is comparable to the pre-clinical NIBP - Gold Standard. The easy setup and the complication-free continuous BP monitoring allow for an early detection of rapid BP changes under preclinical conditions.
Devriendt et. al.	2008	Devriendt, B., & Stroobants, J. (2008). Continuous non invasive blood pressure measurement can replace invasive blood pressure measurement in the major part of the patient population in an urban emergency department. Abstract.	89 patients in the emergency department	CNAP® can replace IBP in the major part of the patient population in the emergency department (ED). This technical innovation can lead towards cost reduction and the most expertised medical and paramedical personnel in the overcrowded ED are better available

Endoscopy

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Siebig et. al	2008	Siebig, S., Rockmann, F., Sabel, K., Zuber-Jerger, I., Dierkes, C., Brännler, T., & Wrede, C. E. (2009). Continuous non-invasive arterial pressure technique improves patient monitoring during interventional endoscopy. International journal of medical sciences, 6(1), 37–42. Retrieved from http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2631161&tool=pmcentrez&rendertype=abstract	40 patients	Conventional intermittent blood pressure monitoring of patients receiving sedating agents failed to detect fast changes in BP. The new CNAP® technique improved the detection of rapid BP changes, and may contribute to a better patient safety for those patients undergoing interventional procedures.

General Anesthesia

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Ilies et. al	2012	Ilies, C., Bauer, M., Berg, P., Rosenberg, J., Hedderich, J., Bein, B., Hinz, J., et al. (2012). Investigation of the agreement of a continuous non-invasive arterial pressure device in comparison with invasive radial artery measurement. British journal of anaesthesia, 108(2), 202–210. Retrieved from http://bja.oxfordjournals.org/content/108/2/202.long	85 patients	The CNAP® Monitor showed an acceptable agreement and was interchangeable with invasive pressure monitoring for mean arterial pressure (MAP) during normotensive conditions.
Sackl et. al.	2008	Sackl, E. (2008). Continuous non-invasive arterial pressure shows high accuracy in comparison to invasive intra-arterial blood pressure measurement. White paper.	15 patients undergoing orthopedic, cardiac and vascular surgery	CNAP® can follow hemodynamic variability as fast as IBP. These results indicate a high accuracy of the non-invasive CNAP® device during normotensive, hypotensive and hypertensive episodes in comparison to the invasive arterial line (AL) measurement.
Jelezcov et. al.	2010	Jelezcov, C., Krajinovic, L., Münster, T., Birkholz, T., Fried, R., Schüttler, J., & Fechner, J. (2010). Precision and accuracy of a new device (CNAPTM) for continuous non-invasive arterial pressure monitoring: assessment during general anaesthesia. British journal of anaesthesia, 105(3), 264–72. doi:10.1093/bja/aeq143	88 patients undergoing elective abdominal surgery, cardio-, or neurosurgery	CNAP® provides real-time estimates of arterial pressure comparable with those generated by an invasive intra-arterial catheter system during general anesthesia. CNAP® precision: 4.5, 3.1, and 3.2 mm Hg (systolic, diastolic, and mean AP, respectively

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Smolle et. al.	2011	Smolle, K., Schmid, M., Weger, C., Prettenthaler, H., & Scharfetter, H. (2011). Evaluation of a continuous non-invasive arterial blood pressure monitoring device (CNAP) in comparison with an invasive arterial blood pressure measurement in the ICU Methods: Results. Poster.	49 patients in the ICU	A good agreement between CNAP® and IBP in critically ill patients on the Medical Intensive Care Unit was detected. (Bias: 0.28mmHg and 23mmHg)

Hemodynamic Management

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Biais et. al	2011	Biais, M., Stecken, L., Ottolenghi, L., Rouillet, S., Quinart, A., Masson, F., & Sztark, F. (2011). The ability of pulse pressure variations obtained with CNAPTM device to predict fluid responsiveness in the operating room. Anesthesia and analgesia, 113(3), 523–8. doi:10.1213/ANE.0b013e3182240054	35 patients undergoing vascular surgery	During vascular surgery respiratory-induced variations in the pulse pressure measured noninvasively in the finger using the CNAP® system closely correlate with pulse pressure variations measured invasively with an arterial catheter. CNAP® pulse pressure variability predicts fluid responsiveness.
Monnet et. al.	2012	Monnet, X., Dres, M., Ferré, A., Le Teuff, G., Jozwiak, M., Bleibtreu, A., Le Deley, M.-C., et al. (2012). Prediction of fluid responsiveness by a continuous non-invasive assessment of arterial pressure in critically ill patients: comparison with four other dynamic indices. British journal of anaesthesia, 1–9. doi:10.1093/bja/aes182	47 critical ill patients with hemodynamic failure	Comparison of PICCO (Cardiac Index) with CNAP®. Noninvasive assessment of PPV measured by CNAP® is valuable in predicting fluid responsiveness.
Robin et. al.	2010	Robin, E., Bloud, M., Tavernier, B., Lebuffe, G., & Vallet, B. (2010). NON INVASIVE PULSE PRESSURE VARIATION AS AN INDICE OF PRELOAD RESPONSIVENESS. Poster, 94–94.	7 patients undergoing abdominal surgery	In this comparison study of CNAP® PPV with Philips PPV, the CNAP® PPV method shows more acceptable results.
Smolle et al.	2011	Smolle, K., Prettenthaler, H., & Schmid, M. (2011). Evaluation of a novel non-invasive Pulse Pressure Variation (PPV) method in critically ill patients Conclusions : Poster.	20 critical ill patients in the ICU	CNAP® PPV compared with invasive PPV: this study shows good agreement between invasive PPV and noninvasive PPV confirming CNAP® PPV being a valuable method for hemodynamic monitoring.

Pediatrics

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Kako et. al	2013	Kako, H., Corridore, M., Rice, J., & Tobias, J. D. (2013). Accuracy of the CNAPTM monitor, a noninvasive continuous blood pressure device, in providing beat-to-beat blood pressure readings in pediatric patients weighing 20-40 kilograms. Paediatric anaesthesia, 1–5. doi:10.1111/pan.12173	20 Patients (11 between 30 and 40 kg, 9 between 20 and 29,9kg)	The surgical procedures included major orthopedic surgery such as spinal fusion (n = 9), surgery for congenital heart disease (n = 7) and neurosurgical procedures (n = 4). CNAP® showed good results but did not meet the AAMI Standard (+/- 5 + 8 mmHg). CNAP® should be used in cases where an arterial line (AL) cannot be placed, in emergent situations when time is limited, in cases of unpredicted patient instability, or when patient positioning makes arterial cannulation difficult.

Urological Surgery

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Luntzer et. al.	2009	Luntzer, R., Urbanek, B., Saldjiyska, A., Berger, I., & Klimscha, W. (2009). An Evaluation of continuous non-invasive arterial pressure monitor (CNAP TM Monitor) in urological surgery Conclusion : Poster, 2–2.	9 patients undergoing urological surgeries (radical prostatectomy)	CNAP® reliably provides beat-to-beat systolic, diastolic and mean blood pressure values which compare very favorably to those obtained invasively during surgeries where hemodynamic instability is likely but without the potential risks associated with arterial cannulation.

Vascular Surgery

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Sackl et. al.	2008	Sackl, E. (2008). Continuous non-invasive arterial pressure shows high accuracy in comparison to invasive intra-arterial blood pressure measurement. White paper.	15 patients undergoing orthopedic, cardiac and vascular surgery	CNAP® can follow hemodynamic variability as fast as IBP. These results indicate a high accuracy of the noninvasive CNAP® device during normotensive, hypotensive and hypertensive episodes in comparison to the invasive arterial line measurement.
Biais et. al	2011	Biais, M., Stecken, L., Ottolenghi, L., Rouillet, S., Quinart, A., Masson, F., & Sztark, F. (2011). The ability of pulse pressure variations obtained with CNAP™ device to predict fluid responsiveness in the operating room. Anesthesia and analgesia, 113(3), 523–8. doi:10.1213/ANE.0b013e3182240054	35 patients undergoing vascular surgery	During vascular surgery, respiratory-induced variations in the pulse pressure measured noninvasively in the finger using the CNAP® system closely correlate with pulse pressure variations measured invasively with an arterial catheter. CNAP® pulse pressure variability predicts fluid responsiveness.
Biais et. al	2010	Biais, M., Vidil, L., Rouillet, S., Masson, F., Quinart, A., Revel, P., & Sztark, F. (2010). Continuous non-invasive arterial pressure measurement: evaluation of CNAP device during vascular surgery. Annales françaises d'anesthésie et de réanimation, 29(7-8), 530–5. doi:10.1016/j.annfar.2010.05.002	25 patients undergoing vascular surgery	CNAP® achieved good results for mean arterial pressure (MAP) in vascular surgery (in comparison to arterial line).

Validation Arterial Line (AL) vs. CNAP®

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Sackl et al.	2008	Sackl, E. (2008). Continuous non-invasive arterial pressure shows high accuracy in comparison to invasive intra-arterial blood pressure measurement. White paper.	15 patients ASA classifications I-III: I in 1 case, II in 12 cases, III in 2 cases	The reported results provide clear evidence of an excellent clinical feasibility and high accuracy of the noninvasive BP measurement by CNAP® in comparison to IBP. CNAP® provides patient comfort and usability similar to a standard upper arm NBP and clinical data show that its accuracy is comparable to IBP.
Ilies et al.	2012	Ilies, C., Bauer, M., Berg, P., Rosenberg, J., Hedderich, J., Bein, B., Hinz, J., et al. (2012). Investigation of the agreement of a continuous non-invasive arterial pressure device in comparison with invasive radial artery measurement. British journal of anaesthesia, 108(2), 202–210. Retrieved from http://bjaoxfordjournals.org/content/108/2/202.long	85 patients	MAP measured with CNAP® agreed with invasive arterial measurements under stable conditions with the advantages of beat-to-beat readings, a rapid indication of AP trend and a visual representation of the pulse wave. Therefore CNAP® may be a potentially valuable monitor for patients in whom there is not an absolute need for invasive pressure monitoring.

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Jeletzov et al.	2010	Jeletzov, C., Krajinovic, L., Münster, T., Birkholz, T., Fried, R., Schüttler, J., & Fechner, J. (2010). Precision and accuracy of a new device (CNAP™) for continuous non-invasive arterial pressure monitoring: assessment during general anaesthesia. <i>British journal of anaesthesia</i> , 105(3), 264–72. doi:10.1093/bja/aeq143	88 Patients	CNAP™ provides real-time estimates of arterial pressure comparable with those generated by an invasive intra-arterial catheter system during general anaesthesia. (Agreement +6.7, -5.6, and -1.6 mm Hg Sys Mean Dias)
Neuner et al.	2012	Neuner, M., Kettner, S. C., Hahn, R., & Rino, H. (2012). Clinical validation of a continuous non-invasive haemodynamic monitor (CNAP™ 500) during general anaesthesia. <i>British Journal of Anaesthesia</i> , (Table 1), 1–5. doi:10.1093/bja/aer499	100 patients	The new CNAP™ Monitor showed an agreement with the IAP that is promising, and the results are still valuable in daily clinical practice.

Validation NIBP vs. CNAP™

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Siebig et al.	2009	Siebig, S., Rockmann, F., Sabel, K., Zuber-Jerger, I., Dierkes, C., Brännler, T., & Wrede, C. E. (2009). Continuous non-invasive arterial pressure technique improves patient monitoring during interventional endoscopy. <i>International journal of medical sciences</i> , 6(1), 37–42. Retrieved from http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2631161&tool=pmcentrez&rendertype=abstract	40 patients	Conventional intermittent blood pressure monitoring of patients receiving se-dating agents failed to detect fast changes in BP. The new CNAP™ technique improved the detection of rapid BP changes, and may contribute to a better patient safety for those patients undergoing interventional procedures.
Chen et al.	2011	Chen, G., Meng, L., Rinehart, J., Alexander, B., & Cannesson, M. (2011). Hemodynamic Management with Non Invasive and Continuous Arterial Pressure Monitoring (CNAP): Comparison with Traditional Cuff Pressure Monitoring. Poster Presentation, ASA Meetin, 1.	26 patients	The CNAP™ Monitor has the ability to decrease the time of hypertension and hypotension compared to conventional intermittent BPCUFF monitoring.

Validation CNAP™ PPV

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Monnet et. al.	2012	Monnet, X., Dres, M., Ferré, A., Le Teuff, G., Jozwiak, M., Bleibtreu, A., Le Deley, M.-C., et al. (2012). Prediction of fluid responsiveness by a continuous non-invasive assessment of arterial pressure in critically ill patients: comparison with four other dynamic indices. <i>British journal of anaesthesia</i> , 1–9. doi:10.1093/bja/aes182	47 critical ill patients with hemo-dynamic failure	Comparison of PICCO (Cardiac Index) with CNAP™: Noninvasive assessment of PPV measured by CNAP™ is valuable in predicting fluid responsiveness.
Robin et al.	2010	Robin, E., Bloud, M., Tavernier, B., Lebuffe, G., & Vallet, B. (2010). NON INVASIVE PULSE PRESSURE VARIATION AS AN INDICE OF PRELOAD RESPONSIVENESS. Poster, 94–94.	7 patients	Comparison of blood pressure between CNAP™ and IBP showed very satisfactory results: The new CNAP™ PPV method shows more acceptable results in comparison to invasive PPVPhilips.

Author	Year	Citation (Title, Journal)	No. of Pts.	Results
Smolle et al.	2011	Smolle, K., Pretenthaler, H., & Schmid, M. (2011). Evaluation of a novel non-invasive Pulse Pressure Variation (PPV) method in critically ill patients Conclusions : Poster.	20 patients ICU	This study shows good agreement between PPVman and PPVauto and therefore the noninvasive CNAP® PPV method is a valuable method for hemodynamic monitoring.