Fighting Disease with Electronics

NIHON KOHDEN

esCCO Information vol. 1

A Novel Technology to Non-Invasively Measure **Continuous Cardiac Output from ECG and SpO_2**

esTimated CCO

Volumetric Information for All Care Levels

Nihon Kohden is redefining Quality of Care with new, non-invasive technologies like PWTT and esCCO by introducing volumetric information to all care levels. Since the invention of pulse oximetry by Nihon Kohden researcher Takuo Aoyagi in 1974[1], the pulse wave has become the most commonly used vital signal in clinical practice. The pulse wave can provide time related information such as intravascular pressure transmission as well as information on the volume change of arterial blood. Estimated Continuous Cardiac Output (esCCO) is a new technology to determine the cardiac output using Pulse Wave Transit Time (PWTT) which is obtained by the pulse oximetry and ECG-signals from each cycle of the ECG and peripheral pulse wave. esCCO provides real-time, continuous and non-invasive cardiac output measurement alongside the familiar vital sign parameters of ECG and SpO_2.

Principle of esCCO

The possibility to derive the cardiac output from pulse pressure information by,

$CO = SV \times HR = (K \times PP) \times HR$

[CO: cardiac output; SV: stroke volume; K: constant value; PP: pulse pressure; HR: heart rate] established in various continuous cardiac output systems using the pulse-contour-analysis, built the starting point for the novel technology esCCO. A better correlation between SV and PWTT was observed compared to that between SV and PP[2], and the formula providing cardiac output values was determined to be expressed by PWTT-Information as follows;

$CO = SV \times HR$

$= K \times (\alpha \times PWTT + \beta) \times HR = esCCO$

[α, β: experimental constants]

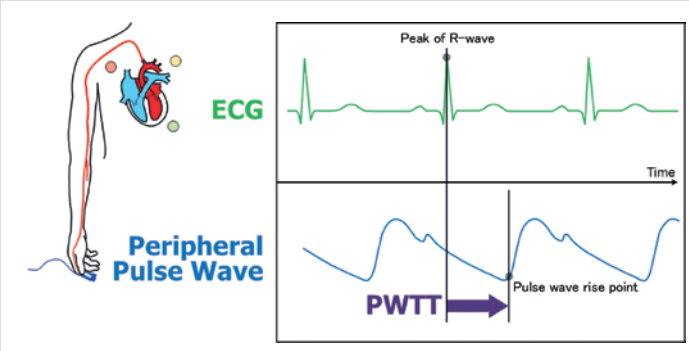

Figure 1 : Pulse Wave Transit Time derived from ECG and pulse oximetry signal

Redefining Quality of Care

Vismo

Life Scope TR

Life Scope G9

Early Decision Making in Goal Directed Fluid Management

Performance of esCCO

Ishihara et al. reported that esCCO derived from PWTT-Information is highly correlated with cardiac output determined by thermodilution technique[3].
In 2009, a multi center study at seven facilities verified the effectiveness of esCCO as a practical application (Fig 2).

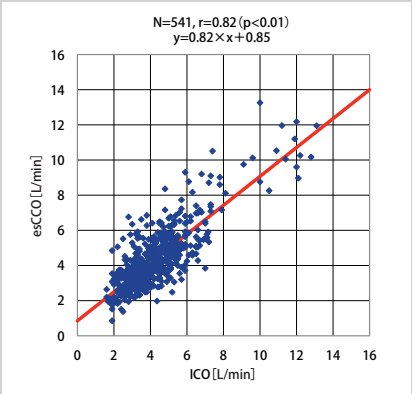

Figure 2 : Comparison between esCCO and cardiac output by cold bolus thermodilution (ICO)[4]

Reliable Measurement with Non-Invasive Calibration

The ambition in research and development though, was the provision of volumetric information, especially for mid and low care levels, to improve patient care and enhance patient safety.
With that, the challenge was to avoid any kind of invasive or minimal-invasive calibration.
By only entering patient information such as age, gender, height and weight, and an initial NIBP measurement, esCCO determines a reference value for calibration and is ready for start the measurement. Additionally, a cardiac output value obtained by other CO devices such as by pulmonary artery catheter can be used for calibration. Both calibration modes reliably track changes in cardiac output and provide advanced monitoring of a patient's hemodynamic status (Fig 3).

Enhanced Hemodynamic Monitoring at No Extra Cost

Provided over the Nihon Kohden Patient Monitoring Series, esCCO represents a care enhancing and economic solution as no additional running costs (accessories) related to the regular use of the monitor appear.

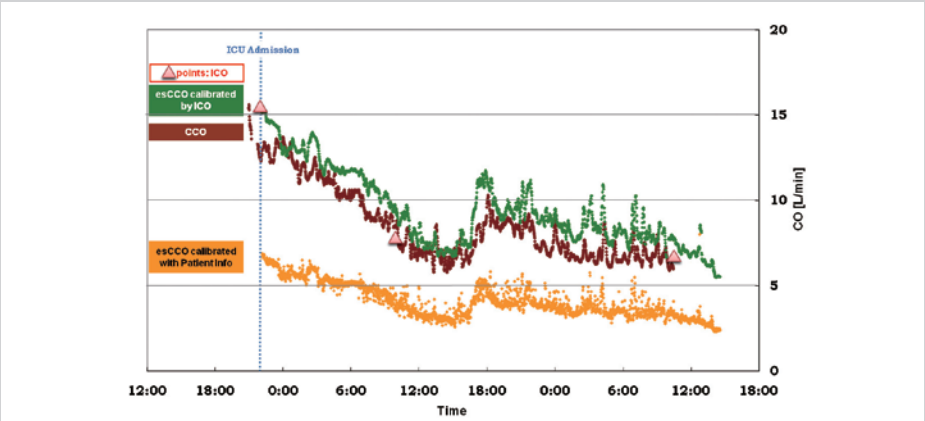

Figure 3 : Comparison of esCCO, ICO, CCO in ICU post liver transplantation. Postoperative change in cardiac output of a liver transplantation patient in intensive care unit (ICU). Cirrhosis is accompanied by various cardiovascular abnormalities which increase cardiac output (CO) and decrease arterial blood pressure and vascular resistance[5]. Therefore, perioperative monitoring of these parameters is extremely important for liver transplantation patients. Figure 3 shows trend of esCCO observed in ICU after liver transplantation. The cardiac output by cold bolus thermodilution (ICO) is given by red triangle. The esCCO, which was once calibrated by ICO on ICU admission, was in excellent agreement with ICO and CCO (brown line) measured by pulmonary artery catheter. Despite the underestimation of CO due to decreased vascular resistance, esCCO calibrated with patient information (gold line) shows an equivalent trend to CCO. These results indicate that esCCO has a promising performance for tracking change in CO after removal of pulmonary artery catheter.

References

1) Severinghaus JW, Honda Y. History of blood gas analysis. VII Pulse oximetry. J Clin Monit, 1987 Apr; 3:135-138.
2) Sugo Y, Ukawa T, Takeda S, Ishihara H, Kazama T, Takeda Z. A Novel Continuous Cardiac Output Monitor Based on Pulse Wave Transit Time. Conf Proc IEEE Eng Med Biol Soc. 2010; 2010; 2853-6
3) Ishihara et al. A new non-invasive continuous cardiac output trend solely utilizing routine cardiovascular monitors. J Clin Monit, 2004 Dec; 18, 313-320.
4) T. Yamada, Y. Sugo, J. Takeda, esCCO ResearchTeam. Verification of a non-invasive continuous cardiac output measurement method based on the pulse-contour analysis combined with pulse wave transit time. Eur J Anaesthesiol 2010; 27 (Suppl 47) : 3AP5-9
5) Ralph F. Lee. Cardiac dysfunction in cirrhosis. Best Practice & Research Clinical Gastroenterology, Vol. 21, No. 1, pp. 125e140, 2007.

8751 SP61-001A '16. 7. CLB. A.

NIHON KOHDEN
NIHON KOHDEN CORPORATION
1-31-4 Nishiochiai, Shinjuku-ku, Tokyo 161-8560, Japan
Phone +81 (3) 5996-8036 Fax +81 (3) 5996-8100
www.nihonkohden.com