esTimated CCO User's Report

Hemodynamic Management Using esCCO

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This report presents an interview with Dr. Ryoichi Ochiai, who has been involved in clinical research on esCCO for many years, about his opinion of hemodynamic management and treatment strategies using esCCO.

Introduction – what is esCCO?

Estimated Continuous Cardiac Output (esCCO) is Nihon Kohden's original technology that provides non-invasive and continuous measurements of cardiac output using only routinely monitored parameters of ECG, SpO_2, and NIBP. Stroke volume is determined based on the time from the ECG R-wave to the rise point of the SpO_2 pulse wave (PWTT*) (Figure 1), and cardiac output is calculated from a product of stroke volume and heart rate. *PWTT: Pulse Wave Transit Time

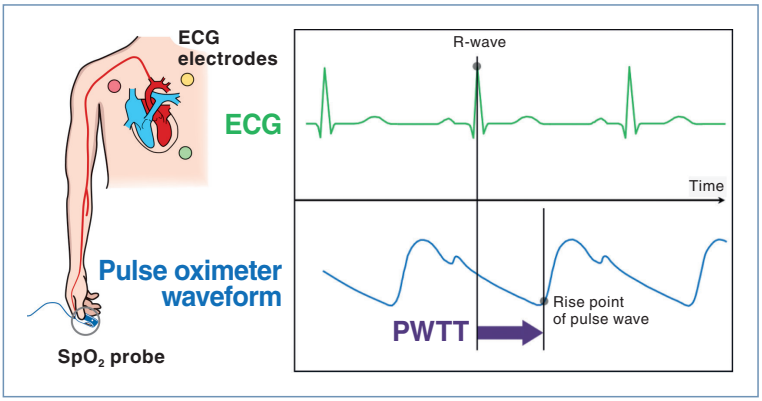

Figure 1 Pulse wave transit time (PWTT) obtained from ECG and pulse oximeter waveform

Q Please tell us about the goal of hemodynamic management during anesthesia.

Maintenance of organ blood flow is important in preventing organ ischemia. The vital organs have a mechanism called autoregulation to maintain the necessary blood flow. In healthy individuals, this autoregulation functions over a very wide range of the perfusion pressure from 50 to 150 mmHg to maintain blood flow.

In contrast, blood flow reduces outside the range of autoregulation, in other words, below the lower limit of blood pressure, to cause organs to fall into an ischemic state. In addition, blood flow increases above the upper limit to increase the risk of edema or bleeding. Therefore, the goal of hemodynamic management during anesthesia is to maintain blood pressure within the range of the autoregulation mechanism (Figure 2).

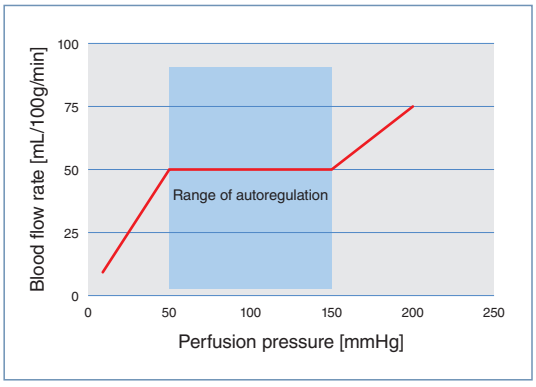

Figure 2 Autoregulation of organ perfusion

Q Blood pressure management is important. How is the cause of decreased blood pressure diagnosed?

Blood pressure is determined by a product of blood flow and vascular resistance. Thus, a decrease in either blood flow or vascular resistance leads to a decrease in blood pressure. Blood flow is represented by cardiac output, and cardiac output monitoring is very important in managing blood pressure.

A decrease in cardiac output can occur in case of either a decrease in myocardial contraction or a decrease in blood returning to the heart. In such cases, myocardial contraction is represented by stroke volume and is a useful parameter in narrowing down the range of causes of decreased blood pressure.

Q Why is monitoring of both stroke volume and cardiac output necessary?

When blood pressure decreases, preload, in other words, circulating blood volume, needs to be assessed but cannot be assessed with central venous pressure. Thus, it is important that fluid-challenge is performed to determine how stroke volume responds. Excess and deficiency of the preload are checked by assessing changes in stroke volume at the start and end of fluid-challenge using a Frank-Starling curve (Figure 3).

If hypotension does not improve even in the presence of an appropriate preload, an assessment of cardiac output allows selection of treatment approaches.

As the fluid-challenge has ruled out the factor of a deficiency in circulating blood volume, a determination of whether to contract blood vessels or increase myocardial contraction to improve hypotension can be made based on an assessment of cardiac output, a measure of hemodynamic status such as cardiac function, and afterload (Figure 4).

A combination of real-time monitoring of stroke volume, cardiac output, and blood pressure with the fluid-challenge allows an early diagnosis of the factor of unexpected decreased blood pressure and enables rapid formulation of treatment strategies.

Because an unexpected decrease in blood pressure can occur in either low-risk surgery or surgery under local anesthesia, I think that the introduction of esCCO enables constant monitoring of these parameters in all cases to create a safer surgical environment.

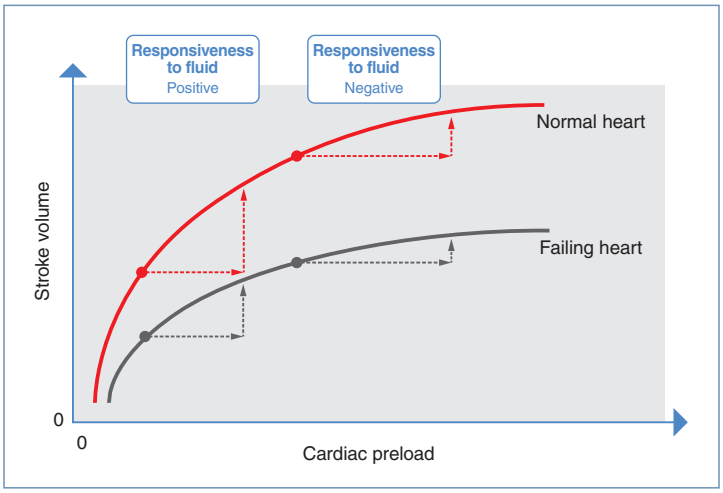

Figure 3 Frank-Starling curve

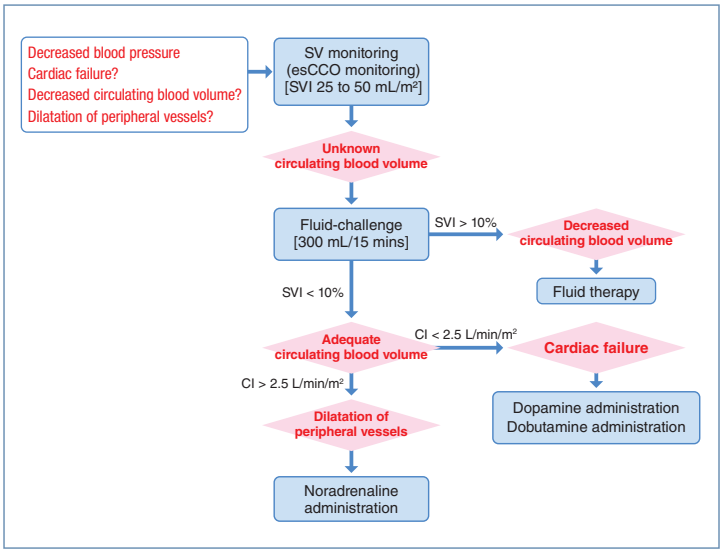

Figure 4 An example of hemodynamic management protocols

Q Various methods for measuring stroke volume are available. Please tell us about current issues.

Thermodilution using a Swan-Ganz's catheter has been widely used, but is highly invasive and very poor in responsiveness to continuous measurement, which were regarded as issues. Thus, arterial pressure waveform analysis using invasive arterial pressure waveforms has been in widespread use, but is not non-invasive because of the need to establish an arterial pressure line.

Just like thermodilution, arterial pressure waveform analysis also requires dedicated medical supplies and seems to have challenges in terms of both invasiveness and economic potential.

In contrast, esCCO, which is a PWTT analysis using ECG, SpO_2, and NIBP, provides non-invasive and continuous measurements of stroke volume (Table 1, Figure 5). The standard and non-invasive parameter providing information on stroke volume brings about advantages from a variety of aspects, including prognosis and improvement in QOL of patients, reduction in the burden on healthcare providers, and medical cost savings. In addition, I think that these advantages are very important in addressing an aging population progressing at an accelerated pace.

Table 1 Features of PWTT analysis (esCCO)

Features of PWTT analysis esCCO
☑ A technology that estimates cardiac output based on the time from the ECG R-wave to the rise point of the pulse oximeter wave (PWTT)
☑ Measured using routinely monitored parameters of ECG, SpO_2, and NIBP
☑ Provides non-invasive and continuous measurements of stroke volume

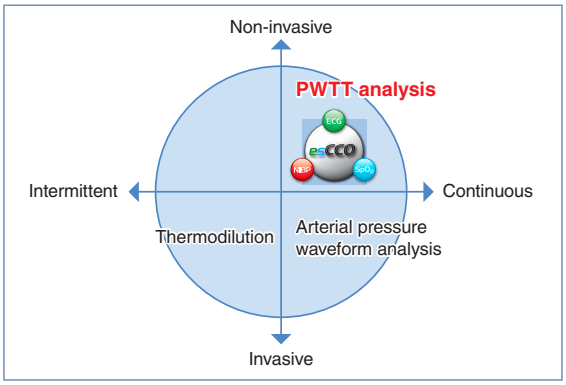

Figure 5 Position of cardiac output measurement technology

Q How does the use of esCCO change hemodynamic management in the perioperative period?

As previous measurement methods are highly invasive and require dedicated medical supplies, hemodynamic management using cardiac output has been limited to patients with a cardiovascular risk or very high-risk surgeries.

If decreased blood pressure occurs in low-risk surgeries, which do not usually involve cardiac output monitoring, the current situation is that many physicians perform fluid and hemodynamic managements dependent on their own experience or skills in consideration of effects on patients' QOL or increase in cost. However, the allowable range of fluid therapy in high risk groups, such as elderly people, is very narrow, and extreme caution is needed to prevent complications (Figure 6).

I think that the use of esCCO provides real-time monitoring of stroke volume and cardiac output based on ECG, SpO_2, and NIBP, and the parameters routinely used in usual surgeries allows more accurate and safer fluid and hemodynamic managements.

esCCO is a non-invasive monitoring tool and is therefore expected to contribute to improvement in the QOL of patients and will have beneficial effects on the prognosis. In addition, there is no need to prepare additional devices or separate equipment, which leads to a reduction in the burden on perioperative care staff and prevents increases in cost. I think that the esCCO technology, which provides an environment for constant monitoring of cardiac output and stroke volume in patients under local anesthesia, as well as patients under general anesthesia, has the potential to change anesthesia management and is of significant value in terms of both activities within the department of anesthesiology and health economics.

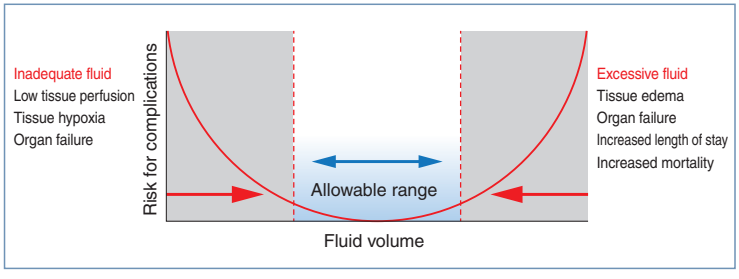

Figure 6 Relationship between fluid volume and risk for complications

Q Dr. Ochiai has put efforts into global dissemination and education on high-quality hemodynamic management, including holding seminars on hemodynamic management in Vietnam. Please let us know about hemodynamic management using esCCO.

I have provided support to developing countries for at least three years and found that there are many countries with limited healthcare resources. I think that use of esCCO provides high-quality hemodynamic management that could not be achieved previously in such countries that cannot spend so much on medical costs.

In contrast, the population is aging and decreasing in Japan. In the context of the need for medical cost savings while ensuring therapeutic efficacy, I think that a new parameter that is non-invasive and requires no additional costs, such as esCCO, may be appreciated.

Seminar in Vietnam

With participants after the seminar

Q Finally, please send a message to physicians in other institutions.

esCCO is a technology that provides non-invasive and continuous monitoring of cardiac output and can be a parameter that enables a new hemodynamic management featuring stroke volume. Please try to perform hemodynamic management with monitoring of blood pressure and stroke volume.

Thank you, Dr. Ochiai.

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