Supplementary Material

***Derivation of CO curve and surface***

Uemura et al previously derived the mathematical model of the CO curve (Uemura et al., 2004). Briefly, in the framework of ventricular arterial coupling, the ventricular property is characterized by Ees.

where Pes and Ves is end-systolic pressure and volume of ventricle, respectively. In contrast, the relationship of MAP and mean flow in the arterial system is expressed as follows.

where R is the systemic vascular resistance. Rearranging Eq. S2 yields Ea which is expressed by R divided by cardiac cycle length, T.

When we assume that MAP approximates Pes, SV is given as a function of Ved from Eqs. S1 and S3 as follows (Sunagawa et al., 1984).

On the other hand, end-diastolic pressure volume relationship is known to be exponential.

where Ped is ventricular end-diastolic pressure and k and α are constant parameters of ventricle.

Substituting Eq. S5 into Eq. S4 and rearranging yields CO as logarithmic function as shown in Eq. S6.

Ped can be expressed by mean atrial pressure as follows.

where PAT represents mean atrial pressure and β is constant parameter of the relationship between Ped and PAT. Substituting Eq. S7 into Eq. S6 gives Eq. S8.

Therefore, we can simplify Eq. S8 with two parameters, S and H, as shown in Eq. S9.

Although Uemura et al. used the three-logarithmic functions for the CO curve in their paper, we chose two-logarithmic functions for simplicity (Sakamoto et al., 2015).

***The incorporation of downstream pressure into right CO surface***

In right CO surface, the impact of downstream pressure (=PLA) is not negligible. Incorporating downstream pressure (=PLA) into Eq. S9, we can algebraically derive the following equation (Sakamoto et al., 2015).

where Ees is the right ventricular systolic property and Rp is the pulmonary vascular resistance, respectively. Thus, right CO surface can be represented as following;

where α is the coefficient of downstream pressure for right heart.

***References***

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