The number of patients with heart failure (HF) is increasing in Japan as well as in other Western countries. High rehospitalization rates are both a clinical and an economic issue, although mortality from HF has been improved in part by optimal medical therapy. In outpatient care, frequent monitoring of fluid status based on body weight and symptoms is ideal for detecting the early warning signs of impending decompensation and thus prevent the worsening of HF. Therefore, structured assessments by telephone or tele-monitoring of symptoms, body weight and physiological data are expected to improve clinical outcomes more than usual care; however, the ability to do so has been controversial.

At any rate, treatment of HF is focused on preventing fluid retention, and the symptoms of congestive HF are related to pulmonary congestion accompanied by increased pulmonary...

**New Index Obtained From Intrathoracic Impedance Measurements**

– Could MOMOTARO Find the Key to Heart Failure Management in the Modern Treasure Chest? –

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**Figure.** Progression of heart failure. The wavy black dashed line indicates a typical course in a patient with usual care. The green wavy line indicates an ideal course in a patient with a CRT and/or ICD equipped with intrathoracic impedance measurement functions. The frequency of the waves corresponds to the frequent optimal opportunities for the management of fluid retention. The blue wavy line indicates the future direction (ie, an ideal course with implantable devices for heart failure therapy). CRT, cardiac resynchronization therapy; ICD, implantable cardiac defibrillator; QOL, quality of life. (Adapted with permission from Gheorghiade M, et al.)

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capillary wedge pressure (PCWP). However, adjustments to pharmacological therapy based on PCWP are not practical in the outpatient setting. Accordingly, a system that is available for daily assessment of fluid retention in ambulatory patients is desirable for the management of HF.

Current cardiovascular implantable electronic devices, including implantable cardiac defibrillators and cardiac resynchronization therapy, incorporate the capability of multifunction remote monitoring, which has become standard care for arrhythmias. The measurement of intrathoracic impedance (ITI) is one of the functions that can be evaluated by applying a subthreshold electrical impulse between a pacemaker lead tip and the device. Because gradual and progressive changes in ITI may be caused by pulmonary congestion, ITI has been introduced as a monitoring system for HF. The OptiVol® algorithm currently employed in the Medtronic devices is one system of ITI measurement. ITI correlates inversely and moderately with PCWP and fluid balance and decreases before the onset of patient symptoms and before hospital admission for fluid overload. Pulmonary congestion is difficult to recognize in its early stages because of the late appearance of symptoms before hospitalization; therefore, such advanced technology should provide better clinical outcomes. However, it has not yet been shown to affect patient outcomes and is not sufficiently accurate to dictate therapy. The OptiVol® algorithm compares temporal changes in ITI with the reference impedance, which is derived from a moving average algorithm, to assess fluid status. When the daily impedance consistently falls below the reference, the differences are added to generate the OptiVol® fluid index. When the fluid index exceeds a preprogrammed threshold, an audible rate to dictate therapy.

The OptiVol® algorithm compares temporal changes in ITI with the reference impedance, which is derived from a moving average algorithm, to assess fluid status. When the daily impedance consistently falls below the reference, the differences are added to generate the OptiVol® fluid index. When the fluid index exceeds a preprogrammed threshold, an audible alert is triggered. In the current system, a threshold of 60Ω is the default value; however, the optimal threshold is controversial, and 120Ω might be more accurate for predicting worsening CHF. Thus, there are some concerns about the current OptiVol® algorithm, which would promote confusion and does not allow it to be a feasible monitoring device in the clinical setting.

The MOMOTARO study, bearing the name of the famous character in Okayama, was challenged with finding a new index derived from the OptiVol® fluid index. Although the reference impedance is moving over time in the default setting, the study’s new index, the “ITI ratio”, is the ratio of the ITI value given at OptiVol® alert to that measured at a fixed baseline. The study authors demonstrated that an ITI ratio <0.96 at an alert event reliably indicated a condition associated with an increase of the B-type natriuretic peptide (BNP) level as compared with the OptiVol® alert, with a threshold of 60Ω. Regarding the ITI ratio, the baseline data has an important role in the detection of a true event related to worsening of HF. The baseline condition is defined as the stable condition for a patient with HF. Because the stable condition is altered during the progression of HF, further studies are needed to reveal how the baseline point could be determined. In addition, the really important challenge is to reveal whether the ITI ratio has the true potential to improve patient outcomes, because the association between the ITI ratio and BNP level is just one aspect of worsening HF (Figure). In patients with cardiovascular implantable electronic devices, arrhythmic events and reduced CRT pacing rate would be risk factors for worsening of HF. As with previous studies, a risk score that combines the ITI ratio with the heart rate, arrhythmic events, and reduced CRT pacing rate may be more reliable in detecting worsening HF and improving clinical outcomes.

Cardiovascular implantable devices have been developed as specialized devices for HF monitoring. The right and left atrial pressures, pulmonary artery pressure, and cardiac output can be measured by these cardiovascular implantable devices, and the temporal changes are available for use in HF management. The implanted devices seem to be an ideal tool for advanced management of HF because we would be optimizing medical therapy based on fluid retention. However, we do not know whether such remote telemonitoring provides the best direction in managing outpatients with HF because there is no evidence of the superiority of telemonitoring in HF management. In addition, because of the invasive nature of device implantation, the balance between the benefits and the risk associated with device implantation must be considered in each case.

We are just about to open a treasure chest that contains a Swan-Ganz catheter in the form of an implantable device. The MOMOTARO study could be the key that opens that chest.

References