Case Studies in Advanced Monitoring: OptiVol®

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Two cases of congestive heart failure with decompensation are presented. The OptiVol® fluid index (Medtronic, Inc., Minneapolis, MN) provides an objective gauge of fluid status that can be difficult to obtain with routine clinical history or even with physical examination. The Cardiac Compass® Report (Medtronic, Inc.) can identify a patient's ability to achieve euvolemia and the need for pharmacologic and nonpharmacologic interventions. Future studies will help define diagnostic and management algorithms using the OptiVol index, as well as in combination with other parameters in the Cardiac Compass Report, to facilitate proactive monitoring of patients with congestive heart failure.
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Case 1

Ms. M. L. H. is a 67-year-old woman with a long history of dilated cardiomyopathy and mitral regurgitation, who has been well compensated until February 2005 when atrial fibrillation developed, and her heart failure symptoms deteriorated despite placement of a biventricular pacemaker and defibrillator. Further attempts to place epicardial leads for biventricular leads and atrioventricular nodal ablation for rate control in April 2005 did not improve her clinical status. She continued to experience monthly admissions for congestive heart failure exacerbations that prompted referral for cardiac transplantation

evaluation. She had no other significant comorbid conditions other than obesity and some prior orthopedic and gynecologic surgeries.

At the initial evaluation, she was taking captopril 25 mg daily, metoprolol succinate 25 mg daily, furosemide 80 mg daily, potassium 20 mEq daily, amiodarone 200 mg daily, digoxin 0.125 mg daily, magnesium oxide 140 mg daily, aspirin 81 mg daily, and warfarin 2.5 mg daily. She had no known drug allergies. On examination, she had mild respiratory distress. Her blood pressure was 98/65 mm Hg, her pulse rate 88 beats per minute, her weight was 207 pounds, and her body mass index was 35. She had some signs of congestion, with jugular venous distention (at 10 cm H_2O), prominent S_3, with a 2/6 systolic murmur at apex. She had decreased pedal pulses, cool extremities, but no significant edema. She appeared sluggish due to dyspnea, but, nonfocal neurologic signs. On laboratory evaluation, her serum sodium was 131 mmol/L, her plasma B-type natriuretic peptide (BNP) level was 952 pg/mL, and she had preserved renal function. Her electrocardiogram showed ventricular paced rhythm. Her echocardiogram showed a left ventricular ejection fraction of 15%, and left ventricular end-diastolic dimension of 6.8 cm, biatrial enlargement, and 3+ mitral regurgitation.

She was classified as American College of Cardiology (ACC) stage C-D, with New York Heart Association (NYHA) functional class III, and appeared "cold" and "wet." Therefore, she was admitted for hemodynamically tailored therapy, requiring dobutamine and intravenous furosemide infusion. She was discharged on home dobutamine infusion after it was deemed she was not a transplant candidate. However, she was soon re-admitted for recurrent congestion in July 2005, and after stabilization underwent coronary sinus lead revision with implantation of InSync Sentry® Cardiac Resynchronization Therapy (CRT-D) (Medtronic, Inc., Minneapolis, MN). She was discharged home in stable condition on furosemide 40 mg daily, metoprolol succinate 50 mg daily, and home milrinone infusion.

During the next few months, she continued to have poor functional capacity and persistent dyspnea. She was seen in clinic in late September 2005, where her blood pressure was 88/50 mm Hg, her pulse rate was 76, and her weight was 209 pounds. Examination revealed persistent jugular venous distention (at 9 cm H_2O), prominent S_3, 2/6 systolic murmur, and scanty rales at right base with 1+ pedal edema and warm extremities. Laboratory evaluation revealed serum sodium of 135 mmol/L, serum blood urea nitrogen (BUN) of 22 mg/dL, serum creatinine of 0.9 mg/dL, and plasma BNP level of 1968 pg/mL. Her Cardiac Compass® Report (Medtronic, Inc.) is shown in Figure 1 (Arrow "A"), showing rise in OptiVol® (Medtronic, Inc.) fluid index consistent with an increase in intrathoracic fluid content.

Based on her clinical examination and her OptiVol fluid index, her furosemide was increased to 40 mg twice daily, and spironolactone 25 mg daily was added with close monitoring of congestive symptoms. At follow-up visit 1 week later, she reported good diuresis and 8-pound weight loss, without the need for hospitalization. Her symptoms and activity level improved (Figure 1, Arrow "B"), along with normalization of the plasma BNP and serum sodium levels.

In February 2006, she noticed 3-pound weight gain, but no significant changes in signs and symptoms of congestion. Her laboratory evaluation revealed the following: serum sodium 141 mmol/L, serum creatinine 0.9 mg/dL, plasma BNP 794 pg/mL. Her Cardiac Compass Report at that time is shown in Figure 1 (Arrow "C"), showing rise in OptiVol fluid index. She was therefore instructed to increase her furosemide dose to 40 mg twice daily for 4 days and then to resume 40 mg once daily. With this regimen, she had prompt resolution of OptiVol fluid index, and repeat plasma BNP level was 336 pg/mL. She also started slow weaning of milrinone infusion.

A few weeks later, in March 2006, there was a call from the visiting nurse regarding the patient's recent 8-pound weight gain. The nurse was concerned, and asked if she should resume her previous milrinone dose. Over the phone, she reported no significant changes in signs and symptoms of congestion, and her Cardiac Compass Report via CareLink® (Medtronic, Inc.) was shown in Figure 1 (Arrow "D"). Further inquiry revealed that she had increased nighttime snacking, which may have explained her weight gain.

Case 2

Ms. J. F. is a 53-year-old woman with insulin-dependent diabetes mellitus first seen at our heart failure clinic in 2001 for evaluation of her nonischemic cardiomyopathy. Her left ventricular ejection fraction at that time was 27%, with 2+ mitral regurgitation, and mild pulmonary hypertension. Heart failure drugs including angiotensin-converting enzyme inhibitors and beta-adrenergic blockers were uptitrated to maximal doses, and she did relatively well for about 2 years until worsening heart failure symptoms developed. She was admitted in April 2003 for volume overload, treated with intravenous diuretics and improved, but was readmitted again

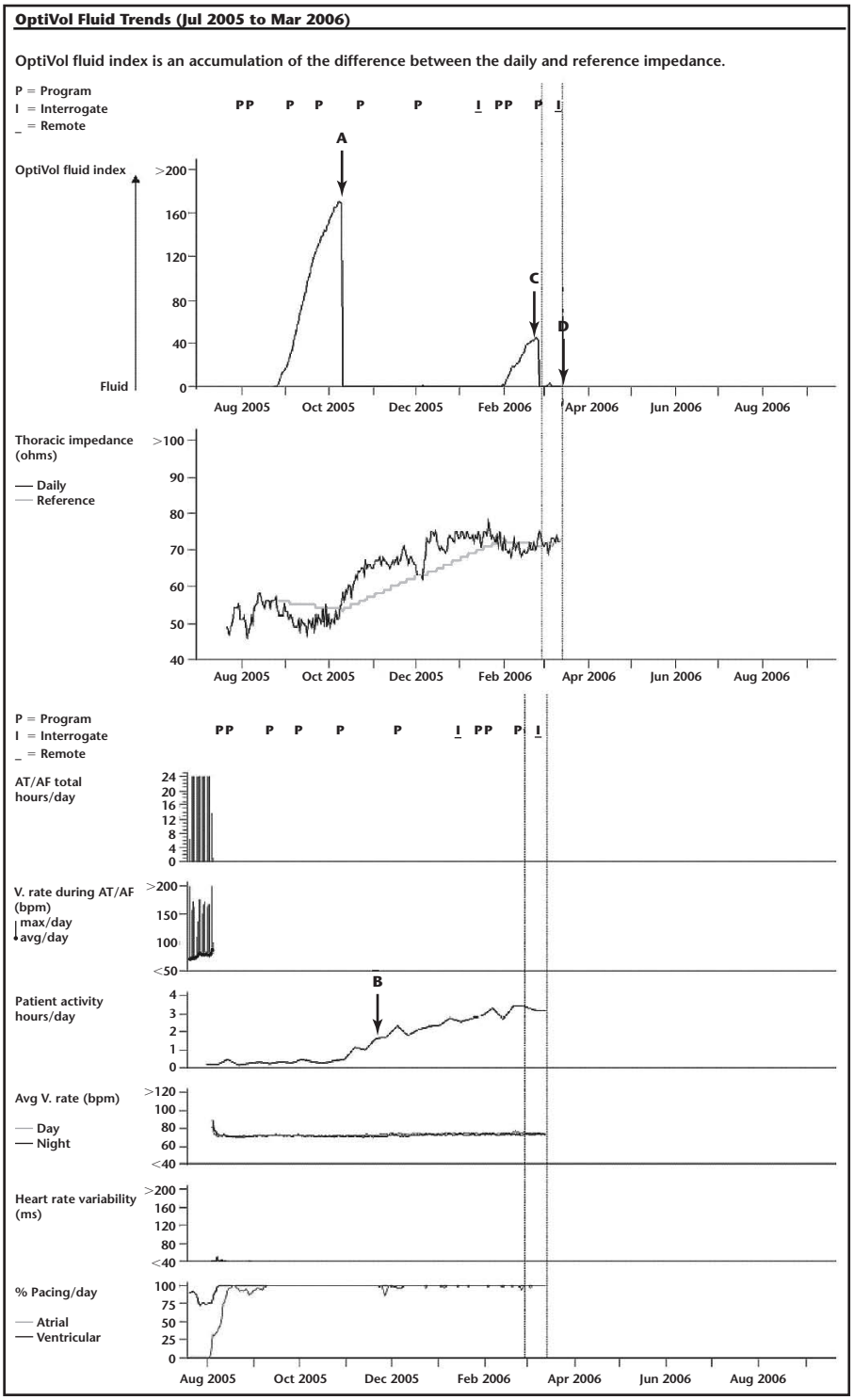

Figure 1. *Case 1: Cardiac Compass Report for Ms. M. L. H.*

for a brief period in early July 2003 for worsening heart failure symptoms. Her symptoms were primarily dyspnea with exertion, paroxysmal nocturnal dyspnea, and orthopnea. She underwent biventricular pacing in August 2003, and maintained NYHA class II-III symptoms. An upgrade to an InSync Sentry CRT-D biventricular pacemaker occurred in March 2005, but she felt worse since her device change.

She came for a clinic visit in September 2005. At that time, she reported having leg and pedal edema and intermittent lower extremity pain. She had 2-pillow orthopnea, but no paroxysmal nocturnal dyspnea. She continued to experience chest discomfort every couple of days, and she was having increasing palpitations since her device change especially when lying down. On physical examination, her blood pressure was 130/70 mm Hg, her pulse rate was regular at 68 beats per minute, and her weight was 255 pounds, which was unchanged (her body mass index was 41.2). Her physical examination was significant for a 1/6 holosystolic murmur at the left sternal border with no gallops or jugular venous distention, and no noticeable organomegaly or pedal edema. Her extremities were warm. Her Cardiac Compass Report is shown in Figure 2 (Arrow "A") and was at the reference range. She was asked to follow-up in 4 months' time, maintaining her furosemide dose at 40 mg twice daily.

She returned for a clinic visit in December 2005, and reported that in November she noticed pedal edema and developed shortness of breath with walking from room to room in her home. The paroxysmal nocturnal dyspnea she normally experiences became worse, and her orthopnea increased from her usual 2-pillow to 3-pillow. She began using an extra

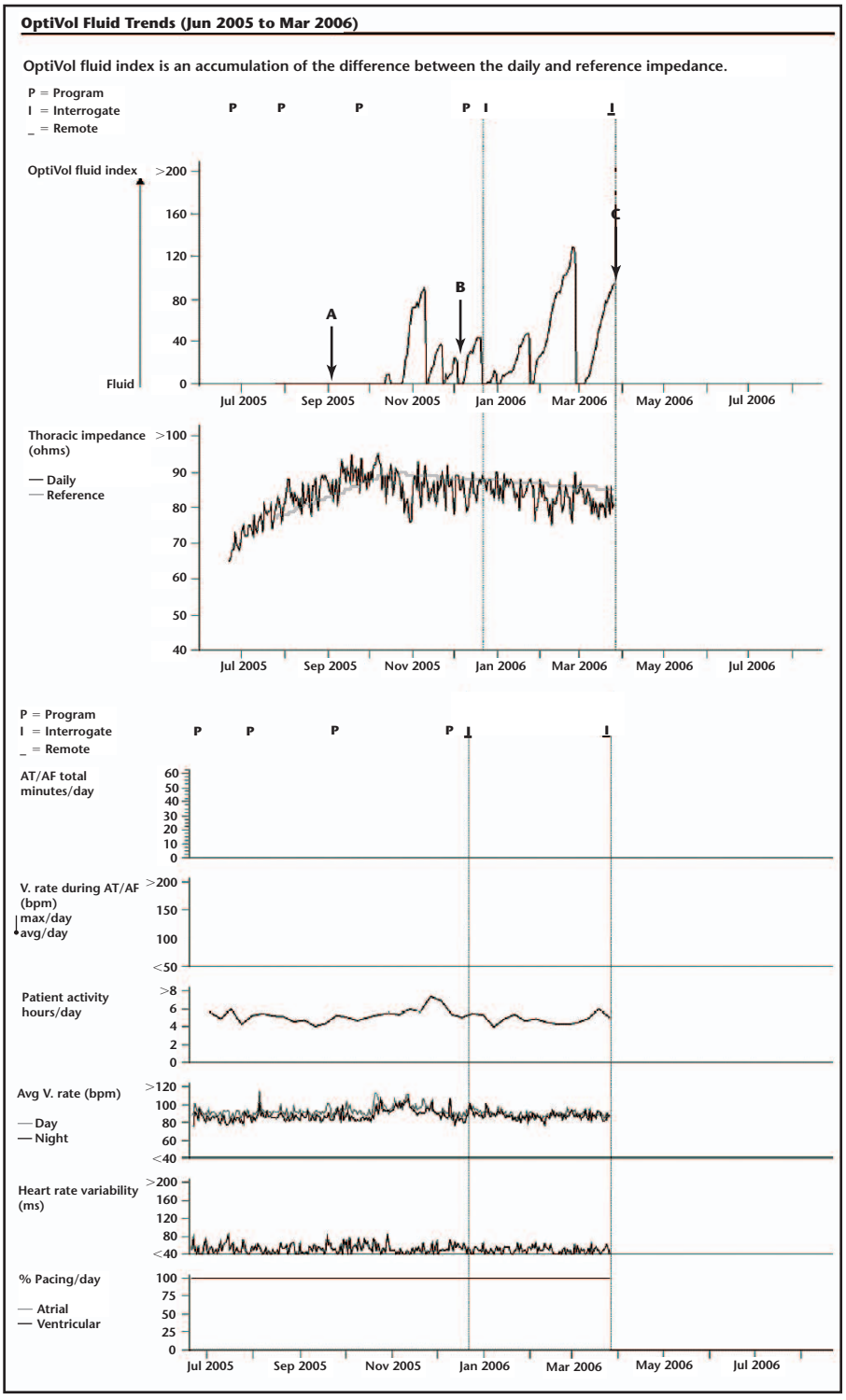

Figure 2. *Case 2: Cardiac Compass Report for Ms. J. F.*

furosemide dose for a few days and noted her symptoms subsided. On examination, her weight was 251 pounds, with overall unchanged physical examination except for signs of mild volume overload. Her Cardiac Compass Report, with an elevated OptiVol fluid index, is shown in Figure 2 (Arrow "B"). She was asked to increase her furosemide to 60 mg in morning and 40 mg in evening.

At her follow-up clinic visit in March 2006, she said she was feeling "fine" and her physical examination was overall unchanged except for a weight gain of 15 pounds to 266 pounds. Her Cardiac Compass Report is illustrated in Figure 2 (Arrow "C" shows interval increases in the OptiVol fluid index). Upon further interrogation, she reported that she was only able to ambulate 1/2 mile and climb 12 to 13 steps before developing dyspnea. She slept on 3 pillows, and still had occasional palpitations, lightheadedness, dizziness, and ankle edema, even though it was not present at the time of the clinic visit. The last "episode" occurred a few weeks before when she took an extra furosemide dose for a few days. Overall, she appeared to have NYHA functional class III symptoms with recurrent episodes of fluid retention. She was therefore instructed to increase her furosemide dose, added spironolactone at 25 mg daily, and was referred to nutritional counseling.

Key Points

The 2 cases illustrated the ability for OptiVol to track clinical status, particularly as it related to fluid status in patients with InSync Sentry CRT-D. The frequency and degree of fluctuations in the OptiVol fluid index provide a window of opportunity to identify an objective gauge of fluid status that can be difficult to obtain with routine clinical history or even

with physical examination. Both cases illustrated several key features with OptiVol fluid indices: (1) the ability of OptiVol fluid indices to track (and indicate) clinically detectable fluid status; (2) the potential for the Cardiac Compass Report to identify the patient's ability to achieve euvolemia over time, and the need for pharmacologic and nonpharmacologic interventions; and (3) the reassurance of a benign OptiVol fluid index in the setting of an ambiguous clinical presentation to allow the caregiver to follow the patient closely without necessitating excessive testing or unnecessary interventions. Whereas these findings are observational, the values of OptiVol fluid index, the reliability over time, and the inter- and intra-individual variability still need further investigation. Future studies will help to better define diagnostic and management algorithms using OptiVol index, as well as in combination with other parameters in the Cardiac Compass Report, to facilitate proactive monitoring of patients with heart failure. ■

Main Points

- These 2 case studies show the ability of OptiVol to track clinical status, particularly in patients undergoing cardiac resynchronization therapy. The frequency and degree of fluctuations in the OptiVol fluid index provide a window of opportunity to identify an objective gauge of fluid status that can be difficult to obtain with routine clinical history or even physical examination.
- Future studies will help define diagnostic and management algorithms using the OptiVol fluid index, as well as in combination with other parameters in the Cardiac Compass Report, to facilitate proactive monitoring of patients with congestive heart failure.