CASE REPORT

INTERMEDIATE

CLINICAL CASE

Correlation Between CardioMEMS and HeartLogic in Predicting Heart Failure Events

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ABSTRACT

A 59-year-old male was admitted with acute on chronic decompensated heart failure. Review of his CardioMEMS (Abbott Laboratories, Atlanta, Georgia) device and HeartLogic (Boston Scientific, Marlborough, Massachusetts) index were helpful in guiding management of his volume status. This paper highlights the correlation between 2 monitoring systems which could be used to predict heart failure events. (**Level of Difficulty: Intermediate.**)
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PRESENTATION

A 59-year-old male known to have a history of chronic heart failure (HF) presented to a satellite hospital on October 22, 2019, after 2 weeks of worsening dyspnea on exertion; orthopnea; fatigue; and a weight gain of 10 lbs. He had contacted the HF clinic, and his torsemide dose was doubled but without much improvement in his urine output or symptoms. Upon presentation, the patient's heart rate was 81 beats/min, blood pressure was 131/98 mm Hg, and respiratory rate was 20 breaths/min. Physical examination revealed normal S1 and S2 sounds, along with an S3 sound, decreased breath sounds at the bases, jugular venous distension, and bilateral pitting lower extremities edema.

MEDICAL HISTORY

The patient had a medical history of nonischemic dilated cardiomyopathy; reduced ejection fraction of 30%; status post-CardioMEMS (Abbott Laboratories, Atlanta, Georgia) implantation on June 6, 2017 and implantation of a cardioverter-defibrillator on July 23, 2018; paroxysmal atrial fibrillation; ventricular tachycardia; hypertension; diabetes mellitus type 2; hyperlipidemia; and chronic kidney disease stage 3.

DIFFERENTIAL DIAGNOSIS

Patient's presentation was consistent with decompensated HF with volume overload. Pneumonia was not clinically suspected as the patient had no fever or productive cough.

LEARNING OBJECTIVES

- To understand the significance of both CardioMEMS and HeartLogic parameters and their usefulness in managing volume status.
- To recognize the correlation between CardioMEMS and HeartLogic parameters in predicting a heart failure event.
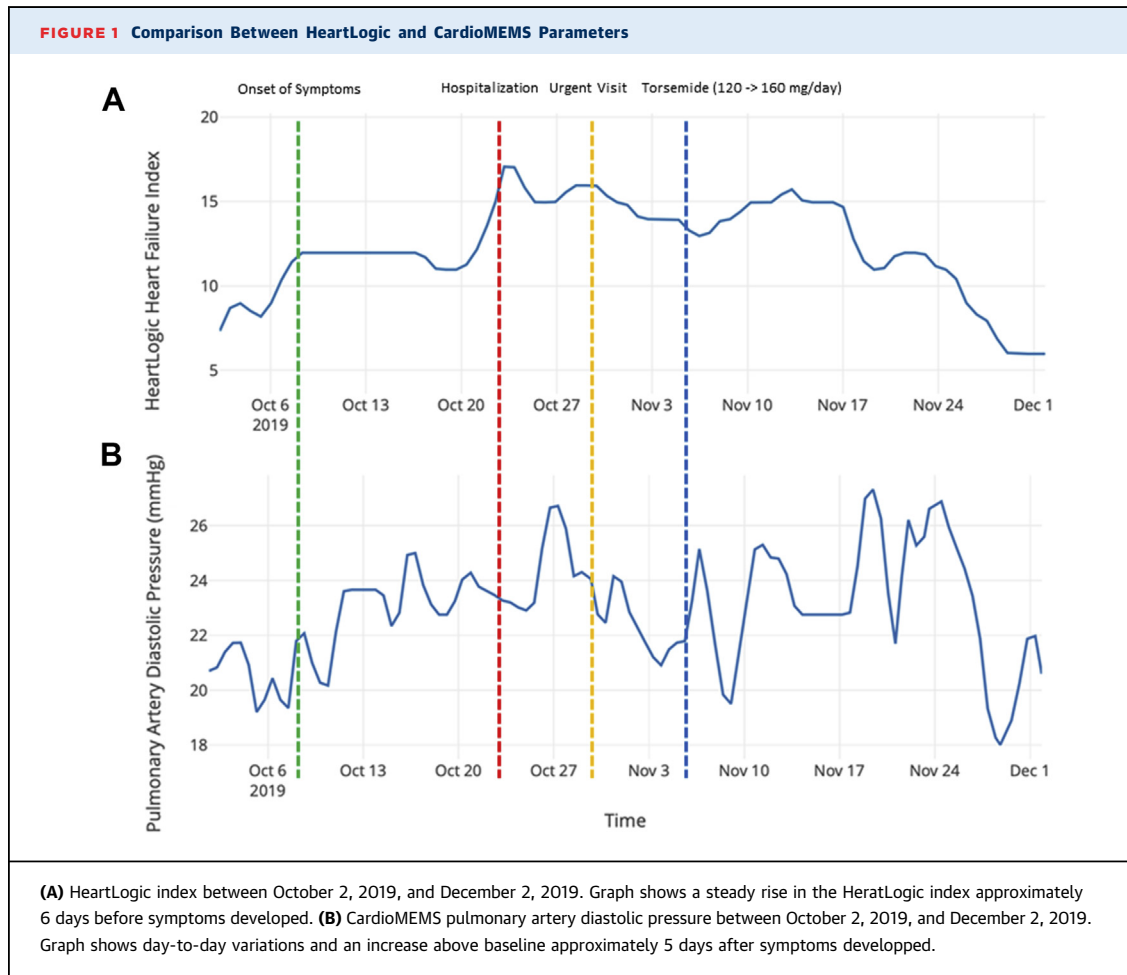
INVESTIGATIONS

The patient's N-terminal pro-brain natriuretic peptide level was elevated at 1,635. Chest radiographs revealed bilateral pulmonary edema and small bilateral pleural effusions. Review of his CardioMEMS index revealed elevated pulmonary artery diastolic pressure (PADP) of 25 mm Hg (**Figure 1B**); his target PADP was 15 to 20 mm Hg. Interrogation of his implantable cardioverter-defibrillator revealed no episodes of arrhythmia. His HeartLogic (Boston Scientific, Marlborough, Massachusetts) index was found to be elevated at 17 (**Figure 1A**). An S3 sound was detected. Thoracic impedance was 42.4 Ω, which was decreased compared to his baseline value. Respiratory rate was 22 breaths/min. Both his nocturnal heart rate and mean heart rate were 88 beats/min. Activity level was 0.5 h/day (**Figures 2 and 3**). In fact, the HeartLogic index was found to be steadily inclining since October 2, 2019, when it was just 7 (21 days preceding his admission), until it reached its peak at 17 one day after admission (**Figure 2**).
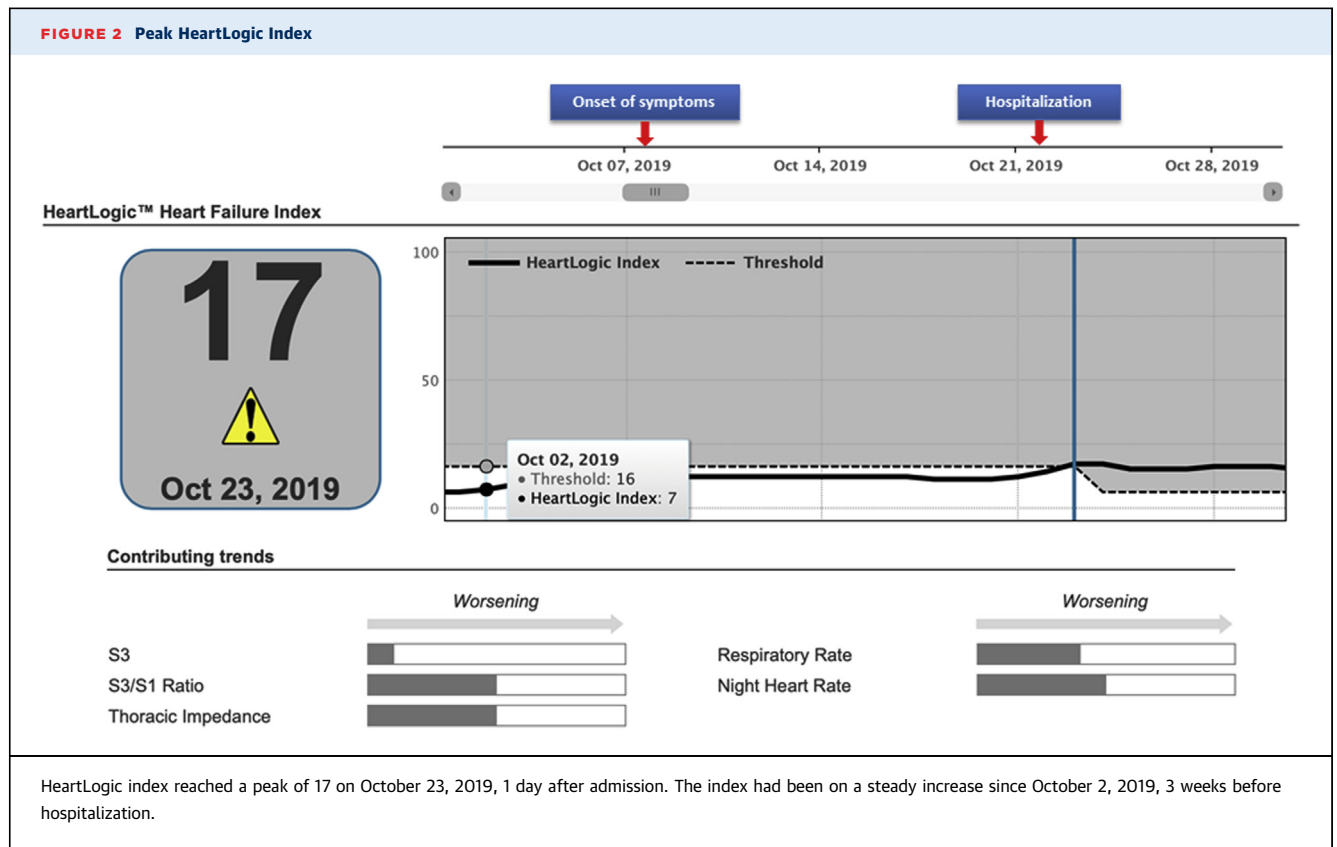
MANAGEMENT

The patient was admitted and started on intravenous (IV) furosemide, 80 mg twice daily. During his hospitalization, the patient had a net negative output of 3 liters, and his symptoms improved after 2 days of diuresis, so he was discharged home in stable condition. He presented for an urgent office visit on October 29, 2019 (5 days after discharge), as he felt his HF symptoms had worsened again. He was found to be in decompensated HF. His CardioMEMS PADP remained elevated above 25 mm Hg (**Figure 1B**). His HeartLogic index remained elevated at 16 with decreased thoracic impedance and increased nighttime heart rate (**Figure 3**). He was treated with a single IV dose of furosemide, 100 mg, in the office and a dose of metolazone, 2.5 mg. His PADP improved to 22 mm Hg, and his HeartLogic index improved to 15 on October 30, 2019 (**Figure 4**). By his next office visit 1 week later on November 5, 2019, the patient felt symptomatically better with the weight loss of 8 lbs and resolution of

FIGURE 1 Comparison Between HeartLogic and CardioMEMS Parameters

(A) HeartLogic index between October 2, 2019, and December 2, 2019. Graph shows a steady rise in the HeratLogic index approximately 6 days before symptoms developed. **(B)** CardioMEMS pulmonary artery diastolic pressure between October 2, 2019, and December 2, 2019. Graph shows day-to-day variations and an increase above baseline approximately 5 days after symptoms developped.

FIGURE 2 Peak HeartLogic Index

HeartLogic index reached a peak of 17 on October 23, 2019, 1 day after admission. The index had been on a steady increase since October 2, 2019, 3 weeks before hospitalization.

his abdominal bloating, chest pain, orthopnea, and PND. His CardioMEMS PADP was elevated at 22 mm Hg, and his HeartLogic index had stabilized at approximately 13 to 14 (**Figures 1 and 4**). The patient was advised to increase his torsemide dosage from 60 mg twice daily to 80 mg twice daily as his weight remained slightly above his dry weight. His thoracic impedance began to increase, and his nighttime heart rate began to decrease on November 11, 2019 (**Figure 3**). His HeartLogic index improved from 12 on November 18, 2019, to 7 on November 28, 2019, when he came out of his alert state (**Figure 1A**) and his CardioMEMS PADP decreased to 18 mm Hg (**Figure 1B**).

DISCUSSION

HF is a significant and growing public health concern that affects 1% to 2% of the population in developed countries and is associated with high morbidity, mortality, and cost (1,2). In the United States alone, there are more than 1 million hospitalizations for HF, with more than $20 billion attributed to inpatient costs (3).

Multiple monitoring algorithms and devices have been established for the prediction of HF

decompensation, including the CardioMEMS device and HeartLogic system. However, to date, evidence comparing the performance of these 2 systems is lacking.

This paper presents a patient with challenging HF management in the setting of chronic kidney disease. A correlation was found, however, between his elevated PADP by using CardioMEMS and an elevated HeartLogic indexes. The threshold for the HeartLogic index remains controversial because this newer technique has not been validated in medical literature. The MultiSENSE study evaluated a multisensory-based algorithm based on multiple variables in patients with implanted cardiac resynchronization therapy defibrillators and concluded that a HeartLogic index above a threshold of 16 is able to predict HF events (4).

Based on the present case, a steady rise in the HeartLogic index was observed 3 weeks prior to admission and was actually above the threshold during the hospitalization itself. Thoracic impedance was one of the most useful parameters because it had been on a steady decline (**Figure 3**). It was noticed that the steady increase in the HeartLogic index occurred approximately 6 days before the onset of symptoms. On the other hand, CardioMEMS PADP was noted to

FIGURE 3 Description of the HeartLogic index Parameters
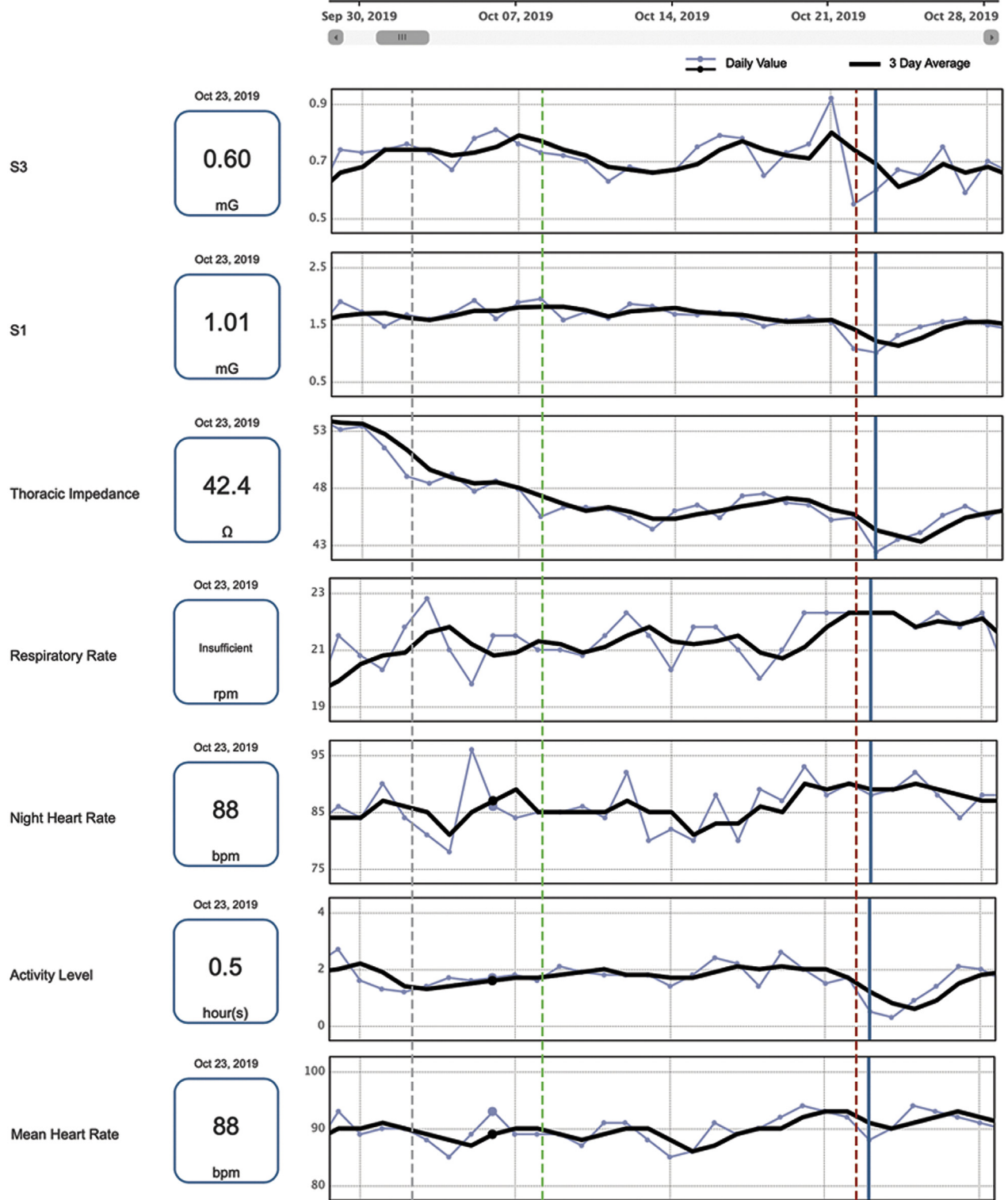
From October 2, 2019 **(gray dashed line)** to October 23, 2019 **(blue line)**, there was a steady decrease in thoracic impedance and an increase in both heart rate and respiratory rate. **Green dashed line** indicates onset of symptoms; **red dashed line** indicates hospitalizations.

FIGURE 4   Summary of Patient's PADP and HeartLogic Indices

Date	09.29	10.02	10.20	10.25	10.26	10.29	10.30	11.05	11.20	11.28	12.11
PADP (mmHg)	18	21	25	23	27	25	22	22	21	18	17
HeartLogic Index	6	7	11	15	15	16	15	14	11	7	0

Annotations above table: Onset of symptoms (10.02); Hospitalization {IV Furosemide} (10.20); Discharge (10.25); Urgent Visit {IV Furosemide, Metolazone} (10.30); Follow-up Visit {Torsemide 120 -> 160 mg/day} (11.20)

From September 29, 2019, to December 11, 2019, this figure illustrates the correlation between the 2 parameters and their individual responses to therapy.
IV = intravenous; PADP = pulmonary artery diastolic pressure.

be consistently above baseline approximately 5 days after the onset of symptoms. Monitoring of these 2 parameters could provide grounds for earlier interventions with adjustments in diuretic dosage, counseling, office visits, and possible IV diuretics in an attempt to prevent hospitalizations. In the present case, the patient had 3 acute events, and diuresis was guided by close monitoring of both HeartLogic and CardioMEMS parameters. Rapid changes of PADP with day-to-day variations were observed in response to treatments, whereas the HeartLogic index had a steadier trend. HeartLogic data were obtained more consistently, given the convenience of the measurements. The availability of the HeartLogic alert, if active at the time of the events, would allow the early detection of clinical decompensation as early as 3 weeks prior to the event.

FOLLOW-UP

The patient continued to do well 1 week later. His breathing and weight were back to baseline.

His HeartLogic index on December 6, 2019, was down to 2.

CONCLUSIONS

The HeartLogic index could be a very useful tool in the prediction of HF decompensation as early as 3 weeks prior to the event. It does correlate well with PADP measurements obtained through CardioMEMS.

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KEY WORDS acute heart failure, cardiac pacemaker, systolic heart failure