

CARDIOMEMS: Pulmonary Artery Pressure Monitoring in Ambulatory Patients with Symptomatic Heart Failure

For years, cardiologists at Penn Medicine have been utilizing the CardioMEMS™ HF system as a warning for disease progression and a preventative for hospitalization in ambulatory patients with heart failure. CardioMEMS features an implantable, wireless pulmonary artery pressure sensor that measures pulmonary artery pressure (PAP), a factor in hemodynamic congestion. Cardiologists at Penn Medicine are now also participating in PROACTIVE-HF, a multicenter clinical trial studying a new pulmonary artery sensor. Both these pulmonary artery sensors wirelessly monitor pulmonary artery pressure and these measurements are sent to the patient's clinical team on a daily basis.

Among the many complexities of heart failure (HF) management is that patients can progress rapidly from relative well-being to decompensated HF and hospitalization. Predicting HF decompensation in order to prevent hospitalizations has proved elusive. Regular physician visits, blood tests, imaging modalities, biomarker tracking, regular communication by phone—all have fallen short of the goal of making a significant impact on mortality and hospitalization rates.^{1,3} Monitoring hemodynamic congestion is an optimal way to gauge the daily status of HF patients.

In recent years, remote monitoring technology has advanced significantly in various areas of medicine. In congestive heart failure, patient symptoms and weight gain are often late signs of congestion and impending heart failure hospitalization. Hemodynamic congestion, however, is an early marker and can precede heart failure hospitalization by weeks. Hemodynamic congestion can be assessed by measuring pulmonary artery pressure (PAP). A device that accurately measures PAP elevation might thus allow for timely clinician intervention before symptoms appear to avert HF hospitalization.

Developed along these lines, CardioMEMS (MicroElectroMechanical Systems) is a wireless, remote, pressure sensitive device consisting of a sensor implanted in the distal pulmonary artery. To address the challenge of compliance, the System uses a simple, in-home electronic monitoring unit to wirelessly transmit daily PAP readings to providers. CardioMEMS is FDA approved and available at Penn Medicine, the site of a currently enrolling clinical trial for the device (NCT02729922).

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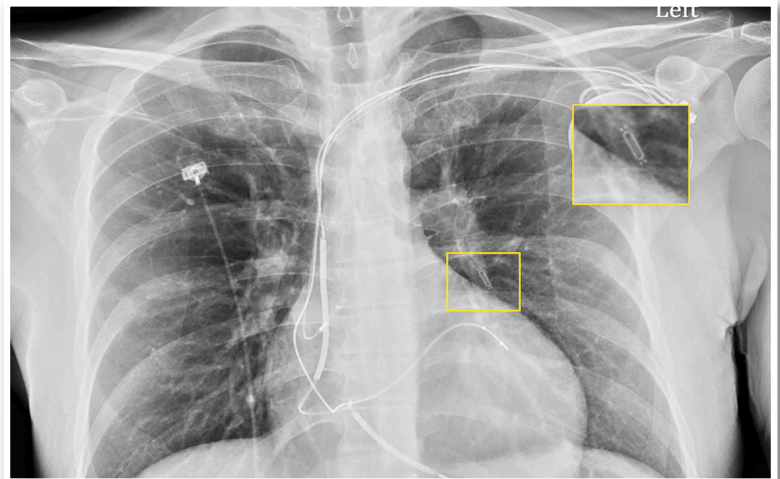


Figure 1: Implanted CardioMEMS device as seen on chest radiograph.

CASE STUDY

Mrs. R, a 72-year-old woman, was referred to Penn Cardiology by her primary care provider after a heart failure hospitalization, even though she felt that she was back to her baseline at her post-discharge follow-up visit. Mrs. R's medical history included hypertension, pre-diabetes (A1C 6.2), dilated cardiomyopathy, and a recent hospitalization for acute decompensated heart failure. Her medications at this time included lisinopril, metoprolol and rosuvastatin.

At Penn, Mrs. R reported recurrent episodes of fatigue and breathlessness following moderate exertion, and had demonstrable ankle edema, mild abdominal distention and mild rales on auscultation of the lungs. On questioning, she revealed that she had been able to manage her at-home care relatively well while her son was at home, but that he had recently accepted a position in another city.

After a brief discussion to discuss the options available to her, which included engaging the services of Penn Medicine Home Health, Mrs. R chose to have the CardioMEMS implant performed.

Following an overview on the use of the CardioMEMS transmitter, a portable device that patients lie on top of every morning for less than a minute, Mrs. R had a minimally invasive outpatient procedure to place the sensor in her pulmonary artery and went home. Her diuretics were adjusted to aid in excess fluid removal until goal PAP was achieved, and her symptoms subsequently improved.

Mrs. R continued to transmit daily pulmonary artery pressures which were remotely monitored by her physicians at Penn Medicine. At approximately two months, a trend appeared in her daily reports demonstrating a progressive rise in her PAP, and her cardiologist responded to this alert by adjusting her diuretics to prevent HF symptoms and hospitalization. Following an adjustment in her diuretic, her PAP returned to baseline. She has been able to remain out of the hospital since implant.



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PROACTIVE-HF is another pulmonary artery sensor that is placed in the proximal pulmonary artery and also wirelessly transmits remote pulmonary artery pressure on a daily basis (NCT04089059). The in-home electronic monitoring unit in this system allows patients to obtain readings in a seated position. In addition, patients are equipped with the Cordella® Heart Failure Monitoring System which provides comprehensive remote heart failure management. This system includes a tablet for daily symptoms monitoring as well as tools to measure daily weight, blood pressure, heart rate and oxygen saturation.

Using either of these two pulmonary artery pressure sensors, patients wirelessly transmit PAP on a daily basis to their cardiologist at Penn Medicine, where early signs of fluid retention can be recognized and addressed medically before symptom progression and heart failure hospitalization occurs. In early clinical trials, patients using CardioMEMS demonstrated lower pulmonary artery pressures, fewer days in the hospital, and better quality of life compared to patients receiving standard medical care.⁴ In later trials, CardioMEMS reduced hospitalizations and improved quality of life for patients with preserved ejection fraction in HF—the only modality, to date, to demonstrate these benefits in this population.⁵

References

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FACULTY TEAM

The Heart Failure Program at Penn Cardiology is among the most active in the United States and is a proud recipient of the Get With The Guidelines®—Heart Failure Gold Quality Achievement Award from the American Heart Association. The Program follows more than 3,500 heart failure patients and more than 639 heart transplant patients. Heart failure specialists at Penn are among a select group of physicians certified by the American Board of Internal Medicine in the Advanced Heart Failure and Transplant Cardiology specialty. In the United States, only about 1200 clinicians are certified in this specialty. We are also proud to have a dedicated team of certified heart failure nurses who have specialized knowledge and training in heart failure care.

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