

How Can Digital Measures Advance Heart Failure Research?



How Can Digital Measures Advance Heart Failure Research?

Chronic heart failure (HF) is a significant health problem with high personal and societal cost. This progressive disease affects up to 65 million people worldwide¹, and more Medicare dollars are spent on HF than on any other chronic disease.²

With the burden of this disease straining both patients and healthcare systems, it's no surprise that wearable digital health technologies (DHTs) are being incorporated in cardiovascular research and development. These technologies can support more detailed data capture that informs our understanding of how HF impacts patient lives and how we can improve prevention and treatment regimes.

HF is classically defined as the inability for the heart to pump sufficient blood to meet the needs of the body, or to do so only at elevated filling pressures. The hallmark symptoms of HF include exercise intolerance, exertional dyspnea, and fatigue, all of which can contribute to poor quality of life.



With the burden of Heart Failure disease straining both patients and healthcare systems, it's no surprise that wearable digital health technologies (DHTs) are being incorporated in cardiovascular research and development.

Traditional measures of these symptoms include patient reported quality of life questionnaires such as Kansas City Cardiomyopathy and Minnesota Living with Heart Failure, and exercise tests such as 6-minute walk test (6MWT) and cardiopulmonary exercise testing (CPET).

Limitations of Traditional Measures

While the traditional measures mentioned above have been shown to correlate with patient outcomes and response to therapy, there are several limitations worth noting.

- **Recall Bias**

People are generally not aware of how much we exercise, are sitting or standing, and how much we sleep. This is one of the reasons health tracking apps are so popular. This recall bias can be exacerbated in patients that may also be ill, older, or on medications that may decrease the likelihood or accuracy of remembering how they were feeling several days or weeks ago.

- **Laboratory Setting**

Exercise tests like the 6MWT and CPET can be confounded by patient performance anxiety, enthusiasm, and the level of pain or discomfort they are experiencing.

- **Single-Point Measurement**

Exercise tests are only capturing a patient's functioning at a single point in time. These measurements are not necessarily representative of an individual's overall level of functioning, which can vary over time across good, better, and bad days.

- **Active Behavior Only**

Exercise tests as a measure of HF patient functioning only capture information about their active performance, but this misses important information about sedentary behaviors.



Digital Measures Relevant to Heart Failure

Wearable digital health technologies (DHTs) are low-burden tools that can collect measures of physical activity, mobility, sleep. The core symptoms of heart failure (exercise intolerance, exertional dyspnea, and fatigue) can impact patients' ability to perform physical activities such as walking and lead to reduced gait speed. Further, sleep disturbances are common in people with heart failure.³

Now multisensor wearables, such as ActiGraph LEAP™, can also collect vital sign measures such as heart rate and variability, respiratory rate, atrial fibrillation, blood pressure, oxygen saturation during sleep, and skin temperature, which can provide additional contextual data related to patient functioning. The right endpoint(s) for your HF study depends on the question you are trying to answer, but the measures listed above are those most likely to be of interest in this patient population.



With wearable DHTs, these clinically relevant measures can be collected in a real-life setting for a multidimensional, natural view of patient behavior. Heart failure clinicians and researchers will need to understand and be able to use wearable DHTs, in addition to traditional questionnaires and exercise tests, as their incorporation into cardiovascular practice is evident today and is expected to continue to mature.⁴

Advantages of Digital Measures

- **Long-Term, Continuous Monitoring**

This data provides a more comprehensive view of exercise tolerance and habits over time that reflect overall activity levels across contexts and environments. Being able to look at patterns of activity in addition to data at a point in time gives researchers a more holistic view that can be more representative of participant function.

- **Objective and Quantitative Data**

This type of data addresses recall bias that can confound questionnaires and allows researchers to capture data when participants are not in the clinic for an exercise test. Data from wearable DHTs can be valuable in both cross-sectional and longitudinal studies to give added insights into participant behavior.

- **Can Capture Active and Sedentary Behavior?**

It is important to understand the pattern of active and sedentary time in HF patients, as lower physical activity levels are associated with worse outcomes in heart failure patients.^{3,4} Wearable DHTs can capture this data in participants' everyday environment.



Wearable DHTs can be a powerful tool for researchers and drug developers in the cardiology space, particularly in heart failure research. ActiGraph's on-demand webinar, *Advancing Heart Failure Research with Digital Measures*, features presentations from Dr. Robert Weiss of John's Hopkins University, Maria Mattera of C-Path Institute, and Christine Guo of ActiGraph sharing specific use cases of digital measures in HF research.

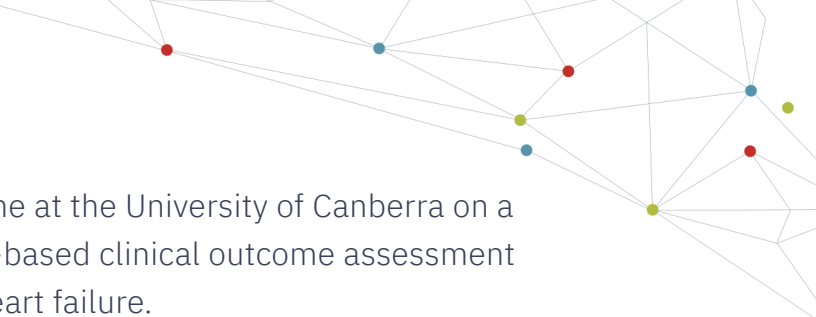
Clinical Relevance of Objective, Real-Life Measures

Both researchers and drug developers share a common goal of improving the lives of patients with heart failure, and much work has been done to develop better prevention programs and/or improved treatment(s). A key piece of achieving this goal is understanding meaningful aspects of health (MAH) to patients with HF, and wearable DHTs can be used to capture data measuring MAH that previously eluded researchers.



In line with this sentiment, the FDA released draft guidance on *Treatment for Heart Failure: Endpoints for Drug Development*⁷ indicating an effect on symptoms or physical function (even without a favorable effect on survival or risk of hospitalization) can be the basis for approving drugs to treat heart failure. The guidance also specifically calls out the intention to consider novel endpoints, including those based on measures of daily activity such as accelerometry data from wearable DHTs.

The Critical Path Institute, as part of their patient-reported outcome (PRO) consortium, conducted a comprehensive survey of patients with heart failure to answer the question: *What can wearable DHTs tell researchers about patients' physical activity that reflects a meaningful aspect of health?* One of the main findings from this study was that fulfilling day-to-day physical activities and walking were most meaningful to patients, which are concepts possible to measure with wearable DHTs. In support, ActiGraph is collaborating with the



Critical Path Institute and Dr. Nicole Freene at the University of Canberra on a project to develop a novel accelerometer-based clinical outcome assessment (COA) of physical activity in adults with heart failure.

In addition to opportunities for improved measures of physical activity, wrist-worn wearable DHTs that include a photoplethysmography (PPG) sensor, such as the ActiGraph LEAP, give researchers the ability to measure heart rate and detect abnormalities (arrhythmias) such as atrial fibrillation (Afib). Afib is the most common form of arrhythmia, is one of the major causes of heart failure and increases the risk of ischemic stroke.⁸ Long-term, more frequent data collection to detect occurrences of Afib outside of a laboratory setting could provide meaningful insights to improve patient well-being and functioning.

Detection of Afib using wearable DHTs has been shown to be feasible and accurate.^{9,10} Wearable DHTs could help researchers uncover new insights into the patterns of Afib, such as the relationship to symptoms and triggers. This type of data also provides the opportunity for a more granular investigation into the effect of treatments on Afib occurrence.

Wearable sensor-based digital measures can complement traditional measures to capture a more complete picture of patient behavior and functioning and can be a powerful tool to help advance HF research. Data captured with wearable DHTs can provide additional, clinically meaningful insights into the health and wellbeing of patients with HF to improve treatments and prevention programs to reduce the burden of this large, unmet health need.



ActiGraph is pioneering the digital transformation of clinical research. We provide end-to-end digital health technology (DHT) solutions by integrating and operationalizing the best hardware, software, and algorithms to generate reliable evidence and get the right treatments to the right patients, faster. ActiGraph's medical-grade wearable technology platform has been used to capture realworld, continuous digital measures of activity, sleep, and mobility for nearly 250 industry-sponsored clinical trials and thousands of academic research studies. Appearing in over 24,000 published scientific papers to date, ActiGraph is the most experienced and trusted wearable technology partner in the industry.

References

1. Gianluigi Savarese, Peter Moritz Becher, Lars H Lund, Petar Seferovic, Giuseppe M C Rosano, Andrew J S Coats, Global burden of heart failure: a comprehensive and updated review of epidemiology, *Cardiovascular Research*, Volume 118, Issue 17, December 2022, Pages 3272–3287, <https://doi.org/10.1093/cvr/cvac013>
2. Health Payer Intelligence. Top 10 Most Expensive Chronic Diseases for Healthcare Payers; 2022. Accessed February 14, 2024. <https://healthpayerintelligence.com/news/top-10-most-expensive-chronic-diseases-for-healthcare-payers>
3. Virginia S. Erickson, RN, PhD, Cheryl A. Westlake, RN, PhD, Kathleen A. Dracup, RN, DNSc, Mary A. Woo, RN, DNSc, Antoine Hage, MD. Sleep Disturbance Symptoms in Patients With Heart Failure. *AACN Adv Crit Care* (2003) 14 (4): 477–487.
4. Erica S. Spatz, M.D., M.H.S., Geoffrey S. Ginsburg, M.D., Ph.D., John S. Rumsfeld, M.D., Ph.D., and Mintu P. Turakhia, M.D., M.A.S. Wearable Digital Health Technologies for Monitoring in Cardiovascular Medicine. *N Engl J Med* 2024; 390:346-56. DOI: 10.1056/NEJMr2301903.
5. Saint-Maurice PF, Troiano RP, Bassett DR Jr, Graubard BI, Carlson SA, Shiroma EJ, Fulton JE, Matthews CE. Association of Daily Step Count and Step Intensity With Mortality Among US Adults. *JAMA*. 2020 Mar 24;323(12):1151-1160. doi: 10.1001/jama.2020.1382. PMID: 32207799; PMCID: PMC7093766.
6. Kraus WE, Powell KE, Haskell WL, Janz KF, Campbell WW, Jakicic JM, Troiano RP, Sprow K, Torres A, Piercy KL; 2018 PHYSICAL ACTIVITY GUIDELINES ADVISORY COMMITTEE*. Physical Activity, All-Cause and Cardiovascular Mortality, and Cardiovascular Disease. *Med Sci Sports Exerc*. 2019 Jun;51(6):1270-1281. doi: 10.1249/MSS.0000000000001939. PMID: 31095084; PMCID: PMC6527136.
7. U.S Food and Drug Administration. Center for Drug Evaluation and Research. Treatment for Heart Failure: Endpoints for Drug Development Guidance for Industry. U.S. Food and Drug Administration; 2019. Accessed February 14, 2024. <https://www.fda.gov/regulatory-information/search-fda-guidance-documents/treatment-heart-failure-endpointsdrug-development-guidance-industry>
8. P. Kirchhof, S. Benussi, D. Kotecha, et al. 2016 ESC guidelines for the management of atrial fibrillation developed in collaboration with EACTS. *Europace*, 18 (2016), pp. 1609-1678.
9. Linda M. Eerikäinen, Alberto G. Bonomi, Lukas R.C. Dekker, Rik Vullings, Ronald M. Aarts, Atrial fibrillation monitoring with wrist-worn photoplethysmography-based wearables: State-of-the-art review, *Cardiovascular Digital Health Journal*, Volume 1, Issue 1, 2020, Pages 45-51, ISSN 2666-6936, <https://doi.org/10.1016/j.cvdhj.2020.03.001>.
10. Duncker D, Ding WY, Etheridge S, Noseworthy PA, Veltmann C, Yao X, Bunch TJ, Gupta D. Smart Wearables for Cardiac Monitoring—Real-World Use beyond Atrial Fibrillation. *Sensors*. 2021; 21(7):2539. <https://doi.org/10.3390/s21072539>