Project Summary/Abstract: Motivated by an unmet need to increase the value of cardiac imaging in our healthcare system, this proposal seeks to improve the quality and expand the applicability of cardiovascular MR (CMR) for patients with a cardiac implantable electronic device (CIED). CMR, if successful, delivers better value than other cardiac imaging modalities (SPECT, echocardiography) in patients with a CIED because they have underlying structural heart disease and often require complex downstream clinical decisions (new or worsening symptoms, VT ablation, battery replacement, CRT upgrades). As a versatile modality, CMR is capable of a comprehensive evaluation including ventricular function, perfusion, scar, and valvular flow. Beyond diagnosis, CMR has been shown to predict major adverse cardiac events (MACE) in both ischemic and non-ischemic cardiomyopathy patients and to afford guidance for electrophysiologic procedures. Unfortunately, due to clinically significant image artifacts induced by CIEDs and arrhythmia and poor breath-holding during imaging, over 3 million Americans with a CIED may not benefit from a standard CMR.

To bridge this gap in cardiac imaging, we propose to synergistically apply two advanced CMR technologies: (1) wideband pulse sequences that are capable of suppressing image artifacts induced by CIEDs and (2) compressed sensing (CS) accelerated real-time sequences that are capable of achieving insensitivity to arrhythmia and breathing motion and reducing specific absorption rate. The scientific premise is supported by our experiences (>9 years) in developing and translating wideband and CS CMR sequences. By leveraging our resources in CS supported by R01HL138578 & R21EB024315, we have assembled a unique suite of CS-accelerated real-time wideband CMR pulse sequences together with inline image reconstruction methods for imaging patients with a CIED. Comprehensive real-time wideband stress CMR combining evaluation of ventricular function, perfusion, valve function, and scar for assessing new or worsening cardiovascular symptoms will enable a 47% reduction in healthcare charges ($1185.67 Medicare reimbursement technical and reading fees) and 88% reduction in scan time (25 min) compared to current clinical practice combining stress SPECT ($1544.80, 3 hours) and resting echocardiography ($707.96, 25 min). For added value, scar burden assessed with CMR would be useful for predicting MACE and guiding EP procedures in CIED patients.

The aims of this proposal are to: (1) evaluate the accuracy and precision of real-time wideband stress CMR in CAD patients with a simulated CIED implantation, (2) determine the prognostic value of real-time wideband stress CMR in CIED patients, and (3) validate real-time wideband late gadolinium enhanced CMR against electroanatomic mapping in CIED patients. This proposal has high impact potential because the proposed real-time wideband CMR technology would be broadly applicable as a single diagnostic/prognostic/pre-procedural test for a growing number of CIED patients, thereby increasing the value of cardiac imaging for this cohort.