Brigham and Women's Hospital Case Study

State of CMR in the U.S.

Cardiac magnetic resonance (CMR) imaging is increasingly considered the gold standard in cardiac diagnostics, offering unparalleled clinical insights, including heart function, muscle scarring, blood flow patterns, tissue characterization, and angiography. In October 2021, American Heart Association (AHA) added its overwhelming support when it updated its clinical guidelines to include CMR as a Class 1 Recommendation for stable angina.

Despite its clear advantages, clinician use of and patient access to CMR is often limited due to multiple factors, including:

- A complex and stressful workflow requiring an experienced technologist to make hundreds of manual manipulations and interventions during the course of an exam
- Unpredictably long scan times creating scheduling challenges for medical imaging departments
- Scarcity of CMR-trained technicians and radiologists in the United States

Dr. Raymond Kwong, Director, Cardiac Magnetic Resonance Imaging for Brigham and Women's Hospital, a prestigious teaching hospital of Harvard Medical School, has observed this supply-demand imbalance firsthand within Boston and its outlying communities. Out of concern for patient quality of care and health outcomes, Dr. Kwong undertook a real-world, clinical adaptation study to examine how artificial intelligence (AI)-assisted CMR – specifically using Vista.ai's One Click MRI™ software – might overcome traditional CMR shortcomings to mitigate patient backlogs and extended wait times.

Background on Brigham's CMR Program

Dr. Kwong has directed the CMR program at Brigham and Women's Hospital since 2001. Since the inception of this program, patient scan volume has increased steadily, more than doubling in the last 10 years alone. The onset of COVID-19 has served as key catalyst for growth since early 2020. In the first six months of that year, the pandemic initially decreased outpatient hospital visits. Rescheduling of deferred medical appointments, coupled with a rise in COVID-related myocarditis and pericarditis, resulted in a surge of CMRs, almost doubling the weekly clinical volume compared to the pre-pandemic period.

Provider sites within the Brigham network funnel inpatients and outpatients to the main campus for scans on one of four MRI machines equipped and staffed to perform CMR exams. The Brigham Health and Brigham and Women's/Mass General Health Care Centers in Foxborough, in particular, have a large patient population requiring CMR for urgent cardiac planning.

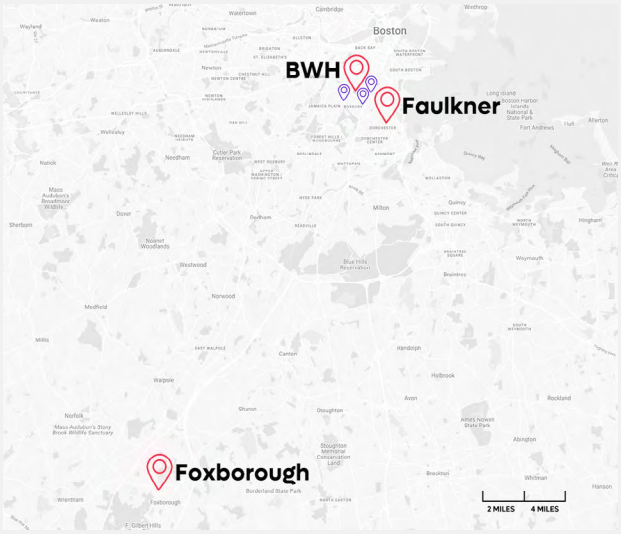


FIGURE 1

431 Florence St, Suite 100, Palo Alto, CA 94301 | vista.ai | info@vista.ai | 650-800-7937 | MSL2301 rev.1

Brigham's Pre-AI Challenges

Brigham and Women's stature as a Top 10 cardiac care hospital in the U.S., prestigious teaching affiliate of Harvard Medical School, and prime location within Boston's medical and biotech hub, in many respects affords it unparalleled access to resources and highly skilled talent. Yet as the hospital seeks to further expand its services, it is hampered by numerous barriers to an efficient and patient-friendly CMR program.

On its regular status quo schedule, Brigham's CMR team conducts 7 to 15 studies a day. Scans average approximately 60 minutes in length, with a high degree of variability due to a multitude of patient-specific attributes and pre-scan unknowns. During an exam, a specially trained MRI technologist needs to make hundreds of intricate manipulations to program the scanner and customize the exam. This creates a high-stress environment in the MRI control room and discomfort for the patient (related to length of the procedure, frequency of breath holds, and potential for claustrophobia). Due to the sheer number of manual selections involved, resulting image quality is highly inconsistent across technologists.

The four scanners available for CMR, also used across many other specialties and anatomies, run at greater than 95% capacity with outpatient wait times stretched three to four weeks – versus several days prior to the COVID-19 pandemic. In the case of cancellations or no-shows, administrative staff are challenged to fill vacated slots due to the disparity in length between CMR and other MRI exams.

Clinical Evaluation of Vista.ai's One Click MRI™

Vista.ai's One Click MRI is an AI-guided software-only platform that, through direct control of Siemens and GE MRI scanners, automates the acquisition of diagnostic-level, highly consistent CMR images. The company has developed and continually optimized One Click MRI over the last decade using data collected from highly experienced CMR technologists across thousands of patient scans and millions of images.

A couple of years ago, Brigham and Women's Hospital started exploring whether integrating Vista.ai's software into the CMR workflow could yield the desired efficiencies to alleviate technologist and radiologist burden, improve patient convenience, and accelerate diagnosis and proper treatment.

In May 2022, after Vista.ai completed its Siemens Access-i integration, enabling customers to combine sequences from Vista.ai and Siemen's respective libraries, Brigham initiated an IRB study to measure various improvements associated with the AI software and to better quantify clinical and patient benefits of the technology.

Study Methodology

Dr. Kwong's practice evaluated One Click MRI over a 6-month period (April to September 2022) across approximately 1,100 consecutive studies for cardiomyopathy and structural heart disease. In total, the team performed 698 studies using its normal process (i.e., without the AI-driven software) and 374 studies using a partial or full-AI assisted workflow.

Results

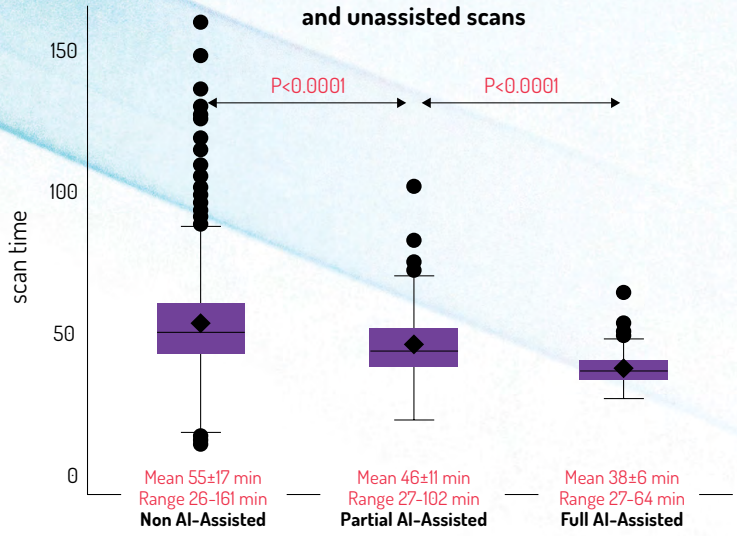
Dr. Kwong's findings using One Click MRI in his CMR practice span three dimensions: 1) Average and variance of CMR scan time, 2) Image quality, and 3) Technologist adoption of the software.

CMR Scan Time

- One Click MRI "full AI-assisted scans" (i.e., technologist oversees the exam but does not intervene) were 31% shorter than Brigham's traditional (non-AI) scans (38±6 minutes versus 55±17 minutes, respectively).
- Full-AI assisted scans times were three-fold more consistent than non-AI scan times (both had minimum times of 26 to 27 min; however, the maximum time for AI-assisted scans was 64 minutes versus 161 minutes for unassisted scans).
- 90% of full AI-assisted scans took less than 45 minutes, while only 25% of unassisted scans completed within that timeframe.

See **Figure 2.**

FIGURE 2 **Difference in time between AI-assisted and unassisted scans**



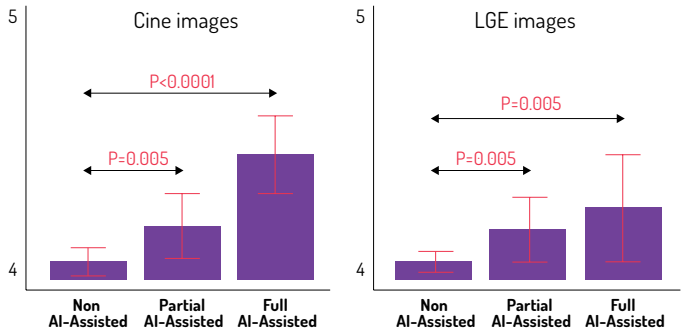
Source: 1,100 consecutive CMR studies in 2022 for cardiomyopathy or structural heart

The clinical benefits of shorter and more precise scan times are clear. Improved scanner throughput enables patients needing CMR to be scanned sooner. Higher confidence in scan times allows Brigham greater flexibility to schedule and change appointments on its mixed-use MRI scanners.

Image Quality

Image quality for AI-assisted scans was significantly better than for unassisted scans. One Click MRI Cine and LGE sequences produced images scoring 4.5 and 4.3, respectively, on a five-point image quality scale compared to 4.1 without the AI software. See **Figure 3.**

FIGURE 3 **Difference in image quality between AI-assisted and unassisted scans**



Legend: 5=Excellent, 4=Good, mild artifacts, 3=Adequate for diagnosis, 2=Poor, 1=Non-diagnostic

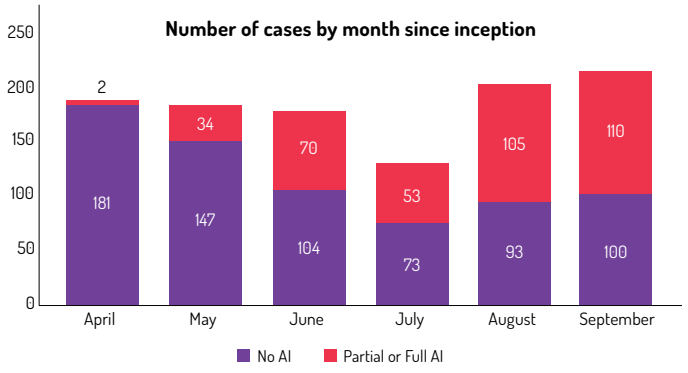
Producing high quality images is essential for timely accurate diagnosis and can prevent the inefficiencies and inconveniences of rescans and potentially un-reimbursable costs.

Technologist Adoption

Prior to testing One Click MRI, Brigham CMR technologists were skeptical the technology could improve CMR workflows and patient care, perhaps influenced by previous experience with other software making similar promises and claims, yet yielding only nominal improvements. As frontline workers running CMR scans, technologist support is critical for adoption.

It was highly encouraging that during the 6-month study period, voluntary use of One Click MRI steadily grew as technologists witnessed the software's ease of use and benefits firsthand. Adoption increased from 13% during the first full month One Click MRI was available (May) to 55% at the end of the study (September). See **Figure 4.**

FIGURE 4



Conclusions

Vista.ai's One Click MRI offers major advantages to cardiology departments of any size. For hospitals such as Brigham and Women's with a well-established CMR program and substantial opportunity to grow, One Click has shown to improve workflow efficiency, increase scanner throughput to clear patient backlogs, and enable geographic expansion. For hospitals with nascent or non-existent CMR programs, One Click makes it possible to forego hiring specially trained CMR technologists while performing CMRs in a time window comparable to MRI scans of other anatomies.

One Click does require technologists to adjust to an altered workflow, but most at Brigham were able to ramp up the learning curve within one or two weeks.

Based on the success of its real-world, clinical adaptation study, Brigham is seriously considering incorporating Vista.ai's One Click MRI software across its organization, including at satellite facilities, with the expectation that they will further reduce scan times to an average of 30 minutes.

Brigham and Women's Hospital estimates that broader implementation of One Click MRI across its network will decrease patient backlogs by 50% while achieving a sustained annual growth rate of 15% for its CMR program.

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[i] Salerno M, Sharif B, Arheden H, et al. Recent Advances in Cardiovascular Magnetic Resonance: Techniques and Applications. Circ Cardiovasc Imaging. 2017;10(6):e003951. doi:10.1161/CIRCIMAGING.116.003951