

Introduction of AI assisted Digital Health Technology to Improve Cardiovascular Pathway Efficiency

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Abstract

Stay Left, Shift Left-10X is a new paradigm for transforming healthcare, striving to cohesively introduce new radical digital health innovations which enable self-care, shared care, earlier diagnosis and more efficient and effective healthcare. This project using advanced Artificial Intelligence (AI) analysis of Electrocardiogram (ECGs), aimed to improve the time patients waited on the in-patient LV Function query echo referral waitlist at an NHS district general hospital by introducing change of practise utilising new novel screening methods.

Current pathways include sending all patients who have been requested to have an LV function test to cardiology for an echocardiographic examination. In hospital requests add to the growing backlogs on current waitlists, and patients are seen when spaces become available. This often extends a patient stay in hospital, causing bed blocks, additional costs and denies those most at need access to care in a timely manner. Furthermore, over stretched echo resources have meant outsourcing is commonplace.

The simple introduction of a new novel 12 lead ECG device incorporating AI analysis (Myovista® wavECG™), would allow pre-screening of all in hospital patients on the waitlist and identify those who can be safely removed, allowing those in need faster access to the service.

Multiple 10X benefits were realised including Stopping Unnecessary Referrals, Quicker Access to Care, Reducing Bed Days, Reducing Outsourcing, Reducing Expenditure and Improving Workflow.

Analysis of the audited figures show that 49.5% of the LV function test queries could potentially be eliminated from the waitlist. This represents a saving of 1682.7 overnight stays, a reduction of 710 unnecessary echo examinations, 28 redeployable staffing days, and a combined cost saving of £618,672.30, delivering a more than 10X return on investment. Furthermore, waitlist time for those requiring an in-patient echo examination would reduce from 56.8 to 45.4 hours, a more than 10-hour reduction.

Introduction

To streamline a process or pathway means to remove unnecessary parts to make it more efficient.

The newly elected Labour government in the UK acknowledged in their health policy that “the NHS is broken”. Waitlists continue to be problematic across all areas of health provision.

Streamlining is needed, but undertaking such tasks in patient pathways is a challenging process. Echocardiography is one such overused and under resourced commodity within the United Kingdom National Health Service (NHS). It is widely accepted that circa 40% of patients referred to cardiology for an echo are benign. New novel technologies exist to potentially screen patients out of the cardiology referral pathway. This project investigates the potential impact of one such technology if deployed within a district general hospital to minimise “in-patient” echo requests.

Background/Challenge:

The echo dept at the Royal Cornwall Hospitals Trust (RCHT) has the capability of performing 3560 in-patient echo examinations per annum. Upon audit in the year 2019, 3523 echoes were undertaken on medical patients within the trust. It was found that 1433 (41%) of the examinations were requested from medical staff querying in patient left ventricular function testing. Of this figure, 710 examinations were found to show no significant reduction in left ventricular function, both in the systolic and diastolic phase. These examinations also showed no evidence of valvular disease or dysfunction and no structural or mechanical abnormality or dysfunction.

Methodology

Steps considered for streamlining the cardiology pathway are as follows:

- 1- Identify existing problems within the cardiology pathway to determine where change can be made. In the case of RCHT, it was deemed to be lowering patient wait times for in-patient echo referrals.
- 2- Identify methods to streamline including procedural, staffing and technological changes. In this case study a technology was selected which had clinically shown to be of benefit by correlating well to echo results for cardiac dysfunction. This meant pre-screening at point of admission to eliminate those not needing onward care is more viable.
- 3- Undertake audit of existing costs to understand what the knock-on effect of such a change would be. Is it worth the time and money to do so?
- 4- Understanding the benefits of any pathway change is vital. With increased efficiency of patient care comes the opportunity to improve that of those who require it most. How to redeploy resources, both staffing and financial were identified.
- 5- Plan the implementation before starting. Ensure staff were well trained and ready to use the equipment. At RCHT several staff members undertaking an ECG are SCST accredited, so a change in technology was no more than learning new buttons to press.
- 6- A staged Implement is important to allow you to monitor for any issues and make adjustments that were otherwise unforeseen.

Technology Architecture

The MyoVista *wav*ECG is a standard 12-Lead high-performance, multi-channel resting interpretive electrocardiograph providing both a Glasgow Interpretive Analysis and unique MyoVista *wav*ECG Information. The MyoVista is a stand-alone device that simultaneously acquires data from multiple channels of ECG signals using 10 surface (limb and chest) electrodes. Once the data is acquired, the ECG signals are amplified, filtered, and digitised.

These signals are then displayed on the built-in touch panel display in both the standard ECG waveform format as well as in a continuous wavelet transform (CWT) 2-Dimensional colour format depicting energy and frequency information across the QRS complexes for all 12 leads. The device allows reviewing, storage, and/or printing of the ECG signals. In addition, the device offers the well-established validated Glasgow Royal Infirmary Algorithm for the resting ECG interpretation/analysis of established calculations of heart rhythms, arrhythmias, and classifications for physician over-read. It is a device primarily intended for use in hospitals, medical clinics and medical offices of any size. The clinical protocol for the MyoVista test is identical to conventional 12-lead ECG, however, as well as providing all of the conventional ECG information it includes a proprietary algorithm which analyses CWT and conventional ECG data to detect left ventricular relaxation abnormalities associated with diastolic dysfunction (LVDD). LVDD is sensitive to nearly all common disease processes that affect cardiovascular function and begins early in the heart disease process and continues to increase in severity as heart disease progresses. It is now recognized as one of the earliest signs of heart disease and typical onset occurs when a patient is still asymptomatic.

Analysis of data from prior multi-centre studies has revealed good correlation between the MyoVista wavECG results and echocardiography for the presence of left ventricular relaxation abnormalities⁽¹⁾ and demonstrate its ability to identify patients not in need of an echocardiographic examination^(2,3).

Results

The “knock on” effects of the existing pathway are:

- 1- Delayed Diagnosis and Care.
- 2- Delayed Discharge.
- 3- Additional burden to overstretched resources and staff.
- 4- Additional costs to outsource work to the private sector.

Streamlining the RCH cardiology echo referral pathway can result in a reduction of time to treatment, the number of patients in the cardiology pathway, the handoff of patients and pathway waitlist. Furthermore, this can be achieved whilst reducing the overall cost of service provision.

The audit evidenced that 20% of the total annual cohort of patients, 49.5% of the left ventricular function query cohort, did not require echocardiographic examination.

The average wait time for the investigation was 56.8 hours to receive the examination. The audit evidenced that 100% of these patients were discharged after the disclosure of the echocardiography examination.

Therefore, it is hypothesised that if a MyoVista ECG was performed at point of admission, this cohort of 710 patients would likely have not been admitted for in-patient investigation. This would have led to a reduction in overnight bed stays by 1682.7.

At the time of the audit NHSE data showed that the average cost for an overnight bed stay in a UK hospital was £349.00. Therefore, this reduction in bed stays would have led to an annual cost saving of £587,262.30, coupled with 28 days of redeployable nursing resources and £31,410 redeployed on unnecessary echo examinations (£52 per echo, NHS tariff).

With the 10-year amortised equipment cost (circa £1,000/unit/yr.), and consumable cost per patient for this new screening process (circa £10), the streamlining (£17,330) is a fraction of the savings, meaning the >35X return on investment makes a compelling case for its broader adoption in other hospitals.

Further to this the resultant reduction in echocardiographic examination on patients with essentially ‘normal hearts’ would have reduced waiting time for the examination to 45.4 hours.

Stay Left, Shift Left 10X (4) Alignment

The deployment of such technology and pathway change meets the requirement of both stay left and shift left by screening out patients who do not need to attend cardiology, keeping them away from health providers and aiding quicker time to discharge. The knock-on effects have multiple (10x) components:

Number	10X Dimension	Description
1	Return on Investment	The ROI greatly exceeded 10X, calculated by cost of bed days savings, Nursing resources and implementation cost
2	Stop Unnecessary Referrals	Pre-screen all LV function test requests with MyoVista, negative results can be removed from pathway, circa 49%.
3	Quicker Access to Care	Removing 49% of said referrals allows those who need care access to resources otherwise congested.
4	Reduce Bed Days	Patients no longer waiting an average of 58 hrs for unnecessary echo.
5	Reduce Outsourcing	Lower echo demand by removing inappropriate patients from pathway. Eliminate need for outsourcing of services.
6	Reduce Expenditure	Less outsourcing and re-deployable expenditure, reserving resources for those who need care.
7	Improve Workflow	Less steps in the pathway, less patients coming through unnecessarily.

Broader Implications and Opportunities for Health systems

Such a project as highlighted is easily implemented and is readily available for use across health systems world-wide. Change to screening time/location/method is as simple as a procedure introduction and as the MyoVista wavECG device utilises common electrode placement for 12 lead ECG, staff training is minimal, with adoption being simple and fast.

Due to the potential benefits to both patients and health systems (clearing of waitlists, quicker access to care and lowering of resource), adoption of such a pathway change should be embraced by health management as the increased efficiency of care and ROI vs capital investment are impressive.

Introducing such change across a health system allows for re-aligning of care pathways. Screening can be moved away from the hospital environment and moved to a community style setting, freeing stretched resources further.

For example, GP's, diagnostic hubs, pharmacy and pop-up screening hubs can feasibly undertake a simple 5-minute test on a patient to include or exclude them from any echo waitlist.

The re-aligning of care will help elevate already overburdened and resource restricted health systems, provide a more efficient service for patients, and more appropriate or quicker access to care for those that need it most.

Conclusion

This case study demonstrates a potential method for streamlining cardiology referral pathways using a new novel technology. The project was investigated and developed by clinical staff and can easily be replicated by others to change practice. The streamlined pathway produced significant benefits to health care providers, the health economy, and most importantly, the patient.

References

- 1) Kagiya et al (2020) Machine Learning Assessment of Left Ventricular Diastolic Function Based on Electrocardiographic Features.
- 2) Potter et al (2019) Machine Learning of ECG Waveforms to Improve Selection for Testing for Asymptomatic Left Ventricular Dysfunction Prompt.
- 3) Borde et al (2024) Utility of Machine Learning with MyoVista wavECG For Detection of Left Ventricular Diastolic Dysfunction in Preoperative Patients.
- 4) Curley, M et al (2020) Stay Left, Shift Left, The Digital Transition of Healthcare, Innovation Value Institute.