Re-engineering the clinical approach to suspected cardiac chest pain assessment in the emergency department by expediting research evidence to practice using artificial intelligence (RAPIDx AI)

Background

Nearly 1 million people present to emergency departments (ED) every year in Australia with suspected cardiac chest pain. In South Australia, this manifests as ~30,000 episodes of care per year, consuming 17,500 emergency bed days, yet up to 85% of these patients are ultimately not diagnosed with myocardial infarction (MI). Clinical work-up to exclude life-threatening cardiac conditions amongst the high-volume population presenting with suspected cardiac chest pain is resource intensive and contributes to unnecessary ED and hospital congestion.

Diagnostic assessment of MI often relies on measuring cardiac troponin present in the bloodstream which indicates myocardial damage. Newer troponin assays available, which can detect very low troponin concentrations have promised to refine MI diagnosis and improve patient outcomes. As such, these high-sensitivity troponin assays have been increasingly incorporated into routine practice worldwide over the last decade, with high sensitivity troponin reporting routinely implemented the South Australian health system in August 2020.

With increased test sensitivity however comes decreased specificity, which manifests in this case as an increased ability to detect those with abnormal troponin results (i.e. indicating myocardial damage) but a decreased ability to attribute these abnormal results to type 1 MI (i.e. MI due to coronary plaque rupture), which is what this test has been used for historically. As such, clinical interpretation of troponin results has become challenging given results may now be elevated due to a large number of causes other than type 1 MI, which don't share the same evidence-based management strategies as type 1 MI. Local data suggests that up to 40% of patients with a troponin test taken have an abnormal result (>14ng/L) but fewer than 5% have the diagnosis of type 1 MI, with misinterpretation appearing to trigger potentially unwarranted investigation leading to excess costs and risk.

Although the introduction high sensitivity troponin assays promised to improve clinical outcomes, this has not been demonstrated in any study worldwide to date. Large studies conducted in our SA public hospitals by Flinders University Health Systems Cardiology Research group, led by Prof Derek Chew, have shown that high sensitivity troponin reporting (despite supplying greater information than previously available to clinicians for decision making) did not improve care, nor reduce all-cause mortality or subsequent MI by 12 months compared to the prior generation troponin reporting. Additionally, no reductions in overall admissions or investigations were observed in those considered low risk. These findings highlight that clinical innovation cannot simply be 'dropped' into the health system, but rather than clinical practices and pathways must evolve alongside innovation. As such, to realize the promises of better patient outcomes and superior health system performance offered by high sensitivity troponin for this large population, a more sophisticated systems-level approach is required, and this is what RAPIDx AI expects to deliver.

Recognising that there is an enormous volume of health data in our health system, especially with introduction of electronic medical records, it is of critical importance that we use this data in ways that improve the wellbeing and outcomes of our patients. Whilst we believe that artificial intelligence can never replace clinicians, there is a significant opportunity to employ it to support clinical decision making and enable more consistent delivery of high-quality evidence-based care.

Aim

We aim to re-engineer the clinical approach to suspected cardiac chest pain assessment in the emergency department. We will deploy and evaluate an artificial intelligence (AI)-based phenotypic algorithm within the ED that uses eexisting health data to predict the likelihood of myocardial infarction and injury sub-types and prospectively support risk assessment and clinical decision-making for patients with suspected cardiac chest pain.

The intervention

The study will deploy a purpose-built electronic interface to capture routinely collected health data for those receiving troponin testing which will then be fed into machine-learning algorithms that will return information to support diagnosis and subsequent management. Specifically, these algorithms will objectively assist in the delineation of types of MI, acute myocardial injury and chronic myocardial injury (or rule-out myocardial injury) with evidence-based guidance provided for subsequent management.

Expected outcomes

The purposeful system-level design of these two elements will establish a self-learning environment where clinician decision-making is enhanced, and consumers are supported to meaningfully engage in their care for suspected cardiac chest pain. It will help deliver more efficient and effective patient care for suspected cardiac chest pain patients and in doing so is expected to measurably reduce ED congestion, facilitate appropriate clinical management, and reduce variation in care to achieve equitable outcomes for all patients. In addition, it will create an enduring, systematic platform to expedite the translation of evidence to clinical practice.

Study implementation

This study is a cluster-randomised clinical trial (i.e., hospital-level randomisation, not patient-level) which will be implemented in 12 hospitals in metropolitan and rural South Australia. Of these 12 hospitals, 6 will be randomly allocated to the control arm (i.e., unchanged standard of practice) and 6 will be randomly allocated to the intervention arm (i.e., implementation of AI-based clinical decision support). Importantly, randomisation techniques will ensure that 3 rural hospitals and 3 metropolitan hospitals are randomised to the intervention to ensure conclusions can be drawn for both clinical settings.

Participating hospitals:

- Flinders Medical Centre
- The Queen Elizabeth Hospital
- Noarlunga Hospital
- Mount Gambier Hospital
- South Coast District Hospital
- Port Augusta Hospital
- Royal Adelaide Hospital
- The Lyell McEwen Hospital
- Modbury Hospital
- Murray Bridge Hospital
- Berri Hospital
- Whyalla Hospital

This study has been designed to be as closely embedded in clinical practice as possible, with the data collection required for this project being that which is already collected within routine practice. Given this study will enrol a total of 9,600 participants across the 12 hospitals, an opt-out consent process will be utilised to facilitate the study yet enable participants to opt-out of allowing their data to be used for this investigation. Ethical approval has been received from the Southern Adelaide Human Research Ethics Committee (SACHREC) which covers all participating sites (OfR no.: 272.20). Participants will be followed up for 12 months beyond their qualifying index ED presentation. Health economic evaluations will also be conducted as an important part of this study.

Partner contributions

The project will be led by a multidisciplinary consortium.

Flinders Health Systems Cardiology Research group will plan, manage and oversee each stage of the project including conducting all start-up activities, leading the conduct of the cluster-randomised trial; and documenting and reporting the systems learnings. They will also develop supporting digital infrastructure to enable to efficient and effective conduct of this investigation.

Australian Institute of Machine Learning (AIML) and Siemens Healthineers
The Algorithm for Myocardial Infarction and Injury and Interface for Clinical Decision Support

A predictive algorithm using high sensitivity troponin has been developed from two prior randomised clinical trials in SA, with validation and enhancements provided by the AIML. This algorithm will be integrated into a clinical interface developed by Siemens Healthineers, known as the AI-PC. This AI-PC tool will guide clinical decision making in real-time through provision of algorithm outputs specific to the individualized information provided.

SA Health and Commission on Excellence and Innovation in Health (CEIH)
Data-linkage Establishing a Registry in Practice

Resources provided by SA Health and CEIH will link current clinical data (including cardiac risk factors, clinical impression of ischaemic risk, electrocardiograms, troponin tests and other routine pathology from SA Pathology reporting systems) to subsequent electronic reporting systems to establish the in-practice registry.

Local Health Networks (LHNs), Integrated Cardiac Clinical Network (iCCNet), Health Translation SA (HTSA) & Flinders Health Systems Cardiology Research
Cluster-randomised Implementation of Decision-support

This project will leverage clinical leadership established through the state-wide LNHs, ICCNet and Health Translation SA to work with local clinical leaders (e.g. medical and nursing) to plan, engage, implement and develop feedback opportunities. The decision-support tool will be designed to be simple, adaptable and will form a component of the clinical record and system-wide data collection. These partners will work together to effectively embed and scientifically evaluate the intervention of AI-based clinical decision-support versus unsupported clinical care on subsequent care and outcomes.

Project contacts

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