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Reducing avoidable chest pain admissions and implementing high-sensitivity troponin testing

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ABSTRACT

NHS accident and emergency departments see 0.5 million patients presenting with a cardiac condition each year. The accurate assessment of chest pain and subsequent diagnosis or exclusion of myocardial infarction (MI) represent a significant challenge, with important consequences on patient outcome and healthcare resources. We conducted a cross-sectional analysis of patients admitted with cardiac chest pain to a busy district general hospital in London. The criteria used by physicians to admit patients for further cardiac investigations were measured against national guidance on chest pain assessment and diagnosis of MI. We found that poor adherence to guidance, unsuitable patient pathways and inappropriate diagnostic tools at the point of presentation led to unnecessary inpatient admissions to the hospital. Quality improvement methods were used with the aim to reduce avoidable admissions to hospital in patients presenting with chest pain. We describe a system to implement new high-sensitivity troponin testing into legacy chest pain pathways. This was achieved through local education of National Institute for Health and Care Excellence (NICE) guidance, the use of patient pro formas and the creation of two new chest pain pathway arms to enable physicians to streamline patients for appropriate inpatient or outpatient care. As a result of these changes, we reduced non-compliance with NICE guidance by 83% and achieved a 42% reduction in avoidable chest pain admissions. Overall, the improvements made by this project were sustained over 2 years and saved £21 000 per month in avoidable admissions.

PROBLEM

West Middlesex University Hospital (WMUH) in London has over 400 inpatient beds and serves a local population with a high prevalence of cardiovascular disease. The acute medical admissions include a large proportion of patients presenting with chest pain to accident and emergency (A&E), with a provisional diagnosis of myocardial infarction (MI). Physicians had noted that many of the patients admitted for chest pain were found not to have MI after negative serial troponins and other cardiac investigations. This observation led us to investigate the problem further.

Our initial audit in November 2016 showed that 26% of all patients presenting with chest pain to A&E were referred for admission; 75% of these inpatients (19% of total) subsequently had two negative troponins and were discharged without further inpatient treatment. Based on this observation, we hypothesised there was scope for improving early diagnostic decisions for patients with chest pain.

On average, over the period of this quality improvement project (QIP), 496 patients per month presented to the emergency department with chest pain.

In the UK, tertiary hospitals with capacity and expertise are commissioned to provide primary percutaneous coronary intervention (PCI) to patients over a larger geographical area. District general hospitals such as WMUH will use agreed protocols and pathways to ensure a timely transfer. At WMUH, patients with ST-elevation myocardial infarction (STEMI) are transferred to the PCI centre at Hammersmith Hospital and are not the focus of this project. Patients with a provisional diagnosis of non-ST-elevation myocardial infarction (NSTEMI) are managed at WMUH and make up the majority of patients presenting with chest pain. Prior to this QIP, these patients followed a generic pathway involving referral from A&E to the acute medical take and transfer after 24 hours to the cardiology team. This pathway involves assessment by three separate teams, three junior doctors, and review by two consultants and nursing in at least two different departments. The impact on resources is therefore significant, and avoiding inappropriate admissions would improve cost and resource efficiency.

In WMUH A&E, the initial diagnosis of MI or the decision for further investigation is based on clinical findings, ECG and the initial troponin I level. Where the initial troponin is negative, a second level is taken at 12 hours from chest pain onset to achieve a 99th centile diagnostic threshold. These patients

are therefore admitted to hospital as A&E doctors must make decisions to admit or discharge patients within 4 hours based on national care standards.

We aimed to study this problem further to identify appropriate areas to improve early rule out of MI and to reduce the number of patients inappropriately admitted to the hospital with non-cardiac chest pain.

BACKGROUND

A total of 21 million patients attended NHS emergency departments across England from 2017 to 2018. According to national statistics, 500 000 of these patients were coded as presenting with a cardiac condition.[1] Accurate diagnosis is important in reducing the morbidity and mortality associated with unrecognised MI.[2] However, misdiagnosis has implications on healthcare resources, unnecessary hospital admissions and patient anxiety.

The National Institute for Health and Care Excellence (NICE) has published a guideline for the assessment and diagnosis of recent-onset chest pain (CG95) updated in 2016.[3] NICE CG95 states the diagnosis of MI requires an increase or decrease in cardiac troponin levels which occur in the context of one of

1. Symptoms of ischaemia.
2. New ST-segment changes, T-wave changes or left bundle branch block on ECG.
3. Development of pathological Q waves on ECG.
4. Evidence of new loss of viable myocardium or regional wall motion abnormalities on imaging.
5. Identification of intracoronary thrombus by angiography.

While five distinct types of MI have been defined by international working groups, this project focuses on patients with type I MI.[4] These result from the spontaneous rupture of atherosclerotic plaques with consequent intraluminal thrombus formation. Exclusion criteria were used to avoid the analysis of patients presenting with type II MI, where ischaemia mainly arises from an oxygen supply and demand mismatch or those with myocardial injury. These patients will typically have concomitant disease and require admission; they would not be appropriate for early discharge and fall outside the aims of this QIP. Type III MI results in sudden death, and type IV and V MIs occur in the context of PCI or cardiothoracic surgery, neither of which are performed at WMUH and fall outside the scope of this QIP.

NICE CG95 provides clear criteria for the diagnosis of MI. However, practical considerations limit how the guidelines can be applied to rule out MI within the 4-hour A&E decision period. In the acute setting, out-of-hours cardiac imaging and angiography for stable patients with NSTEMI are not widely available nor always appropriate. If the initial troponin is negative, clinicians must use ECG changes and symptoms of ischaemia to weigh the probability of an MI diagnosis. This is dependent on a thorough patient history, which is complicated by variability in symptom reporting and the poor sensitivity and specificity of even typical chest pain.[5] The ECG criteria for MI within the NICE guidelines are based on evidence showing a sensitivity between 25% and 42%.[6] This means that, of the five diagnostic NICE criteria, two are unavailable out of hours at WMUH (and most local NHS hospitals) and the remaining three cannot reliably be used as rule-out tools.

The rule out of MI at our hospital is therefore dependent on negative serial troponins, which, due to the 12-hour assay, means patients are invariably admitted to the hospital.

Similar diagnostic challenges were addressed in a QIP conducted at Leicester Hospital, where a series of pro formas and educational interventions were implemented to improve the diagnosis of MI within an A&E observation ward.[7] We also note that colleagues in Belfast were able to reduce inappropriate admissions by creating a specific chest pain pathway.[8]

MEASUREMENT

The primary aim of this QIP was to reduce unnecessary admissions of patients with chest pain without a cardiac cause. The primary endpoint measured was the number of patients admitted in whom MI was subsequently ruled out, as a proportion of the total number of patients assessed with chest pain in A&E. We hoped through QIP methods that we could reduce the number of these avoidable admissions. We aimed to achieve this by implementing NICE CG95 as our standard of care, and the criteria within this document therefore formed secondary endpoints (presence of typical chest pain, ECG changes and elevated troponin).

We recorded data over a 1-month period in November 2016. Patients presenting with chest pain were identified from take list spreadsheets. These outlined patients who had been referred from A&E to the medical team for admission, their primary presenting complaint and decisions regarding treatment. Details of A&E admissions/discharges, blood test results and echocardiography reports were obtained from hospital records. Performing the audit retrospectively allowed time for the patients admitted to be investigated and to establish their outcomes. Exclusion criteria were applied to ensure only type I MIs were analysed. Figure 1 illustrates the chest pain pathway at WMUH at the outset of this QIP.

We recorded cardiac risk factors such as diabetes, smoking status, age, previous MI and hypertension. NICE CG95 states that a patient with an initially negative troponin in the context of low cardiac risk can be discharged from the hospital. The presence of risk factors is therefore an important factor in a clinician's decision to admit patients to the hospital.

We also evaluated the hospital bed days lost to patients admitted unnecessarily to measure impact on hospital resources.

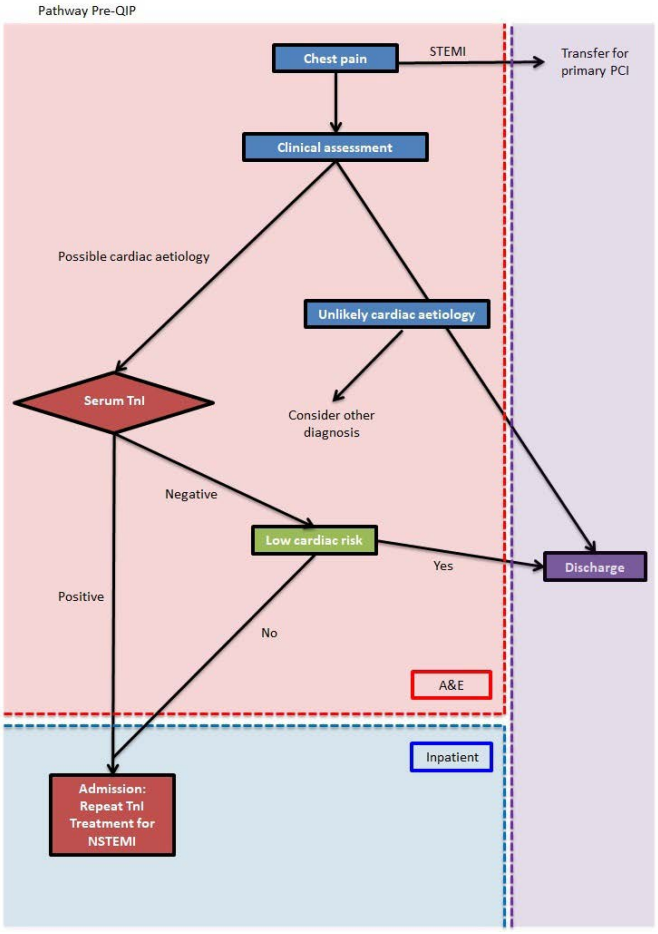

Figure 1 Flowchart demonstrating the chest pain pathway at West Middlesex University Hospital prior to QIP implementations. Shaded areas represent the clinical setting of decisions within the pathway (red denotes A&E; blue denotes inpatient ward; and purple denotes outpatient). Decisions in A&E are made within a 4-hour time frame as per national care standards. A&E, accident and emergency; NSTEMI, non-ST-elevation myocardial infarction; PCI, percutaneous coronary intervention; QIP, quality improvement project; STEMI, ST-elevation myocardial infarction; TnI, troponin I.

Findings from our baseline measurement

1. A total of 422 patients with chest pain were assessed in A&E in November 2016. A total of 110 were admitted to the hospital for investigation of type I MI. Nineteen per cent of the total was subsequently found to not have MI following negative repeat troponin.
2. Twenty-six per cent of inpatients with chest pain did not meet any of NICE CG95 diagnostic criteria for MI at the point of referral.
3. Fifty-nine per cent of the patients who presented with chest pain were discharged from A&E with follow-up by their general practitioner.
4. Of the 110 patients audited, 69% had one or more cardiac risk factors or had a previous cardiac event.

The baseline results revealed several areas for possible improvement. We showed that 28% of the patients did not meet the criteria for MI diagnosis at the point of referral (negative troponin, normal ECG and non-cardiac chest pain). Of the total patients assessed with chest pain, 19% were admitted to the hospital but did not have MI and were therefore potentially avoidable admissions.

We hypothesised that we could reduce unnecessary chest pain admissions by regularly presenting these findings to colleagues, creating tools to improve adherence to NICE CG95 guidance and building a chest pain management pathway with appropriate inpatient and outpatient care.

DESIGN

The specific, measurable, attainable, relevant and time framed (SMART) aim of this QIP was to reduce the number of patients admitted for chest pain without a cardiac cause. Our objectives were to improve adherence to NICE CG95 on assessing chest pain and to create better clinical tools and new patient pathways to reduce avoidable hospital admissions.

Our first intervention was to increase awareness of the problems identified in the initial audit. The results obtained from our baseline measurements and the contents of NICE CG95 on MI diagnosis were disseminated in regular educational meetings with A&E and acute medical doctors. The objective was to increase awareness of the evidence-based approach to ruling out/in MI, as well as the downstream consequences on hospital resources. We also used this opportunity to allow doctors to feedback their practical experiences of managing acute chest pain with the aim of potentially developing further interventions. Following these sessions, we collected focused interim data to measure the impact of this intervention on the QIP endpoints.

We presented the interim data in ongoing educational meetings. The feedback from these sessions revealed that when faced with the early binary choice between admission or discharge, A&E doctors would admit a patient where the diagnosis of MI was unlikely but there were symptoms of stable angina. This was seen as a safer and favourable alternative to discharge and delayed follow-up in the community.

Using the baseline and interim data as well as the feedback received by A&E doctors, we created a rapid access chest pain (RACP) clinic, allowing patients with stable angina to be referred for further cardiac investigations in an outpatient setting within 24 hours. The expectation of this intervention was that creating an additional outpatient pathway would reduce the number of patients with stable angina being admitted to hospital. After implementing the RACP, we collected focused interim data again to measure its impact on avoidable admission rate.

We found with the second round of interim data that we were continuing to reduce admissions, but that the RACP was underused. We then took feedback from medical and A&E doctors to understand why. Based on the feedback, we created a pro forma to aid clinicians in stratifying patients for admission, discharge or RACP clinic.

In June 2017, we measured all primary and secondary endpoints in patients presenting with chest pain and compared this to our baseline data in November 2016. We then measured the cumulative effect of the interventions outlined. We created an audit tool to sustain ongoing measurements.

We presented our QIP at regional strategy meetings and, based on the problems identified, procured funding for the implementation of a high-sensitivity troponin (hsTn) assay and clinical decision unit (CDU) in A&E. This was an unexpected outcome made possible by the support of senior colleagues in A&E and cardiology departments, who were able to appreciate the quality improvement achieved by the project and the remaining problems. In April 2019, after the implementation of the hsTn and CDU, we repeated the data collection on all endpoints again.

STRATEGY

Our baseline measurements correspond to the first cycle of our plan, do, study, act (PDSA) strategy, which informed the subsequent phases of our QIP. We used interim data collection to measure and inform further interventions.

PDSA cycle 1

The aim in PDSA 1 was to assess and then address the quality of chest pain assessment in A&E and to correlate this to relevant guidance. Comparing performance to national guidance could then be presented to key stakeholders (doctors, nurses and patient flow coordinators) to enact behaviour change. The appropriate standard in assessing chest pain (NICE CG95) was identified. This guided the measurements for the baseline audit. Data were collected from patients presenting to the A&E department of WMUH in November 2016. The analysis of this data highlighted specific learning points and areas of improvement, which were disseminated in educational presentations to A&E and acute physicians. Feedback about the challenges physicians faced when making early decisions was also obtained during these sessions.

PDSA cycle 2

In PDSA cycle 2, we aimed to act on feedback obtained from key stakeholders in PDSA 1. In addition to sustaining improvements from the previous cycle, we hypothesised we could further improve compliance with NICE guidance by creating new chest pain pathways. The strategy for change here was to further encourage A&E staff to consider NICE guidance by referring patients for outpatient investigations.

We performed a focused interim audit of chest pain referrals to measure the impact of these educational sessions. The results showed that a higher proportion of patients admitted fulfilled the NICE criteria, and avoidable admission rates fell by 15%. Based on the interim audit results and physician feedback, we noted that some patients admitted for angina could be managed as outpatients. These results were used in meetings to plan and create an additional outpatient chest pain pathway: the RACP clinic.

PDSA cycle 3

The aim of this PDSA cycle was to measure the impact of the newly created RACP clinic and to increase referrals to it. We hypothesised that increased awareness and purpose of the clinic would give clinicians the confidence to appropriately refer. Overall, this strategy would also give clinicians further insight into the investigation and further management of patients with chest pain. We performed another focused interim audit to measure the impact of the new RACP clinic on inpatient admissions. We found that it had cumulative impact on reducing admission rates and improved adherence to NICE CG95. However, we noted patients were still admitted who could have been managed through the RACP pathway. Based on the results of the second interim audit, we wanted to improve the amount and quality of referrals to the RACP. An acute coronary syndrome (ACS) pro forma was created to aid clinicians in selecting appropriate patients for admission, discharge or referral to the RACP clinic. It was used in the A&E department by both acute medical and A&E doctors.

PDSA cycle 4

The aim of PDSA 4 was to measure the cumulative impact of all interventions to date. We hypothesised that the interventions from previous cycles had created appropriate pathways for the implementation of hsTn. Our strategy was to present these data to key stakeholders to attract further funding and agreement required to implement hsTn testing.

The baseline measurement was repeated in June 2017 to measure the overall cumulative effect of all interventions as well as secondary endpoints. This demonstrated that the educational sessions, creation of the RACP clinic and ACS pro forma reduced admission rates. We have used these data to justify ongoing educational sessions, audit of performance and funding for the RACP clinic.

PDSA cycle 5

The aim of this PDSA cycle was to measure the impact of hsTn implementation on avoidable chest pain admissions and the overall sustainability of the QIP. We presented these data at local and regional quality improvement meetings highlighting the importance of effective early decisions in avoiding unnecessary admissions. From this, we were able to agree on the implementation of a hsTn assay at WMUH. We created an additional pathway within the A&E CDU, for patients to undergo repeat troponin test at 3 hours. This avoided admission of patients without conclusive troponin rise. Following the use of hsTn for several months, we measured all endpoints again to measure its effect on inpatient admissions.

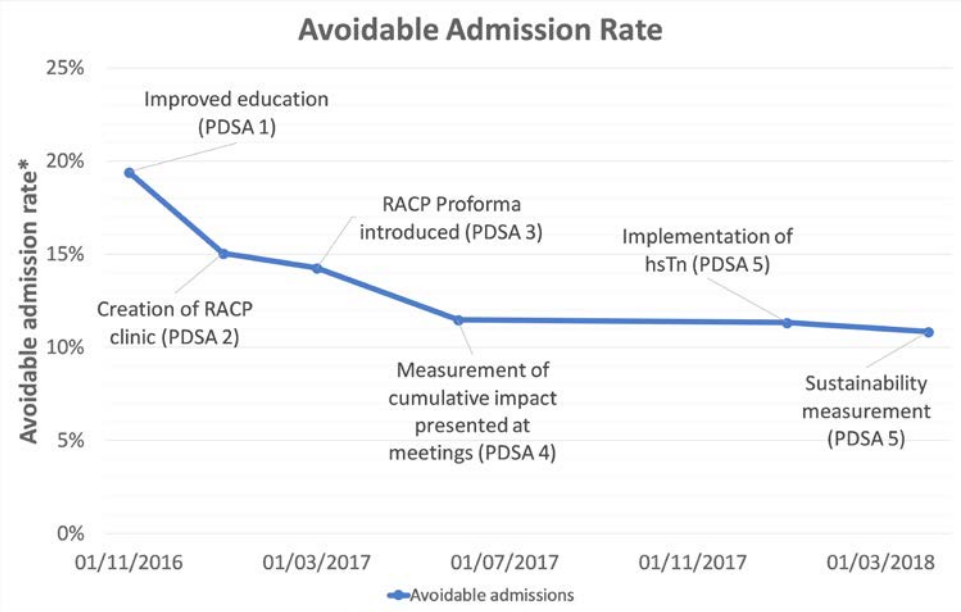

Figure 2 Run chart mapping time to primary endpoint measurement of avoidable inpatient admission. Annotations correlated to PDSA interventions. *Avoidable admission rate was calculated as the proportion of patients with non-MI chest pain admitted of the total number of patients with chest pain presenting to accident and emergency. hsTn, high-sensitivity troponin; PDSA, plan, do, study, act; RACP, rapid access chest pain.

RESULTS

We measured primary and secondary endpoint data three times during this QIP. In addition, we performed focused interim measurements of only the primary endpoint following PDSA cycles 2 and 3. The run chart shows the cumulative impact of each PDSA, with a relative reduction in avoidable admission rate of 42% over the time period of this QIP (see figure 2).

The proportion of patients with chest pain assessed in A&E and referred for inpatient admission was reduced from 26% to 16% (38% relative reduction). Figure 3 illustrates the new chest pain pathway. Serial troponin testing of patients at low and intermediate risks occurs within the A&E department, allowing for more early discharges of patients without troponin rise.

Non-compliance with NICE CG95 (no ECG changes and non-cardiac chest pain) was reduced from 36% to 6% of all patients who were admitted for chest pain. This represents an 83% relative reduction.

Patients with negative investigations but cardiac risk factors were referred from A&E directly to the newly created RACP clinic, which avoided unnecessary admission of patients who presented with stable angina.

Inpatient bed days for patients admitted with chest pain who were found not to have MI were reduced from 262 prior to QIP interventions to 127 post-QIP (relative reduction of 51%).

The NHS reference cost tariff system states the cost of admitting actual or suspected MI is on average £572 per patient.[9] The exact cost is dependent on the number of comorbidities and any other treatments or diagnosis made and can increase to £3400 per patient. In calculating cost savings, we assumed an average of 500 patients presenting with chest pain per month. We extrapolated the cost of investigating and treating MI, with the 42% reduction in avoidable admissions achieved; based on this calculation, this QIP has saved £21 400 per month in avoidable admissions.

LESSONS AND LIMITATIONS

This project looked at patients presenting with chest pain to identify areas of improvement in early management decisions. Patients who were discharged were not followed up; thus, their outcomes remain unknown. While we may have reduced unnecessary admissions for non-cardiac chest pain, it is uncertain what effect this had on the number of missed MIs in patients who were discharged. However, several trials have established hsTn as a superior rule-out test. Real-world data have shown that its use for early discharge does not affect mortality and morbidity in these patients.[10]

The cost savings calculated in the analysis are derived from the average cost of a bed day calculated from NHS reference costs. The cost of an inpatient stay in the NHS is based on a nationally agreed tariff system and is dependent on multiple factors (patient interactions, ward type, weekday/weekend, investigations performed, treatment and comorbidities).[9] Although we used a conservative average calculation based on typical coding data for acute medical patients, this may not accurately represent cost savings due to the complexity of the NHS tariff system. In addition, we have not factored in the initial and running costs of the hsTn assay, RACP and CDU.

Another limitation of this QIP was the analysis of cross-sectional data. The number of patients presenting to

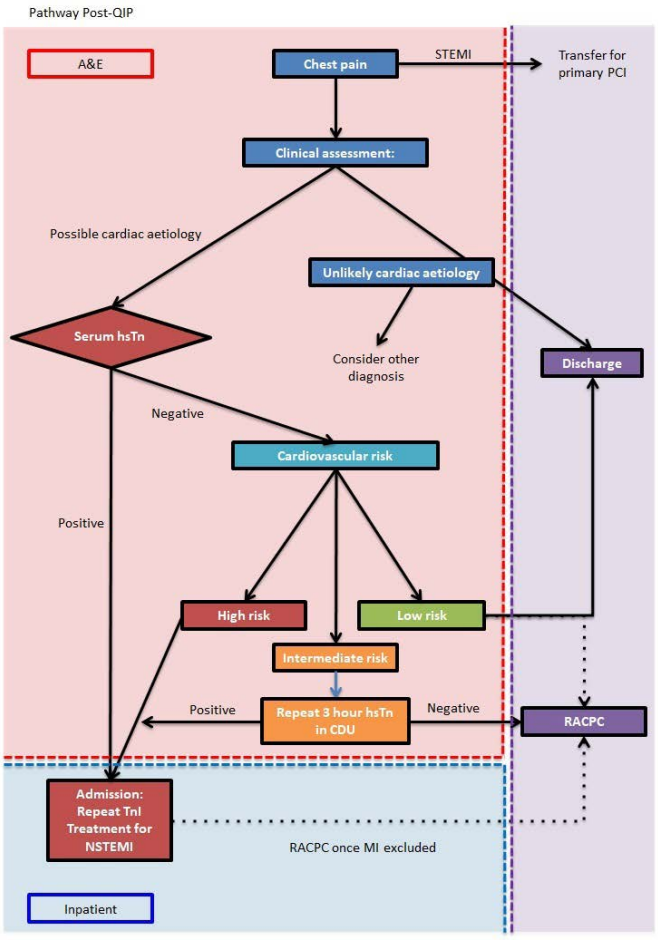

Figure 3 Flowchart demonstrating the chest pain pathway at WMUH after QIP implementations. Shaded areas represent the clinical setting of decisions within the pathway (red denotes A&E; blue denotes inpatient ward; and purple denotes outpatient). Decisions in A&E are made within a 4-hour time frame as per national care standards. A&E, accident and emergency; CDU, clinical decision unit; hsTn, high-sensitivity troponin; MI, myocardial infarction; NSTEMI, non-ST-elevation myocardial infarction; PCI, percutaneous coronary intervention; QIP, quality improvement project; RACPC, rapid access chest pain clinic; STEMI, ST-elevation myocardial infarction; TnI, troponin I.

A&E and their demographics were variable and unpredictable with each month. At the baseline measurement, 422 patients presented to A&E with chest pain. This varied from 453 to 600 for the subsequent data collection points. Interestingly, this variability did not translate to the referral or MI diagnosis rate, which remained stable. In our analysis to allow for this variation, we calculated admission rate relative to total numbers assessed in A&E.

CONCLUSION

Our baseline audit identified several areas of improvement in the management of patients presenting with chest pain. We improved compliance with NICE CG95, refined the hospital chest pain referral pathway and implemented hsTn testing. Through these interventions, our project achieved a 42% reduction in non-MI chest pain hospital admissions, which corresponds to cost savings of approximately £21 000 per month.

This QIP will be sustained through the continued use of hsTn in combination with the newly created CDU and RACP pathways. We will continue to assess their impact by using the audit tool and presenting findings at regular educational and departmental meetings.

As healthcare providers consider the introduction of hsTn into existing chest pain pathways, the interventions developed here may serve as a template to reduce rates of avoidable chest pain admissions.

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