National variation in coronary angiography rates and timing after an acute coronary syndrome in New Zealand (ANZACS-QI 6)

Michael J A Williams, Scott A Harding, Gerard Devlin, Chris Nunn, Seif El-Jack, Tony Scott, Mildred Lee, Andrew J Kerr on behalf of the ANZACS-QI investigators

ABSTRACT

AIM: The New Zealand Cardiac Clinical Network and the Ministry of Health recommend a “3-day door-to-catheter target” for acute coronary syndromes (ACS) admissions, requiring that at least 70% of ACS patients referred for invasive coronary angiography (ICA) undergo this within 3 days of hospital admission. We assessed the variability in use of ICA, timing of ICA, and duration of hospital admission across New Zealand District Health Boards (DHBs).

METHODS: All patients admitted to all New Zealand public hospitals with suspected ACS undergoing ICA over 1 year ending November 2014 had demographic, risk factor, and diagnostic data collected prospectively using the All New Zealand Acute Coronary Syndrome Quality Improvement (ANZACS-QI) registry. Complete datasets were available in 7,988 (98.4%) patients. DHBs were categorised as those able to perform percutaneous coronary intervention on-site (intervention-capable) or not.

RESULTS: There was a near two-fold variation between DHBs in the age standardised rate (ASR) of ICA ranging from 16.8 per 10,000 to 34.1 per 10,000 population (New Zealand rate; 27.9 per 10,000). Patients in intervention-capable DHBs had a 30% higher ASR of ICA. The proportion of ACS patients meeting the 3-day target ranged from 56.7% to 92.9% (New Zealand; 76.4%). Those in intervention-capable DHBs were more likely to meet the target (78.7% vs 68.0%, p<0.0001) and spent 0.84 days (p<.0001) less in hospital.

CONCLUSIONS: There is a considerable variation in the rate and timing of ICA in New Zealand. Patients with ACS admitted to DHBs without interventional-capability are disadvantaged. New initiatives to correct this discrepancy are needed.

Invasive coronary angiography (ICA) to assess for the presence of obstructive coronary artery disease (CAD) is a high volume, relatively expensive investigation which, along with revascularisation, reduces mortality in acute coronary syndrome (ACS). ICA is recommended, after appropriate risk stratification, for patients presenting with an ACS. There is the potential for both under- and over-utilisation of ICA. Furthermore, the timeliness of investigation is also important. Specifically for those with ACS, New Zealand and international guidelines recommend ICA within at least 3 days of admission, and earlier for some high-risk subgroups. A prior audit of three New Zealand hospitals reported that between 2007 and 2010 only about half of ACS patients received ICA in this timeframe. A 2012 nationwide New Zealand acute coronary syndrome (NZ ACS) audit reported that delays were greatest for patients presenting to non-intervention capable hospitals. Subsequently, the New Zealand Cardiac Clinical Network, supported by the Ministry of Health, proposed a “3-day door-to-catheter target” for ACS, requiring that at least 70% of ACS patients referred for ICA undergo this within 3 days of hospital admission. The 70% level was set, based on preliminary work reporting that a delay
may be indicated due to medical comorbidity in up to 30% of patients. This target was included in all district health boards (DHBs) annual plans and formed a key initial focus for the Network and Cardiac Society-led, and Ministry of Health funded All New Zealand Acute Coronary Syndrome Quality Improvement programme (ANZACS-QI). This programme uses a web-based registry to prospectively collect information on all patients undergoing ICA in New Zealand.

In this paper, we report data for the first year of comprehensive New Zealand public hospital catheterisation laboratory use of the ANZACS-QI registry. Virtually all ACS admissions in New Zealand are to public hospitals. Therefore the ANZACS-QI registry captures data on nearly all ICA performed for this indication. Our aim is to report the variation in use of and in time delays for ICA across the 20 DHBs in New Zealand.

Methods

ANZACS-QI Catheterisation and Percutaneous Coronary Intervention (CathPCI) registry data from 01 November 2013 to 31 October 2014 were extracted on 17 February 2015. All first angiograms in those presenting with suspected ACS (per patient analysis) in the 1-year study period with fully completed CathPCI data were included in this study. Individual patient characteristics, procedural details, indication, and outcome data were collected and collated at an individual hospital and a national level. The angiography rate per 10,000 population for each DHB were age-standardised rate (ASR). The standard population used was the European Standard Population with 5 age groups (20–44, 45–59, 60–69, 70–79, and 80+). The DHB population data used were the 2013 DHB Ethnic Group Population Projections, updated in 2014.

DHBs were divided into those with at least one hospital that performed percutaneous coronary intervention (PCI), and those DHBs without this interventional capability. While non-intervention-capable DHBs predominantly refer and transport their ACS patients to another DHB for ICA, there are some non-intervention-capable DHBs with a non-interventional cardiac catheterisation laboratory. Depending on local policy, they may perform the initial ICA and then transfer as appropriate for PCI or cardiac surgery to another DHB.

Data collections and definitions

The ANZACS-QI programme uses a web-based data collection and decision support platform to collect data on patients presenting with ACS (ACS registry), and on all patients undergoing ICA and PCI (CathPCI registry). Since November 2013, all New Zealand public hospitals that provide ICA services have completed the web-based CathPCI registry form for every coronary procedure performed. This analysis used data collected from CathPCI registry. An electronic CathPCI form is generated for all patients who have an ICA procedure. This form contains mandatory demographic, clinical and angiographic data fields supported by definition fields. Data are entered by medical, radiology and nursing staff at the time of the procedure and finalised at, or shortly after, discharge home.

A summary of the study definitions follows: procedural indications were categorised according to presumed diagnosis at presentation to the catheterisation laboratory into ACS or non-ACS. During the study period, 8,122 ACS patients underwent ICA. Of these 7,988 (98.4%) patients had complete datasets and are the cohort used in this study. ACS indications were subdivided into suspected ST-elevation myocardial infarction (STEMI) within 12 hours of symptom onset (STEMI <12h) and other suspected ACS, including all patients who were diagnosed with, or suspected to have, unstable angina, non ST-segment myocardial infarction (NSTEMI), or STEMI >12 hours after symptom onset. The site of arterial access was recorded as radial or femoral. Obstructive coronary artery disease was defined as the presence of a ≥50% diameter stenosis in at least one major coronary artery. Mild coronary artery disease was defined as a stenosis < 50% in one or more coronary arteries, and normal coronary arteries as no coronary artery stenosis in any vessel. Major coronary arteries were defined as left main stem, left anterior descending (including diagonal), circumflex (including obtuse marginal), ramus intermedius and right coronary artery.

Components of in-hospital stay: The total length of hospital stay, and its components, admission to the coronary angiography
Table 1: All New Zealand coronary angiograms performed for acute coronary syndrome over 12 months: total and categorised by District Health Boards with and without an intervention-capable cardiac catheterisation laboratory.

<table>
<thead>
<tr>
<th></th>
<th>New Zealand (n=7,988)</th>
<th>Admitted to hospital in DHB with an interventional catheterisation laboratory</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes (n=6,225)</td>
<td>No (n=1,763)</td>
</tr>
<tr>
<td><strong>Age, years</strong></td>
<td></td>
<td>64.1 ± 12.1 65 (56–73) 16–98</td>
<td>64.0 ± 12.2 65 (55–73) 19–97</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>5,342 (66.9)</td>
<td>4,190 (67.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2,646 (33.1)</td>
<td>2,035 (32.7)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td>819 (10.3)</td>
<td>523 (8.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>418 (5.2)</td>
<td>379 (6.1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>322 (4.0)</td>
<td>303 (4.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>249 (3.1)</td>
<td>229 (3.7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6,108 (77.4)</td>
<td>4,791 (77.0)</td>
</tr>
<tr>
<td><strong>Indication for angiogram, n (%)</strong></td>
<td></td>
<td>1,402/7,988 (17.6)</td>
<td>1,173/6,225 (18.8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6,586/7,988 (82.4)</td>
<td>5,052/6,225 (81.2)</td>
</tr>
<tr>
<td>Prior CABG, n (%)</td>
<td></td>
<td>Yes</td>
<td>519 (6.5)</td>
</tr>
<tr>
<td>Vascular access, n (%)</td>
<td></td>
<td>Femoral</td>
<td>1,274 (15.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Radial</td>
<td>6,705 (83.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brachial</td>
<td>9 (0.1)</td>
</tr>
<tr>
<td>Obstructive CAD on angiogram, n (%)</td>
<td></td>
<td>All ACS</td>
<td>6,015/7,988 (75.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ST elevation MI &lt;12 hours</td>
<td>1,276/1,402 (91.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other suspected/known ACS</td>
<td>4,739/6,586 (72.0)</td>
</tr>
<tr>
<td>Three vessel + LMS CAD in those without prior CABG, n (%)</td>
<td></td>
<td>1,777/7,469 (23.8)</td>
<td>1,378/5,814 (23.7)</td>
</tr>
</tbody>
</table>

DHB; district health board, SD; standard deviation; IQR; interquartile range, NZ; New Zealand, ST elevation MI; ST segment elevation myocardial infarction, ACS; acute coronary syndrome, CABG; coronary artery bypass surgery, CAD; coronary artery disease, LMS; left main stem. Obstructive CAD = ≥50% stenosis in ≥1 vessels.

Procedure (door to cath) and time from coronary angiography to discharge (cath to discharge) were captured for all patients. Discharge was defined as discharge home or to residential care/private hospital, or in the case of those referred for in-patient cardiac surgery, the date of transfer to the surgical team. For patients who were transferred to another hospital for coronary angiography the following three subdivisions of the door to cath time were collected: time from admission to the tertiary hospital referral (admission to referral); time from referral to transfer to the tertiary hospital (referral to transfer); and time from tertiary hospital transfer to ICA (transfer to cath).

**Statistical analysis**

Descriptive statistics for continuous variables were summarised as mean with standard deviation, and/or median with inter-quartile range (IQR). Categorical data are reported by frequency and percentage. For continuous variables, comparisons between groups were performed by
student’s t-test for normally distributed and the non-parametric Mann-Whitney U test for non-normally distributed data. For categorical variables, Pearson’s chi-squared test or Fisher exact tests were used where appropriate. All P-values reported were two-tailed, and a P-value <0.05 was considered significant. Data were analysed using SAS statistical package, version 9.3 (SAS Institute, Cary, NC).

Results

The characteristics of the 7,988 patients undergoing ICA after an ACS admission are shown in Table 1. There were 6,225 (77.9%) admitted to a hospital in a DHB with an intervention-capable cardiac catheterisation laboratory, with the remainder admitted in DHBs without this facility. Of the cohort 1,402 (17.6%) had an indication of presumed STEMI<12h, with the remainder being other suspected ACS. Vascular access was predominantly by the radial artery, used in 6,705 (83.9%) of patients. The rate of radial access was higher in DHBs with an intervention-capable catheterisation laboratory (85.8% vs 77.5%, P <0.0001). Non-obstructive CAD was observed in 25% of patients having ICA (normal 11%, mild obstructive CAD, 14%).

Variation in coronary angiography rates

The New Zealand ASR of ICA rate for an ACS indication was 27.9 per 10,000 population. There was variation in the ASR of ICA performed in different DHBs in New Zealand, with a two-fold variation from the lowest rate of 16.8 per 10,000 population, to the highest rate of 34.1 per 10,000 population. In Figure 1, the ASR of ICA was significantly lower than the national ASR for seven of the eleven DHBs without an intervention-capable catheterisation laboratory compared with three of nine with an intervention-capable facility. Four of the nine intervention-capable DHBs had ASRs significantly higher than the national rate, but none of the non-intervention-capable DHBs.

Table 1 also compares patients who had ICA in DHBs with (75%) and without an intervention-capable public hospital catheterisation facility (25%). Compared with DHBs with intervention-capability, those without had patients of similar age and
**Figure 2:** Proportion of acute coronary syndrome patients with obstructive coronary artery disease.

Error bars indicate 95% confidence intervals. DHB; district health board, CathLab; catheterisation laboratory. New Zealand proportion with obstructive coronary artery disease 75.3% (red dotted line).

**Table 2:** Delays in coronary angiography after acute coronary syndrome in District Health Boards with and without an interventional catheterisation laboratory.

<table>
<thead>
<tr>
<th></th>
<th>DHBs with interventional catheterisation lab.</th>
<th>DHBs without interventional catheterisation lab.</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meeting the ACS 3-day target, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEMI &lt;12 hrs</td>
<td>4,902/6,225 (78.7%)</td>
<td>1,198/1,763 (68.0%)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Other suspected/know ACS</td>
<td>1,158/1,173 (98.7%)</td>
<td>217/229 (94.8%)</td>
<td>.0005</td>
</tr>
<tr>
<td></td>
<td>3,744/5,052 (74.1%)</td>
<td>981/1,534 (64.0%)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td><strong>Admission to coronary angiography</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>6,222</td>
<td>1,761</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>2.26 ± 2.79</td>
<td>2.87 ± 2.49</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>2 (0–3)</td>
<td>2 (1–4)</td>
<td></td>
</tr>
<tr>
<td><strong>Coronary angiography to discharge</strong></td>
<td></td>
<td></td>
<td>.0709</td>
</tr>
<tr>
<td>N</td>
<td>6,225</td>
<td>1,763</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>2.98 ± 4.17</td>
<td>3.22 ± 6.33</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>1 (1–3)</td>
<td>1 (1–3)</td>
<td></td>
</tr>
<tr>
<td><strong>Length of stay</strong></td>
<td></td>
<td></td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>N</td>
<td>6,223</td>
<td>1,763</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>5.24 ± 5.05</td>
<td>6.08 ± 6.96</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>4 (2–6)</td>
<td>4 (3–7)</td>
<td></td>
</tr>
</tbody>
</table>

DHB; district health board, SD; standard deviation; IQR; interquartile range.
gender, but a higher proportion of Māori, and lower proportions of Pacific, Indian and other Asian ethnicities.

These results are based on whether the patient lives in a DHB with or without an intervention-capable catheterisation laboratory. However, several DHBs have a catheterisation laboratory which is not intervention-capable, and some DHBs have more than one hospital, only one of which has a catheterisation laboratory. When the analysis was repeated to compare acute patients initially admitted to a hospital with or without a cardiac catheterisation laboratory, the findings were similar (data not shown).

The proportion of all ACS patients with obstructive coronary disease was 75.3%, and was 91.0% in the sub-group presenting with suspected ST-elevation MI within 12 hours of symptom onset. There was relatively little variability across DHBs in the proportion of patients found to have obstructive CAD, ranging from a low of 68.9% to a high of 83.3% (Figure 2).

Patients from DHBs without intervention-capability were slightly more likely to have obstructive coronary artery disease when studied for a suspected non ST-segment elevation ACS, although there was no difference in the proportion of patients with more severe coronary disease, three vessel and/or left main stem coronary disease.

Timing of coronary angiography

In all patients with ACS, the median (IQR) time from admission to ICA was 2 (1–3) days. Overall, 6,100 (76.4%) patients had ICA performed within 3 days of admission and the median (IQR) length of stay was 4 (3–6) days. When we compared the admission to ICA times across DHBs, the proportion of patients having ICA within 3 days of admission varied from 56.7% to 92.9% (Figure 3). In DHBs without intervention capability, fewer patients with ACS had ICA within 3 days of admission (68.0% vs 78.7%, p<0.0001) and time from admission to angiography was 0.61 days longer (Table 2). Nearly all patients with STEMI <12 hours had angiography within 3 days (Table 2, Figure A1). For other suspected/known ACS, all but one of the intervention-capable DHBs met the national 3-day target of at least 70% of patients, but only four of eleven non-intervention-capable DHBs achieved this target (Figure A2). The longer time from admission to angiography was the major contributor to the 0.84 days longer length-of-stay observed in DHBs without interventional capability.

---

Figure 3: Proportion of patients meeting the 3-day target; coronary angiography within 3 days of admission for those referred after acute coronary syndrome in District Health Boards with and without an interventional catheterisation laboratory.

Error bars indicate 95% confidence intervals. DHB; district health board. CathLab; catheterisation laboratory. New Zealand target of 70% having angiography ≤ 3 days of admission (red dotted line).
Figure 4: Components of in-hospital stay for acute coronary syndrome patients with and without transfer to another hospital for coronary angiography.

Of the 1,763 patients presenting with ACS in DHBs without an intervention-capable catheterisation laboratory, 1,182 (67.0%) required transfer to another hospital for their ICA. The other third of ACS patients presenting to non-intervention-capable DHBs had the initial ICA performed in a local non-intervention-capable facility and were then transferred for intervention if indicated. The components of in-hospital stay for ACS patients admitted to a non-intervention-capable hospital are shown in Figure 4. The total length of stay for transferred patients was a mean of 1.5 days longer (6.7 vs 5.2 days). This longer length of stay was largely due to a greater delay in receiving coronary angiography of 1.6 days. This delay was made up of 1 day between admission and referral, another day between referral and transfer, and nearly 2 days from transfer to the ICA procedure. Of note, the transferred patients waited in the intervention-capable hospitals for 1.8 days, almost as long as those initially admitted to intervention-capable hospitals.

Discussion

In this prospective nationwide registry, which captured virtually all coronary angiography procedures performed in ACS patients presenting to hospital in New Zealand over 1 year, there was a nearly two-fold variation in age standardised rates of ICA for this indication across the twenty DHBs. The lowest rates were seen in DHBs without on-site intervention-capable cardiac catheterisation laboratories. Furthermore patients admitted with an ACS in a DHB without interventional capability experienced the longest delays, resulting in a nearly 1-day longer hospital stay. For the over 1,000 ACS patients per year who needed to be transferred to an intervention capable hospital for their ICA, the average length of hospital stay was 1.5 days longer.

Variability in rate of coronary angiography

There are a number of potential influences on the variation in ICA rates including variation in rates of ACS presentation, demographic and comorbidity variables, facility and medical personnel factors. In particular, the findings of the present study suggest that an important determinant of variability in ICA rates relates to the absence of an intervention-capable cardiac catheterisation laboratory within the DHB where the patient resides. Although the number of catheterisation laboratory facilities in a region has been shown to be a determinant of ICA rates in fee-for-service health systems, there are no equivalent analyses available in New Zealand. However, a parallel could be drawn in relation to disparities in rates of CT scanning with urban New Zealanders,
shown to be 1.6 times more likely to have CT scans than rural New Zealanders without on-site CT scanning at their local hospital.\textsuperscript{11} This disparity was eliminated when on-site CT scanning facilities were introduced at one rural hospital.\textsuperscript{12}

A further possible factor influencing the rate of ICA in ACS is the role of the medical decision maker. In New Zealand, patients are referred for coronary angiography by either cardiologists or general physicians/medical officers, depending on the size and location of the referring hospital, with smaller DHBs more often having general physicians caring for ACS patients. Although a difference by subspecialty training in referral pattern is a likely contributor to the variation between DHBs, it is interesting to note that there is important variation even across the intervention capable DHBs.

Logistically, it will not be possible to introduce intervention-capable cardiac catheterisation laboratories and employ cardiologists in all New Zealand hospitals. Therefore, in order to reduce the variability in rates of ICA, the national and regional cardiac networks need to develop comprehensive clinical pathways aimed at eliminating barriers to timely patient transportation and ensuring equitable access to coronary angiography, regardless of geographic location.

Timeliness of coronary angiography in ACS patients

A previous study, including admissions between 2007 and 2010, reported a median admission to coronary angiography time of 3 (IQR 2–5) days, with only just over half having angiography within 3 days of admission.\textsuperscript{5} Similarly, the 2007 NZ ACS audit,\textsuperscript{13} found that only 59% of patients had ICA in under 5 days, with ACS patients presenting to a non-interventional hospital waiting longer for angiography compared to those in interventional centres (median 5.1 vs 2.5 days). Subsequently, the NZ ACS audit group reported that in 2012 the median door-to-catheter time for ACS patients was 2.7 days. Again, patients with NSTEMI/unstable angina in non-interventional centres waited longer for angiography compared to those in interventional centres (median 3.8 vs 2.1 days).\textsuperscript{6}

The findings in the present study indicate that, compared with the historical data, there has been a substantial reduction in median time from admission to angiography to 2 (IQR 1–3) days for patients with ACS. This has occurred since national implementation of the ANZACS-QI “3-day door-to-catheter target” by the NZ Cardiac Clinical Network and Ministry of Health in 2013. Although a formal economic analysis has not yet been performed, the observed reduction in door-to-catheter times of approximately 1 day, relative to historical controls, of around 8,000 patients per year, represents an important ongoing saving for the DHBs. Patients admitted to DHBs without interventional-capable cardiac catheterisation laboratories still wait longer for coronary angiography, although the difference has reduced to 0.61 days. There has been a significant improvement in the proportion of patients having coronary angiography in a timely manner, with 76.4% having ICA within 3 days of admission. Of concern, there remains substantial variation according to DHB, with a range from 56.7% to 92.9% meeting the 3-day target. The variability is influenced by centres without interventional cardiac catheterisation laboratories having additional delays to ICA.

Delays to ICA in patients with NSTEMI presenting to hospitals without cardiac catheterisation laboratories has also been highlighted in the UK National Health Service in terms of both wasted bed days and delays in obtaining the prognostic benefit from early revascularisation.\textsuperscript{14} Our data suggest that for patients requiring transfer, there are important delays in referral, transfer and performance of ICA once the patient has been transferred. Attention to processes in each of these pre-ICA phases will help to reduce length-of-stay for patients admitted to hospitals without interventional cardiac catheterisation laboratories. A recent UK study evaluated a protocol-driven early transfer process with a decision on transfer made within 1 hour of diagnosis, resulting in a substantial reduction in admission to ICA time to a median 1 (IQR 0.7–2.0) day.\textsuperscript{15}

We propose a modification of this approach appropriate to New Zealand, which is characterised by a geographically-dispersed population and smaller regional centres. It is recommended that
the national and regional cardiac networks develop protocols requiring referral of patients with ACS admitted to hospitals without cardiac catheterisation laboratories at the time of first diagnosis to the regional PCI capable hospital. This would facilitate early triage of patients, with immediate transfer of high-risk STEMI and NSTEMI patients who will obtain the greatest clinical benefit from early angiography. The remaining ACS patients suitable for coronary angiography would have immediate formulation of transfer plans, with transfer for angiography generally occurring the morning after the day of admission. This approach would have patients transferred to a PCI-capable hospital no later than 1 day after their admission, and is likely to largely eliminate the current delay to angiography for patients admitted to a hospital without an interventional cardiac catheterisation laboratory. Consultation with the ambulance service to plan for timely transfer of patients, and dedicated beds at the referral PCI-capable hospital, are an important part of developing such a protocol. ANZACS-QI has just begun to report the components of the “door-to-catheterisation” delay for each hospital. These components include the time from admission to referral, transfer delay, and time from arrival at the PCI-capable hospital to angiography. This should facilitate the identification of where in the overall system the delays are occurring, and guide development of the specific process improvements required.

What are the consequences of lower rates of and delayed coronary angiography?

Previous NZ ACS audits have shown lower rates of coronary angiography in non-interventional centres for patients admitted with definite ACS (58% vs 49%), translating into lower rates of revascularisation (41% vs 32%). Meta-analysis in patients with NSTEMI has shown higher rates of ICA and revascularisation are associated with reductions in: mortality; recurrent myocardial infarction; and rehospitalisation for unstable angina. Delays in timing of ICA are associated with increased rates of recurrent ischaemia and an increase in hospital stay. These results indicate the potential for adverse events faced by patients admitted to New Zealand hospitals without interventional cardiac catheterisation laboratories.

Rate of non-obstructive CAD at angiography

The overall rate of non-obstructive coronary artery disease was 25% in New Zealand hospitals, with relatively little variation across DHBs, implying consistent patient selection across the country. Previous angiographic studies of patients presenting with ACS have reported rates from 10% to 25% of non-obstructive coronary artery disease. The important clinical finding identified in these studies is that patients presenting with ACS and non-obstructive coronary artery disease have an increased risk of long-term recurrent ischaemic events and require similar aggressive medical therapy to those with obstructive coronary artery disease.

Conclusions

There is significant variability between DHBs in the overall rates of coronary angiography performed, and in the timing of coronary angiography amongst those with ACS. Compared with prior data, the delay from admission to angiography for these patients has improved. However, patients admitted in DHBs without interventional cardiac catheterisation laboratories still experience a longer delay from admission to ICA, resulting in a longer length of hospital stay. Structural changes to regional cardiac pathways are required to address these discrepancies.
Appendix

**Figure A1:** Proportion of patients meeting the 3-day target: coronary angiography within 3 days of admission for those referred after STEMI <12 hrs in District Health Boards with and without an interventional catheterisation laboratory.

**Figure A2:** Proportion of patients meeting the 3-day target: coronary angiography within 3 days of admission for those referred after other suspected/known ACS in District Health Boards with and without an interventional catheterisation laboratory.
Competing interests:
Scott Harding reports grants from AstraZeneca, and personal fees from Boston Scientific, Medtronic and Bio-Excel, outside the submitted work.

Acknowledgements:
ANZACS-QI programme implementation, coordination and analysis: Programme implementation is coordinated by the National Institute for Health Innovation (NIHI) at the University of Auckland. The ANZACS-QI software was developed and supported by Enigma Solutions. ANZACS-QI Governance group: Andrew Aitken, Gerry Devlin, Karen Evison, Andrew Kerr (chair), Peter Larsen, Kim Marshall, Mark Simmonds, Michael Williams, David Smyth, Stewart, Harvey White. ANZACS-QI Project management: Sarah Masson, Charmaine Flynn (Northern coordinator), Maxine Rhodes (Southern coordinator).

Author information:
Michael JA Williams, Cardiologist, Cardiology Department, Dunedin Hospital, Dunedin and Clinical Professor, Department of Medicine, Dunedin School of Medicine, University of Otago, Dunedin; Scott A Harding, Cardiologist, Cardiology Department, Wellington Hospital, Wellington and Adjunct Professor, School of Biological Science, Victoria University, Wellington; Gerard Devlin, Cardiologist, Cardiology Department, Waikato Hospital, Hamilton and Honorary Associate Professor of Medicine, University of Auckland, Auckland; Chris Nunn, Cardiologist, Cardiology Department, Waikato Hospital, Hamilton; Seif El-Jack, Cardiologist, Cardiology Department, North Shore Hospital, Auckland; Tony Scott, Cardiologist, Cardiology Department, North Shore Hospital, Auckland; Mildred Lee, Health Analyst, Middlemore Hospital, Auckland; Andrew Kerr, Cardiologist, Cardiology Department, Middlemore Hospital, Auckland and Honorary Associate Professor of Medicine, University of Auckland, Auckland.

Corresponding author:
Professor Michael Williams, Cardiology Department, Dunedin Hospital, 201 Great King Street, Private Bag 1921, Dunedin 9054, New Zealand.
michael.williams@otago.ac.nz

URL:

REFERENCES:


