Door to balloon times: streamlining admission for primary percutaneous coronary intervention

Neil Swanson, Christopher Nunn, Steve Holmes, Gerry Devlin

Abstract:

Aims Primary angioplasty is superior to thrombolysis in ST elevation myocardial infarction (STEMI). This advantage is dependent on how quickly angioplasty can be performed. Several strategies have been suggested to cut door to balloon (D2B) times. We aimed to audit and reorganise the admission process to accelerate D2B times, in Waikato Hospital, New Zealand.

Methods The admission process for STEMI was audited. Three changes were made. One step in the catheterisation lab activation system (referral to cardiology registrar on call) was removed. Single call pager activation of the catheterisation lab team was adopted. Feedback of timing performance data by email and printout was established. Timing data were collected for 6 months before and after these changes.

Results After the admission process was changed 88.5% of patients had a D2B time <90 min vs 63.6% before. Median D2B times were reduced from 74.5 min to 59 min (p=0.09). Median time from admission to arrival at cath lab was reduced from 50min to 35 min (p=0.019).

Conclusions Relatively minor changes in admission process, without new resources, can lead to reductions in door to balloon times. This was achieved in a hospital with a selective PPCI policy and modest annual volume of PPCI.

Primary percutaneous intervention has become an increasingly common strategy for the management of ST elevation MI. Metanalysis of 23 STEMI trials\(^9\) has confirmed the benefits of PPCI, reducing 30-day mortality, reinfarction and stroke. However, increased delay before such intervention has been associated with poorer outcomes.\(^11\)\(^-\)\(^14\)\(^,\)\(^15\) Both US and European guidelines\(^16\)\(^,\)\(^17\) emphasise the importance of prompt (<90 min) performance of PPCI, by skilled teams in high volume centres.

The D2B Alliance, an association of professional bodies interested in improving D2B times (i.e. the time from arrival in hospital to first balloon inflation, [http://www.d2balliance.com/Menu/D2BImplementationManual](http://www.d2balliance.com/Menu/D2BImplementationManual)) in the US. They found that six strategies\(^18\) were associated with significantly reduced D2B times (Table 1).

Waikato Hospital is in North Island New Zealand, with a local population of approximately 200,000, around 20% Maori. A PPCI policy (described below) was established a decade ago for all high-risk patients presenting to Waikato Hospital with STEMI. It allows for testing of the strategies of the D2B Alliance in a unit with smaller PPCI volumes, volumes similar however to many units worldwide.

In-house audit of the existing admission procedure was compared to the successful strategies outlined by the D2B alliance. Following multidisciplinary discussions,
changes in the admission process were instituted and the results audited, comparing D2B times in the 6-month periods before and after the changes were instituted.

Figure 1. Example feedback email used in Waikato. Timing data allow staff members feedback for patients they have dealt with personally

![Feedback Email](image)

Table 1. Strategies associated with reduced D2B times. ED=emergency department, cath lab=cardiac catheterisation laboratory. Strategies in bold were adopted wholly or partly during the study period. Data from Bradley et al 18

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Mean reduction in D2B (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED activates the cath. lab while patient still en route</td>
<td>19.3</td>
</tr>
<tr>
<td>ED physicians activate the cath. lab</td>
<td>8.2</td>
</tr>
<tr>
<td>Single call to a central operator activates cath. lab</td>
<td>13.8</td>
</tr>
<tr>
<td>Cath. lab staff to arrive within 20 minutes after page</td>
<td>19.3</td>
</tr>
<tr>
<td>Attending cardiologist always on site</td>
<td>14.6</td>
</tr>
<tr>
<td>Having staff receive real-time feedback</td>
<td>8.6</td>
</tr>
</tbody>
</table>

1. The Emergency Department (ED) physician reviewing the initial ECG called the cardiologist on call directly. Previously, they had contacted the on call cardiology registrar to come and make an assessment before they might then call the oncall cardiologist. This then removed one step in activating the catheterisation lab, but did not allow ED staff to directly activate the catheterisation lab team themselves. Out of hours, the cardiologist could activate the cath lab team by a single call and they would arrive in 20 minutes.

2. A test call was made, which all cath lab staff were issued pagers to answer to prevent the situations where switchboard had occasionally found it hard to know whom to call and how to contact them.
3. Prompt email feedback (see Figure 1) to all medical and non-medical staff involved in the patient’s initial care. This gave a brief record of timing data. Email addresses were stored securely, accessible only by the data entry team members. The feedback system also made reports to nurse leaders and educators in the department. Printouts of the (anonymous) report were pinned to the ED staff notice board, and in cath lab. Previously, no early feedback had occurred.

A D2B team was formed which took responsibility for the new admission process. In-house teaching sessions were arranged and feedback encouraged. A STEMI admission algorithm was prominently displayed in ED and cath lab.

Methods

Audit of the current admission procedure identified to what extent strategies recommended by the D2B Alliance were already in place or where these strategies might be introduced. Ethical approval was not required as the audit was performed as part of service improvement and review.

Study population—Changes were made in February 2007, with data collection for 6 months before and after this point. PPCI patients constituted a higher-risk subgroup of STEMI patients. They were defined as patients presenting with anterior ST elevation, new left bundle branch block or inferior and lateral myocardial infarcts with reciprocal changes or right ventricular involvement. Any patients with hemodynamic instability, including cardiogenic shock were included. All patients with contraindications to thrombolysis were treated with PPCI.

The lower-risk remaining patients were given thrombolysis.

Patients already in the hospital were not included in the analysis, nor were patients transferred from other centres.

Changes instituted—After initial audit and multidisciplinary discussion, three main changes (see Table 1) were made to the admission process A target of achieving a door-to-balloon time of <90 minutes for >75% of non-transfer PPCI patients was used to judge the effect of these changes.

Definitions—D2B time = time from hospital arrival to establishment of reperfusion by an interventional device.
ED=Emergency department
PPCI=Primary Percutaneous coronary intervention by angioplasty, with or without stent, for STEMI.

Data collection and analysis—Treatment times were recorded for all PPCI patients. These were the time of symptom onset, time of arrival in ED, time of call to cardiologist, time of cath lab arrival and time of first balloon inflation. This allowed calculation of the D2B time, the primary endpoint of the study, as well as analysis of the relative contribution of the various steps in admission to the overall delay. The proportion of patients with D2B time <90 minutes and median D2B time were calculated.

Statistical methods—Non-parametric values were compared with the Wilcoxon rank-sum test (for two samples) using StatPlus Professional 2007 software (AnalystSoft). A Chi-squared (Pearson’s) test was used to test for differences in baseline demographics and for 30-day mortality before and after admission process was changed, although the study was not powered for mortality as an endpoint. A value of P<0.05 was considered significant.

Results:

Baseline demographics between the cohorts were broadly similar, although a higher incidence of smoking was seen in the earlier group (see Table 2). None of the patients were undergoing repeat procedures, making the two groups independent samples.

Effect of changed admission process on D2B times—72 patients were triaged for treatment with PPCI during the study period. Of these, 38/72 patients’ data were included in the study, 12 pre-change, 26 post-change. The remainder were excluded because the patient was already in the hospital at the time of infarction (16/34), was an inter-hospital transfers (3/34) or did not proceed to PCI (because of non-occlusive
coronary disease (7/34), surgical disease (1/34) and subsequent diagnoses other than AMI (7/34).

Table 2. Baseline demographic findings between patients studied before the changed admission procedure (Pre) and after (Post)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pre</th>
<th>Post</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>63.2</td>
<td>58.8</td>
<td>0.35</td>
</tr>
<tr>
<td>Male (%)</td>
<td>83.3</td>
<td>80.8</td>
<td>0.85</td>
</tr>
<tr>
<td>Maori (%)</td>
<td>8.3</td>
<td>7.7</td>
<td>0.95</td>
</tr>
<tr>
<td>Diabetic (%)</td>
<td>8.3</td>
<td>7.7</td>
<td>0.95</td>
</tr>
<tr>
<td>Previous MI (%)</td>
<td>8.3</td>
<td>0.0</td>
<td>0.14</td>
</tr>
<tr>
<td>Smoker (%)</td>
<td>41.7</td>
<td>11.5</td>
<td>0.03</td>
</tr>
</tbody>
</table>

A trend towards shorter D2B times (74.5 min vs. 59 min, p=0.09) was seen (Figure 2), due to improved (50 min vs. 35 min, p=0.02) median admission to cath lab arrival times. Prior to the changed admission process, 63.6% of patients had a D2B time <90 min. Subsequently 88.5% of patients were treated <90 min. Other component parts of the total D2B time were not different between the two groups. Two patients in each group died within 30 days of the index procedure.

Figure 2. Effect of changing PPCI admission process within Waikato Hospital.

Door to balloon time (D2B) shows a trend (*74.5 min vs. 59 min, p=0.09) to improvement from the six month period “Pre” change to the six month period “Post” change. This was due to a statistically significant improvement (†50 min vs. 35 min, p=0.02) in the time from admission to emergency department to the time of arrival in the catheterisation laboratory, which appeared to be mainly occurring in the period after initial referral to a cardiologist (‡30 vs 15 min, p=0.001).
Discussion

Overall changes to the admission process resulted in a 15-minute reduction in D2B times. It was not possible to determine the relative contribution the individual changes had on this improvement. The time from hospital arrival to cardiologist being called was not reduced, yet the time from hospital arrival to cath lab arrival was. This suggests that preparation for cath lab was minimised and that the physical journey to cath lab was being accelerated. On some occasions, ED physicians pushed patients to cath lab themselves. Other unquantifiable variables, such as the immediate availability of ED physicians to deal with PPCI patients (rather than other emergencies in ED) may have played a part.

Pain to balloon times in Waikato were not different between the two groups, despite the reduction in D2B times. This reflects the relatively small contribution triage (hospital arrival to cath lab) times have on overall treatment delays. Patient presentation delays comprise the major component of this overall. Only community education is likely to improve this.

Calling the cardiologist on call directly to access the cath lab removed initial cardiology registrar assessment, although they still came to assess the patient in preparation for cath lab. Further reduction in D2B times might be anticipated if the ED physician or nurse, were to call the cath lab team without discussion with a cardiologist. A selective PPCI policy makes this more difficult since the decision to call in the cath lab team is made on a case-by-case basis, by the senior cardiology clinician.

The test call was changed to become weekly after feedback from switchboard operators.

Staff in ED were generally very positive to the feedback innovation although it is not possible to know what proportion of feedback emails were actually read. The feedback reports were used in departmental teaching sessions.

Prehospital activation of the cath lab with telemetered ECGs was not introduced in this study as it would have required additional IT infrastructure and training. No requirement was made for the on-call cardiologist to be resident. In Waikato, with around 70 PPCI patients per year, this was felt to be unreasonable, with major resource implications.

A selective policy for PPCI, as in Waikato, attempts to target higher-risk patients with the most to gain from PPCI. The Zwolle trial showed that non-anterior MIs had similar mortality with either PPCI or thrombolysis. Retrospective analysis of the DANAMI-2 (Danish Multicentre Randomized Study on Fibrinolytic Therapy Versus Acute Coronary Angioplasty in Acute Myocardial Infarction) suggested that patients without hemodynamic upset or pulmonary congestion had no benefit in mortality or composite endpoints with PPCI over thrombolysis. It is unknown whether the selective policy used in Waikato may have influenced D2B times.

**Study limitations**—Study numbers are small, but are similar to the primary angioplasty workload seen in a year in many centres worldwide. The Wilcoxon rank
sum test may be less accurate when sample sizes are less than 20. These small numbers mean the results have to be interpreted with some caution. The influence of an ongoing audit may have altered behaviour of staff members to accelerate the admission process independent of the altered admission algorithm. It has not been established that a reduction in D2B times results in reduced adverse events. This would require a much larger study, powered for a mortality difference. Accelerating the D2B times may risk increasing the number of patients taken to cath lab inappropriately, although this was not observed during the study. The generalisability of these findings to units with a non-selective PPCI approach may be limited.

Conclusions

The benefits of PPCI may be reduced by long delays. Part of this delay, which clinicians have some ability to reduce, is the D2B time.

This study has shown that change involving several hospital departments can be successfully initiated. This approach allows the adoption of evidence-based, simple strategies resulting in significant reductions in the time spent prior to cath lab arrival. This requires commitment and organisation, but not greatly increased resources.

Competing interests: None known.

Author information: Neil Swanson, Cardiologist, Cardiology Department, James Cook University Hospital, Middlesbrough, United Kingdom; Christopher Nunn, Cardiologist, Cardiology Department, Waikato Hospital, Hamilton; Steve Holmes, senior audit administrator, Cardiology Department, Waikato Hospital, Hamilton; Gerry Devlin, Cardiologist, Cardiology Department, Waikato Hospital, Hamilton.

Acknowledgements: The authors acknowledge M Burningham and K Golding for their roles in data collection.

Correspondence: Neil Swanson, Cardiology Department, James Cook University Hospital, Middlesborough, TS4 3BW, United Kingdom. Fax: +44 1642 854190; email: neil.swanson@stees.nhs.uk

References:


