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High-risk myocardial infarction patients appear to derive more mortality benefit from short door-to-balloon time than low-risk patients

Deleted: – time for a new model of care?

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SUMMARY

Objectives: To evaluate reduction of door-to-balloon (DTB) time and its impact on in-hospital mortality of high-risk infarct patients in a collaboration of district general hospitals (DGH) with a physician-to-patient model.

Methods: Primary percutaneous coronary interventions (PPCI) with short DTB time offer mortality benefit for STEMI but literatures are conflicting on this benefit for high-risk versus low-risk patients.

In a unique model at Sandwell and West Birmingham Hospitals, 5 interventional cardiologists provide 24-hour PPCI at whichever one of its 2 DGH that patients present to.

A retrospective audit was performed on 3 years (July 2005-June 2008) of PPCI data in the British Cardiovascular Intervention Society database. Data were analysed in 4 periods corresponding to change from daytime-only to 24-hour PPCI. DTB time and in-hospital mortality were the main outcome measures.

Results: Of the 459 patients, median DTB time improved from 89 minutes (interquartile range 49-120) to 68 minutes (50-91) (P=0.005) and proportion of patients achieving target 90-minute DTB time increased from 53% (21/40) to 75% (93/124) (P=0.005). In-hospital mortality was less for short DTB time (4.6% [13/284] vs. 11.5% [20/174]; OR 0.37, 95%CI 0.18-0.75; P=0.008).

With the proviso that our study was limited in power, long DTB time (>90 minutes vs. ≤90 minutes) was associated with higher in-hospital mortality in high-risk patients (15.6% [20/128] vs. 7.1% [12/168]; OR 2.41, 95%CI 1.14-5.06; P=0.024) and not in low-risk patients (0% [0/46] vs. 0.9% [1/117]; OR 0, 95%CI 0-9.88; P=1.000).

Conclusions: A collaboration of DGH with a physician-to-patient model can deliver timely PPCI that appear to translate into mortality benefit more so in high-risk patients. Low-risk patients would therefore probably tolerate delays associated with transfer to large centres

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2 while high-risk patients would not and need alternative strategy. A collaboration of smaller
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4 hospitals with a pool of mobile interventional cardiologists could be such an alternative.
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6

Deleted: Time for a re-think?

7 8 **Key words**

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10 District general hospital; door-to-balloon time; primary angioplasty; primary percutaneous
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12 coronary intervention; ST-segment elevation myocardial infarction.
13

14 15 16 **WHAT'S KNOWN**

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18 Timely 24-hour primary angioplasties (with door-to-balloon time shorter than 90 minutes) are
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20 the treatment of choice for ST-segment elevation myocardial infarction.
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24 Timely primary angioplasties are associated with mortality benefit but studies showed
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26 conflicting results for this benefit in high-risk versus low-risk patients.
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28 29 30 **WHAT'S NEW**

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32 A collaboration of district general hospitals with a physician-to-patient model can deliver
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34 timely 24-hour primary angioplasties.
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38 High-risk patients appear to derive more mortality benefit from timely primary angioplasties
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40 than low-risk patients.
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44 This model offers an alternative to the by-passing of or the transfer from smaller hospitals to
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46 larger centres for primary angioplasties.
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48 49 50 **INTRODUCTION**

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Timely primary percutaneous coronary interventions (PPCI) are the preferred treatment for ST-segment elevation myocardial infarction (STEMI) (1,2) even if their provision requires the transfer of patients from a non-angioplasty to an angioplasty centre (3). PPCI with short door-to-balloon (DTB) time (the interval between arrival in hospital and first balloon dilatation of an occluded coronary vessel) are associated with reduced in-hospital mortality (4,5); studies however showed conflicting results of this mortality benefit for high-risk versus low-risk patients (4,6,7). In a collaboration of district general hospitals with a physician-to-patient model, the ability of delivering PPCI with a short DTB time and the impact of short DTB time on in-hospital mortality of high-risk versus low-risk patients have not been studied.

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Sandwell and West Birmingham Hospitals NHS Trust in the United Kingdom

provides a unique model of care for patients having a STEMI. A group of 5 interventional cardiologists provide PPCI at whichever one of the 2 acute DGH that their patients present to. The service was rolled out as a daytime-only provision in July 2005 and this service became 24-hour provision in January 2007, PPCI are activated by emergency medicine physicians who would contact the on-call interventional cardiologist and the PPCI team directly. During weekdays 5pm-9am and weekends, there are separate on-call teams of staff nurses, radiographers and cardiac physiologists for each site with only the interventional cardiologist and cardiology registrar travelling to both sites.

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Deleted: and interventional team arrives within 30 minutes of paging by a single nurse from coronary care unit

We aimed to ascertain to what extent that target DTB time was achieved in this model, if PPCI within target DTB time translated to reduced in-hospital mortality and if there was a different impact of short DTB time on high-risk versus low-risk infarct patients. The remit of this study did not include the comparison of different models or their efficacy in reducing DTB time.

MATERIALS AND METHODS

Participants

A retrospective audit of the British Cardiovascular Intervention Society database was carried out on consecutive patients receiving PPCI for STEMI. The PPCI occurred over 3 years (July 2005 to June 2008) in 4 periods corresponding to change in practice: 5-day daytime 8am-8pm (July 2005-January 2006), 7-day daytime (February 2006-December 2006), first 24-hour PPCI period (January 2007-November 2007) and second 24-hour period (December 2007-June 2008) after preliminary presentation of results at the British Cardiovascular Society (June 2008) (8).

Outcome measures

We examined trends in median DTB times and proportion of patients who met target 90-minute DTB time. The recommendations are aiming for a DTB time ≤ 90 minutes for each patient, median DTB time ≤ 90 minutes and $\geq 75\%$ of patients achieving the target DTB time (9,10).

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Statistical analysis

Categorical variables were expressed as numbers with percentage, or as odds ratio (OR) with 95% confidence interval (CI) and compared using Fisher's exact test for 2x2 tables, chi-square test for tables larger than 2x2 or Cochran-Mantel-Haenszel test for repeated 2x2 tables. Continuous variables were expressed as mean +/- one standard deviation and compared using Student unpaired t test, or as median with interquartile range (IQR) and compared using Kruskal-Wallis test. All P values are 2-tailed and values >0.05 are considered to represent statistical non-significance (NS).

Assuming an in-hospital mortality of 3.0% for short DTB time and 7.5% for long DTB time (based on McNamara et al) (4) for all-comers, with 230 patients in each group, this

study had 50% power to show that short DTB time was associated with reduced in-hospital mortality. Assuming an in-hospital mortality of 4.5% for short DTB time and 10.5% for long DTB time for patients at high risk of dying from their STEMI, with 115 patients in each group, the power was 30%. Assuming an in-hospital mortality of 1.5% for short DTB time and 3.0% for long DTB time for patients at low risk, with 115 patients in each group, the power was 5%.

RESULTS

Baseline characteristics and angiographic data

There were 462 patients undergoing PPCI with DTB times available in 459 (99%). Mean age was 63 +/- 14 (range 16-100) years, 342 (75%) patients were male and 68 (15%) diabetic.

Demography was similar for both hospitals which treated similar number of patients (Table 1).

There were 498 vessels stented consisting of 249 (54%) left anterior descending arteries (142 [31%] proximal and 107 [23%] non-proximal), 87 (19%) left circumflex arteries and 193 (42%) right coronary arteries. Forty eight (10%) patients had ≥ 2 vessels stented, 120 (26%) had ≥ 2 lesions stented, 171 (37%) had ≥ 2 stents and 54 (12%) had ≥ 1 drug eluting stent (DES). There were 659 stents implanted and 214 (32%) were DES.

Outcomes

Median DTB time improved from 89 minutes (IQR 49-120 minutes) to 68 minutes (IQR 50-91 minutes) (P=0.005) and proportion of patients achieving target 90-minute DTB time or less increased from 53% (21/40) to 75% (93/124) (P=0.005) (Figure 1).

Patients with short DTB time (< 90 minutes) were comparable to those with long DTB time (> 90 minutes) in the characteristics of age, diabetes, abciximab use and

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Use of drug eluting stents and abciximab¶

There were 659 stents implanted and 214 (32%) were DES. Concerns over late stent thrombosis in DES raised in the European Society of Cardiology (September 2006 [11,12] and September 2007 [13]) coincided with decreasing DES use from 45% (68/220 stents) in July 2005-September 2006 period to 36% (100/380 stents) in October 2006-September 2007 period (OR 0.80, 95% CI 0.55-1.15; P=0.258=NS) and to 20% (46/271 stents) in October 2007-June 2008 period (OR 0.57, 0.39-0.85; P=0.006 compared to the immediate preceding period).¶

There were 182 (78%) patients who received abciximab glycoprotein IIb/IIIa inhibitor. Following the favourable outcomes for bivalirudin direct thrombin inhibitor in the Harmonizing Outcomes With Revascularization and Stents in Acute Myocardial Infarction (HORIZONS-AMI) trial (October 2007) (14,15), abciximab use decreased from 91% (288/317) in July 2005-October 2007 period to 64% (91/142) in November 2007-June 2008 period (OR 0.18, 95% CI 0.11-0.30; P<0.0001).¶

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cardiogenic shock (Table 2). There were, however, higher proportions of male and DES use in patients with long DTB time. Moreover, patients with long DTB time were also of higher risk conferred mainly by their higher proportion of anterior STEMI. One could surmise that this observed difference might have occurred by chance or that patients with anterior STEMI were more unwell requiring prolonged pre-PPCI stabilisation such as endotracheal intubation.

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There was a significantly higher proportion of out-of-hours PPCI in the group with long DTB time (56% [98/174] of patients with long DTB time had out-of-hours PPCI compared to 36% [103/285] of patients with short DTB time had out-of-hours PPCI, OR 2.28, 95% CI 1.55-3.35; P<0.0001) (Table 2). Stating this result in two other ways, a lower percentage of patients met target DTB time in out-of-hours (51.2% or 103/[103 + 98]) than during-hours (70.5% or 182/[182 + 76]); and DTB time exceeding 90 minutes occurred more frequently in out-of-hours (56.3% or 98/174) than during-hours (43.7% or [174 -98]/174). There was suggestion in literatures that out-of-hours PPCI had worse in-hospital mortality than during-hours PPCI (11). In our study, there was indeed a non-significant increase in in-hospital mortality for out-of-hours PPCI (8.0% [16/201]) compared to during-hours PPCI (6.6% [17/258]) (OR 1.23, 95% CI 0.61-2.46; P=0.589) (Table 3).

Deleted: More out-of-hours than during-hours (weekday 8am-8pm) PPCI missed target DTB time (56% [98/174] of DTB time >90 minutes vs. 36% [103/285] of DTB time ≤90 minutes occurred out-of-hours; OR 2.28, 95% CI 1.55-3.35; P<0.0001) (Table 2).

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All-comers' in-hospital mortality was 7.2% (33/459) (Table 3). For patients presenting with cardiogenic shock, i.e. persistent hypotension (systolic blood pressure <90 mmHg) and associated features such as tachycardia and pulmonary oedema, in-hospital mortality was 40.0% (20/50) compared to 3.2% (13/409) in those without shock (OR 20.31, 95% CI 9.30-44.34; P<0.0001) (Table 3).

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Overall, there were 182 (78%) patients who received abciximab glycoprotein IIb/IIIa inhibitor. Following the favourable outcomes for bivalirudin direct thrombin inhibitor in the Harmonizing Outcomes With Revascularization and Stents in Acute Myocardial Infarction (HORIZONS-AMI) trial (October 2007) (12,13), abciximab use decreased from 91%

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2 (288/317) in July 2005-October 2007 period to 64% (91/142) in November 2007-June 2008
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4 period (OR 0.18, 95% CI 0.11-0.30; P<0.0001).

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6 Consistent with benefit shown in literatures for abciximab in STEMI (14), our
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8 patients who did not receive abciximab had higher in-hospital mortality (15.0% [12/80]) than
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10 patients who had abciximab (5.5% [21/379]) (OR 3.01, 95% CI 1.43-6.33; P=0.007) (Table
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12 3).

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14 Coinciding with the controversies on the safety of DES highlighted in the European
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16 Society of Cardiology (September 2006 [15,16] and September 2007 [17]), there was
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18 decreasing DES use from 45% (68/220 stents) in July 2005-September 2006 period to 36%
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20 (100/380 stents) in October 2006-September 2007 period (OR 0.80, 95% CI 0.55-1.15;
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22 P=0.258=NS) and to 20% (46/271 stents) in October 2007-June 2008 period (OR 0.57, 0.39-
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24 0.85; P=0.006 compared to the immediate preceding period). There was a non-significant
25
26 trend that patients who received BMS had higher in-hospital mortality (8.4% [26/310]) than
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28 patients who received DES (4.7% [7/149]) (OR 1.86, 95% CI 0.80-4.28; P=0.179) (Table 3).

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30 For all-comers, patients who met target DTB time had lower in-hospital mortality
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32 (4.6% [13/285] vs. 11.5% [20/174]; OR 0.37, 95% CI 0.18-0.75; P=0.008) (Table 4). This
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34 trend was generally maintained across various patient subgroups (Table 4).

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36 When considering patients who had high risk of dying from STEMI (having one or
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38 more high-risk factors of cardiogenic shock, anterior STEMI, age ≥ 75 years or diabetes
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40 mellitus) (4,6,7,9) as one subgroup, long DTB time (>90 minutes vs. ≤ 90 minutes) was
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42 associated with higher in-hospital mortality in high-risk patients (15.6% [20/128] vs. 7.1%
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44 [12/168]; OR 2.41, 95% CI 1.14-5.06; P=0.024) and not so in low-risk patients (0% [0/46] vs.
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46 0.9% [1/117]; OR 0, 95% CI 0-9.88; P=1.000) (Table 5). Number of high-risk patients was
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48 substantial, representing 64% (296/459) of patients in our study and there were relatively
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50 more female gender and DES use among these patients (Table 6).

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DISCUSSION

By the final period, 75% patients met the target DTB time and the median DTB was 68 minutes. This median DTB time compared favourably to the average median DTB time in the United States (100.4 minutes) (18) and in the United Kingdom (59.4 minutes) (19). The latter included shorter DTB times from hospitals receiving transferred patients whose transport time and time spent in the referring hospitals were not counted. Our in-hospital mortality of 3.2% for patients without cardiogenic shock was comparable to the average rate of 4.8% in the United Kingdom (19).

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There was evidence that 24-hour PPCI was associated with reduction in DTB time and in-hospital mortality when compared to a mixed strategy of daytime-only PPCI and out-of-hours thrombolysis (20). Our result of 8.1% in-hospital mortality for mixed strategy versus 6.8% for 24-hour PPCI (Table3), even though statistically not significant, was consistent with these findings. With staff only having to work in one rather than switch confusingly between two time-dependent systems, the better outcome of 24-hour strategy could be related to efficiency through regular practice of one system and reduced susceptibility to delays by system-confusion.

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We believe that our model achieved reasonable DTB time through several ways. First, our protocol is kept simple and there are no artificial barriers such as time of the day or age criterion. Secondly, as discussed above, routine practice of one system promotes familiarity and efficiency. Thirdly, we have good communication with the paramedics and the emergency department. With the knowledge that reliable PPCI service is available, the paramedics are more likely to bring STEMI patients to our hospitals and keep up the experience and efficiency in PPCI for our staff. Fourthly, although there is no provision for specialist vehicles, all PPCI team members are required to live within 30 minutes away.

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Fifthly and more difficult to quantify, there is commitment and dedication from all persons involved, be they managers, consultants, paramedics or portering staff, to provide a speedy and efficient PPCI service to their local community.

By-passing of the emergency department by direct ambulance admission to the cardiac catheterisation laboratory significantly reduces DTB time (21) and could be a logical next step for our hospitals. In a study by Dorsch (21), directly admitted patients had significantly reduced median DTB time (58 vs. 105 minutes, $P < 0.001$) and the target 90-minute DTB time was achieved in 94% of direct admissions compared to 29% of patients referred from the emergency department. Granted that Dorsch's study was prospective and our study was retrospective, it was interesting to note that our corresponding results of 68 minutes and 75% were closer to Dorsch's results for patients who bypassed the emergency department than for their patients who were admitted via the emergency department.

On the other hand, activation of catheterisation laboratory by emergency physicians had been shown to be effective in reducing DTB time compared to activation by interventional cardiologists (18, 22). Therefore, it could be argued whether a pre-existing well-run emergency physician-activated PPCI service should be replaced with a paramedic-activated service. This reminisces the argument against replacing a well-run thrombolysis service with a new PPCI service. Any new PPCI service might initially perform less well but given time, teething problems would be overcome and efficiency and efficacy should improve. The same reasoning could be applied to a newly set-up paramedic-activated PPCI service. However, in the case of our already reasonable DTB time, it would still be valid to argue whether the by-passing of the emergency department would reduce DTB time substantially or only marginally. Since longer out-of-hours DTB time was primarily due to delays between obtaining the electrocardiogram and patient arrival at the catheterisation

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2 laboratory (11), we believe that this potential reduction in DTB time is likely to be substantial
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6 The literatures on the benefit and safety of DES, both short term and long term, were
7 conflicting. For example, there were concerns over acute and late stent thrombosis if DES
8 were used in patients with high thrombus burden (23). However, the decision to choose BMS
9 or DES by our interventional cardiologists was not dictated by thrombus burden but by
10 overall safety concerns for late stent thrombosis and possible increased cardiac death from
11 DES highlighted in the European Society of Cardiology, as alluded to in the results section.

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14 During these periods of uncertainty, our operators would use DES in lesions with high
15 risk of restenosis such as those that were >15mm in length or <3mm in diameter (24,25). In
16 the period following our study, the result of the Thrombus Aspiration during Percutaneous
17 coronary intervention in Acute myocardial infarction Study (TAPAS) (26) on the efficacy of
18 thrombectomy and the one-year report of HORIZONS-AMI (27) on the comparable safety of
19 paclitaxel DES had somewhat respectively removed the issue with thrombus burden and
20 restored some confidence in the use of DES in STEMI in our hospitals. Our results that
21 patients with DES had lower in-hospital mortality than those with BMS (Table 3), although
22 statistically not significant, were therefore reassuring and more consistent with subsequent
23 literatures.

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26 Although targeting for a short DTB time appears to be intuitively beneficial, there
27 were conflicting results regarding the impact of short DTB time on mortality. An earlier
28 study showed no association between DTB time and mortality (28). A different study showed
29 late mortality benefit of short DTB time only in high-risk patients or in early presenters (6,7)
30 while another showed in-hospital mortality benefit in both high-risk and low-risk patients (4).

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33 High-risk factors, however, were not consistently defined. For example, Brodie et al
34 (7) included age and excluded diabetes in their subgroup analysis of a randomised trial and
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2 single-centre registry study while the reverse was true for a multi-centre registry study by
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4 McNamara et al (4). Hypotension and tachycardia in the study by McNamara et al, and heart
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6 failure in the study by Brodie et al were replaced with cardiogenic shock in our study. Our
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8 study design (effectively a mini-registry study) and increased mortality benefit in high-risk
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10 patients were closer to the study by Brodie et al.

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12 There could be inherent differences between single-centre versus multi-centre and
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14 between observational versus randomised studies that cause these conflicting results. Since it
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16 would not be ethical to randomise patients to short versus long DTB time, a clarification may
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18 come from future meta-analysis of subgroups in randomised trials.

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20 Although both of our hospitals are angioplasty centres, the physician-to-patient model
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22 could be extended to hospitals that have angioplasty facilities without in-house interventional
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24 cardiologists. PPCI ~~were~~ considered superior to in-hospital thrombolysis even when transfer
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26 to an angioplasty centre (patient-to-physician strategy) was necessary (3). There was some
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28 evidence, however, that the elimination of patient transfer by using a physician-to-patient
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30 strategy could improve DTB time (29). In that study, patients who presented to hospitals
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32 without in-house interventional cardiologists were randomised to receiving PPCI on-site by
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34 visiting interventional cardiologists or to transfer to an angioplasty centre. A no-transfer
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36 model has the additional benefit of dispensing with separate DTB times for non-transferred
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38 ~~and~~ transferred patients.

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40 Clinical outcomes of PPCI are reported to improve with higher procedural volume
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42 (30) and the conclusion is that PPCI should be performed by high-volume, usually large,
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44 centres. In the United Kingdom, there is a national drive towards provision of PPCI in large
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46 centres and by-passing of smaller hospitals such as DGH. There are difficulties with this
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48 single model approach. Firstly, there will always be some patients who present with or
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50 develop STEMI in smaller hospitals. These patients would need transfer and incur delays.
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Secondly, even if all patients could by-pass the smaller hospitals, there are distance and traffic congestion to contend with. Thirdly, there will be waste of skills and resources in some smaller hospitals that are already angioplasty-capable and providing a useful service to their community. Our collaborative model of smaller hospitals with a pool of mobile interventional cardiologists could be an alternative that offers solutions to these difficulties in the United Kingdom and in other countries where the same difficulties are encountered.

Our study had several limitations. Firstly, there could be variables that might impact on mortality that happen to vary with DTB time. For example, long DTB time could be related to language barrier, inefficient delivery of care or prolonged pre-PPCI stabilisation for patients in critical condition. Indeed, our patients with long DTB time also had a higher proportion of anterior STEMI which in itself increases the risk of death. However, we believe that our conclusion (that high-risk patients had higher in-hospital mortality if they also had long DTB time) is still valid because risk factors other than anterior STEMI, such as age and cardiogenic shock that were present almost equally in both DTB time groups (Table 2), were also important in determining the overall risk and hence the mortality. Secondly, our results might not apply to patients requiring transfer for PPCI. Thirdly, our mortality data did not extend to post-discharge period. Fourthly, we could not quantify the impact of 24-hour strategy versus physician-to-patient strategy on DTB time. However, the emphasis of our study was on how smaller hospitals could re-configure their PPCI service and still achieve favourable DTB time, and not on how different strategies or models reduce DTB time. Fifthly, the power of our study was limited by our modest number of patients. The subdivision of short and long DTB times by patients' risk factors further reduced this power. Despite this limitation, we had observed a significant difference in in-hospital mortality between short and long DTB time among high-risk patients due to this difference being larger than the one used in the power calculation. On the other hand, the observed absence of

Deleted: Our study had several limitations. Firstly, being a retrospective observational study, it was possible that there were unassessed variables for which DTB time was not important. Similarly, there could be variables that impact on mortality that happen to vary with DTB time. Secondly, our results might not apply to patients requiring transfer for PPCI. Thirdly, our mortality data did not extend to post-discharge.¶

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significant difference in in-hospital mortality between short and long DTB time among low-risk patients could be a chance finding related to the low power of our study. Both intuitively and based on available literatures (4), any difference that our study might have failed to detect would likely to be a higher instead of lower in-hospital mortality if low-risk patients also had long DTB time.

With the caveat that our study was underpowered, we firstly conclude that high-risk patients appear to derive mortality benefit from short DTB time while low-risk patients appear not to. Low-risk patients would therefore probably fare well with delays associated with transfer to large centres. On the other hand, high-risk patients who are not admitted directly to large centres would tolerate delays poorly and need alternative models such as the one described in this study. In the event that a hospital could adopt a model that eliminates transfers for these high-risk patients, such a hospital would also not transfer out its low-risk patients who would then also derive any benefit of short DTB time that our study might not have detected.

Secondly and more importantly, we conclude that a collaboration of DGH with a physician-to-patient model can achieve favourable DTB time that translates to in-hospital mortality benefit.

Disclosures

None.

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Acknowledgements

None.

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Figure legends

Figure 1 Median door-to-balloon times and percentage of primary angioplasties achieving target door-to-balloon time of ≤ 90 minutes

Key: DTB = door-to-balloon time; PPCI = primary percutaneous coronary intervention;

DTB<90 = door-to-balloon time ≤ 90 minutes; 24/7 = 24-hour service

Tables

Tables 1 to 6

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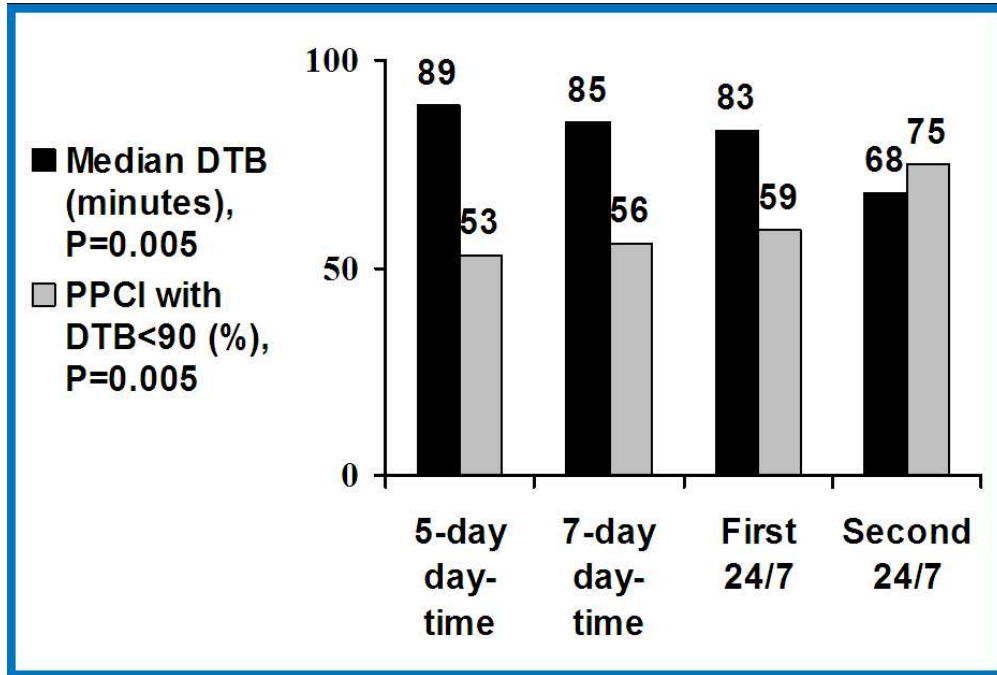
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Review Only

Table 1 Showing patients' characteristics for the two hospitals

Characteristics	Patients at Sandwell General Hospital (n=242)	Patients at Birmingham City Hospital (n=217)	P values
Mean age (years)	63	62	0.289=NS
≥75 years	24% (57)	21% (46)	0.576=NS
Male	74% (178)	76% (164)	0.668=NS
Diabetes	13% (32)	17% (36)	0.358=NS
Hyperlipidaemia	34% (82)	28% (61)	0.191=NS
Hypertension	45% (110)	47% (103)	0.708=NS
Smoking	35% (84)	33% (72)	0.768=NS
Family history	32% (77)	28% (60)	0.358=NS
Abciximab use	79% (190)	87% (189)	0.019
DES use	36% (88)	28% (61)	0.072=NS
Anterior STEMI	40% (96)	50% (109)	0.024
Cardiogenic shock	11% (27)	11% (23)	0.882=NS
24-hour PPCI	71% (173)	69% (150)	0.609=NS
Out-of-hours PPCI	44% (106)	44% (95)	1.000=NS
High-risk	58% (141)	71% (155)	0.003

Key: DES = drug eluting stent; Anterior STEMI = anterior ST-segment elevation myocardial infarction; PPCI = primary percutaneous coronary intervention; High-risk = anterior STEMI, cardiogenic shock, age ≥75 years or diabetes; NS = not significant

Table 2 Showing patients' characteristics with short versus long door-to-balloon times

Characteristics	Patients with DTB time \leq 90 minutes (n=285)	Patients with DTB time >90 minutes (n=174)	P values
Mean age (years)	63	62	0.709=NS
\geq 75 years	22% (63)	23% (40)	0.819=NS
Male	71% (202)	80% (140)	0.027
Diabetes	14% (41)	16% (27)	0.787=NS
Abciximab use	81% (232)	84% (147)	0.448=NS
DES usage	28% (81)	39% (68)	0.024
Anterior STEMI	39% (110)	54% (94)	0.001
Cardiogenic shock	10% (28)	13% (22)	0.358=NS
24-hour PPCI	74% (210)	65% (113)	0.058=NS
Out-of-hours PPCI	36% (103)	56% (98)	<0.0001
High-risk	59% (168)	74% (128)	0.002

Key: DTB time = door-to-balloon time; DES = drug eluting stent; Anterior STEMI = anterior ST-segment elevation myocardial infarction; PPCI = primary percutaneous coronary intervention; High-risk = anterior STEMI, cardiogenic shock, age \geq 75 years or diabetes; NS = not significant

Table 3 Showing in-hospital mortality for various patients' characteristics

Characteristics	In-hospital mortality	Odds ratio	95% confidence interval	P values (Fisher's exact test)
<75 years	4.2% (15/356)	4.81	2.36 to 9.83	<0.0001
≥75 years	17.5% (18/103)			
Male	5.3% (18/342)	2.65	1.30 to 5.38	0.011
Female	12.8% (15/117)			
Non-diabetic	6.9% (27/391)	1.30	0.53 to 3.21	0.609=NS
Diabetic	8.8 % (6/68)			
Abciximab used	5.5% (21/379)	3.01	1.43 to 6.33	0.007
Abciximab not used	15.0% (12/80)			
DES used	4.7% (7/149)	1.86	0.80 to 4.28	0.179=NS
BMS used	8.4% (26/310)			
Non-anterior STEMI	5.1% (13/255)	2.02	0.99 to 4.12	0.068=NS
Anterior STEMI	9.8% (20/204)			
No cardiogenic shock	3.2% (13/409)	20.31	9.30 to 44.34	<0.0001

Cardiogenic shock	40.0% (20/50)			
24-hour PPCI	6.8% (22/323)	1.20	0.58 to 2.52	0.693=NS
Daytime-only PPCI	8.1% (11/136)			
During-hours (weekday 8am-8pm) PPCI	6.6% (17/258)	1.23	0.61 to 2.46	0.589=NS
Out-of-hours PPCI	8.0% (16/201)			
Low-risk	0.6% (1/163)	19.6	3.36 to 14.46	<0.0001
High-risk	10.8% (32/296)			
Overall	7.2% (33/459)			

Key: DES = drug eluting stent; BMS = bare metal stent; Anterior STEMI = anterior ST-segment elevation myocardial infarction; PPCI = primary percutaneous coronary intervention; High-risk = anterior STEMI, cardiogenic shock, age ≥ 75 years or diabetes; NS = not significant

Table 4 Showing in-hospital mortality for short versus long door-to-balloon times corrected for various patients' characteristics

Characteristics	In-hospital mortality for DTB time ≤ 90 minutes	In-hospital mortality for DTB time > 90 minutes	P values (Cochran-Mantel-Haenszel test)
<75 years	3.2% (7/222)	6.0% (8/134)	0.009
≥ 75 years	9.5% (6/63)	30.0% (12/40)	
Male	4.5% (9/202)	6.4% (9/140)	0.003
Female	4.8% (4/83)	32.4% (11/34)	
Non-diabetic	3.7% (9/244)	12.2% (18/147)	0.010
Diabetic	9.8% (4/41)	7.4% (2/27)	
Abciximab used	3.0% (7/232)	9.5% (14/147)	0.006
Abciximab not used	11.3% (6/53)	22.2% (6/27)	
DES used	3.7% (3/81)	5.9% (4/68)	0.005
BMS used	4.9% (10/204)	15.1% (16/106)	
Non-anterior STEMI	2.9% (5/175)	10.0% (8/80)	0.020
Anterior STEMI	7.3% (8/110)	12.8% (12/94)	
No cardiogenic shock	1.9% (5/257)	5.3% (8/152)	0.016

Cardiogenic shock	28.6% (8/28)	54.5% (12/22)	
24-hour PPCI	4.8% (10/210)	10.6% (12/113)	0.010
Daytime-only PPCI	4.0% (3/75)	13.1% (8/61)	
During-hours PPCI	3.8% (7/182)	13.2% (10/76)	0.011
Out-of-hours PPCI	5.8% (6/103)	10.2% (10/98)	
Low-risk	0.9% (1/117)	0% (0/46)	0.045
High-risk	7.1% (12/168)	15.6% (20/128)	
Overall	4.6% (13/285)	11.5% (20/174)	0.008

Key: DTB time = door-to-balloon time; DES = drug eluting stent; BMS = bare metal stent;

Anterior STEMI = anterior ST-segment elevation myocardial infarction; PPCI = primary

percutaneous coronary intervention; High-risk = anterior STEMI, cardiogenic shock, age ≥ 75

years or diabetes; NS = not significant

Table 5 Showing in-hospital mortality of short door-to-balloon time for each high-risk factor

Characteristics	In-hospital mortality for DTB time ≤ 90 minutes	In-hospital mortality for DTB time > 90 minutes	Odds ratio	95% confidence intervals	P values (Fisher's exact test)
Non-anterior STEMI	2.9% (5/175)	10.0% (8/80)	3.78	1.25 to 11.36	0.028
Anterior STEMI	7.3% (8/110)	12.8% (12/94)	1.87	0.75 to 4.66	0.239=NS
Non-cardiogenic shock	1.9% (5/257)	5.3% (8/152)	2.80	0.94 to 8.29	0.081=NS
Cardiogenic shock	28.6% (8/28)	54.5% (12/22)	3.00	0.95 to 9.53	0.085=NS
< 75 years	3.2% (7/222)	6.0% (8/134)	1.95	0.72 to	0.276=NS

				5.30	
≥75 years	9.5% (6/63)	30.0% (12/40)	4.07	1.42 to 11.60	0.015
Non-diabetic	3.7% (9/244)	12.2% (18/147)	3.64	1.62 to 8.18	0.002
Diabetic	9.8% (4/41)	7.4% (2/27)	0.74	0.15 to 3.78	1.000=NS
Low-risk	0.9% (1/117)	0% (0/46)	0	0 to 9.88	1.000=NS
High-risk	7.1% (12/168)	15.6% (20/128)	2.41	1.14 to 5.06	0.024
Overall	4.6% (13/285)	11.5% (20/174)	2.72	1.33 to 5.54	0.008

Key: DTB time = door-to-balloon time; High-risk = anterior STEMI, cardiogenic shock, age ≥75 years or diabetes; NS = not significant

Table 6 Showing characteristics of high-risk versus low-risk patients

Characteristics	High risk patients (n=296)	Low risk patients (n=163)	P values
Mean age (years)	65	57	<0.0001
≥75 years	35% (103)	0% (0)	<0.0001
Male	71% (211)	80% (131)	0.034
Diabetes	23% (68)	0% (0)	<0.0001
Abciximab use	81% (239)	86% (140)	0.199=NS
DES use	36% (107)	26% (42)	0.029
Anterior STEMI	69% (204)	0% (0)	<0.0001
Cardiogenic shock	17% (50)	0% (0)	<0.0001

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24-hour PPCI	69% (203)	74% (120)	0.286=NS
Out-of-hours PPCI	46% (136)	40% (65)	0.238=NS

Key: High-risk = anterior STEMI, cardiogenic shock, age ≥ 75 years or diabetes; DES = drug eluting stent; Anterior STEMI = anterior ST-segment elevation myocardial infarction; PPCI = primary percutaneous coronary intervention; NS = not significant

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