

# Effectiveness of a 'thrombolysis nurse' in shortening delay to thrombolysis in acute myocardial infarction

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**ABSTRACT** – **Objectives:** To determine whether a specialist cardiac nurse would improve delay to thrombolysis in acute myocardial infarction (MI).

■ **Subjects:** Patients presenting with chest pain to a district general hospital.

■ **Method:** Comparison of: a) door-to-needle times of patients with 'definite' MI when the nurse was on and off duty (15 months) and prior to her employment (3 months); b) pain-to-needle times for definite MI; and c) door-to-needle times of patients without definite MI on first electrocardiogram (ECG) but who subsequently qualified for thrombolysis.

■ **Results:** Of 365 patients included in the study, 289 had definite MI. Before the appointment of a thrombolysis nurse, door-to-needle times were 0% at 30 minutes, 7% at 45 minutes and 34% at 60 minutes. Since the appointment, with the nurse on-duty, they have improved to 58%, 91% and 100% respectively, a saving of 36 minutes in median door-to-needle time ( $p=0.0001$ ). There was a median saving of 95 minutes in pain-to-needle times with the thrombolysis nurse on duty compared with off duty ( $p=0.0001$ ). Finally, with the nurse on duty there was also a saving of 36 minutes in median door-to-needle time in patients in whom the first ECG was non-diagnostic for MI ( $p=0.02$ ).

■ **Conclusions:** A thrombolysis nurse produced a dramatic improvement in median door-to-needle and pain-to-needle times in patients presenting with definite MI. This would lead to an additional 41 lives saved at 30 months per 1,000 patients treated. With 24-hour thrombolysis nurse cover, this would potentially lead to 8 additional lives saved at 30 months at a cost of £12,300 each. There was also a striking improvement in door-to-needle times for patients presenting with a non-diagnostic first ECG who subsequently qualified for thrombolysis.

Acute myocardial infarction (MI) is the most common cause of mortality in Western society. Restoring the patency of an occluded coronary artery by lysis of occlusive thrombus with thrombolytic agents significantly reduces mortality, but survival is indirectly proportional to the delay before

initiating thrombolysis<sup>1-4</sup>. Hence, the British Heart Foundation Working Group recommends that the time lapse from calling the emergency services (including transfer to hospital) to initiation of thrombolysis should ideally be less than 60 minutes and certainly no more than 90 minutes<sup>5</sup>.

In clinical practice, delay to thrombolysis remains a problem. The situation in the UK has been compounded in recent years by the marked increase in acute medical admissions which has prolonged waiting times in accident and emergency departments (A&E). In an attempt to shorten the delays to thrombolysis, 'fast-track' systems have been introduced which, when employed effectively, can reduce such delays to 49 minutes<sup>6</sup>. Furthermore, it has been shown that medical staff can administer thrombolysis to patients presenting to A&E within 21 minutes<sup>7</sup>. However, these systems are not applicable to all hospitals, especially those with high throughput A&Es.

A recent attempt to reduce time-delays has involved introducing specialist cardiac nurses, or 'thrombolysis nurses', into the immediate care setting of acute MI. These senior coronary care nurses are specifically trained in thrombolysis and have been given an extended role in the management of MI. Studies have confirmed that such nurses can assess patients with suspected MI accurately and safely for thrombolytic therapy<sup>8,9</sup>.

The aim of our study was to assess whether the presence of a coronary care trained thrombolysis nurse would result in any reduction in time-delays to thrombolysis ('door-to-needle' and 'pain-to-needle' times) in a district general hospital (DGH). In addition, the cost-effectiveness of employing a nurse was assessed and the role audited to evaluate any other benefits.

## Subjects and methods

Door-to-needle times were recorded for a 3-month period before, and a 15-month period during, the employment of a thrombolysis nurse in the A&E at University Hospital, Aintree. Pain-to-needle times were recorded when the thrombolysis nurse was on and off duty.

### Pre-thrombolysis nurse period

Prior to the appointment of a thrombolysis nurse, all patients presenting to the A&E with chest pain were triaged by an A&E nurse. A protocol devised by the cardiology department for the management of patients with chest pain was followed (copy available from authors on request). An

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electrocardiogram (ECG) was performed immediately and shown to an A&E doctor, who was then responsible for taking a history and examining the patient. All patients with clear evidence of acute MI received soluble aspirin, and thrombolysis was administered immediately in A&E unless contraindicated. Tissue plasminogen activator was the agent of choice in patients under the age of 75 years presenting within four hours of the onset of pain with an anterior MI (based on the GUSTO study<sup>10</sup>) and for those in whom there was a specific contraindication to streptokinase. All other patients received streptokinase.

#### Role of thrombolysis nurse

The role of the thrombolysis nurse was to optimise the treatment of acute MI with particular reference to reducing door-to-needle times for thrombolysis. She triaged all patients with chest pain immediately they attended the A&E. Established chest pain and thrombolysis protocols were followed. The thrombolysis nurse assessed patients using a pro forma devised as a checklist for management (Table 1) and interpreted the ECG to determine whether an acute MI was present, thus necessitating immediate thrombolysis. Thrombolysis was initiated in A&E and the patient transferred to the coronary care unit (CCU) by the thrombolysis nurse and a doctor.

The role also included education and supervision of doctors and nurses in the A&E, both on a formal basis with regular teaching sessions, and more informally in the clinical arena. Overall working time was 37 hours per five-day week.

As well as assessing and managing patients with chest pain and acute MI, the thrombolysis nurse was available in A&E to advise on treatment of arrhythmias, cardiac failure and cardiac arrests. The number of patients seen was recorded.

#### Data collection

Data were collected for three months before the appointment of a thrombolysis nurse, and for 15 months during the nurse's employment (including off-duty periods). The time of arrival of patients in the A&E, whether the first ECG was diagnostic for acute MI and time to thrombolysis were audited for all three groups, as well as the reason for any delay in thrombolysis. Only patients with a clear-cut acute MI (>30 minutes of ischaemic-type chest pain coupled with typical ECG changes) who subsequently received thrombolysis, were used when comparing data in this study. These patients were subdivided into those in whom the diagnosis of acute MI could be clearly made on the history and first ECG at presentation (defined in our study as 'definite' MI) and those in whom thrombolysis was delayed for a variety of 'legitimate' reasons such as non-diagnostic first ECG or atypical history.

Data were also collected on pain-to-needle times for all patients when the thrombolysis nurse was on- and off-duty.

**Table 1. Main areas covered by thrombolysis nurse's checklist for management.**

Timing of events & presenting history	Initial diagnosis definite MI probable MI
Past medical and drug history previous MI previous angina previous thrombolysis (drug/date)	unstable angina ischaemic heart disease chest pain (other)/other diagnosis
Risk factors smoking/alcohol intake hyperlipidaemia (cholesterol if known) diabetes mellitus hypertension peripheral vascular disease stroke family history weight	Indications for thrombolysis criteria met repeat ECG in 30 minutes
Allergies	Contraindications to thrombolysis too late diagnosis uncertain non-qualifying ECG prolonged CPR
Aspirin given?	acute peptic ulcer and/or dyspepsia recent surgery bleeding diathesis proliferative diabetic retinopathy (refer to cardiology)
Initial assessment & findings vital signs ECG	recent stroke menstruation/pregnancy serious life-threatening disease aortic dissection or pericarditis warfarin (refer to cardiology) chronic liver disease
Cannulation	
Oxygen therapy	Reason for delayed thrombolysis initial ECG not diagnostic
Investigations requested (& results) CXR FBC Cardiac enzymes U&Es and glucose clotting	CPR required hypertensive unstable rhythm unstable blood pressure referred to CCU
Treatment aspirin suscard buccal diamorphine maxalon	Thrombolysis streptokinase tissue plasminogen activator other door-to-needle time

MI = acute myocardial infarction; ECG = electrocardiogram; CXR = chest x-ray; FBC = full blood count; U&Es = urea and electrolytes; CPR = cardiopulmonary resuscitation; CCU = coronary care unit.

Finally, the subgroup of patients in whom thrombolysis was delayed as a result of non-diagnostic first ECG, was further assessed to establish whether there was any difference in the delay to thrombolysis once the ECG had become diagnostic for acute MI.

#### Statistical analysis

Data on time to thrombolysis of the three groups of patients (before employment of a thrombolysis nurse, when the

thrombolysis nurse was on duty, and when the nurse was off duty) were expressed as median times with interquartile ranges. All data were compared using non-parametric analysis of variance (Kruskal-Wallis Test) in view of the non-normal distribution of the data. The Wilcoxon Rank Sum Test was used for comparisons between the three groups of patients. *P*-values <0.05 were considered statistically significant.

### Results

Over the 18-month period of the study, 365 patients presented to the A&E and subsequently received thrombolysis for acute MI. Of these, 289 patients presented with clear symptoms of MI with a diagnostic first ECG (defined as 'definite' MI) warranting immediate thrombolysis.

During the three months before the appointment of a thrombolysis nurse, 57 patients presented with acute MI, of whom 41 had a definite MI. Only 34% of these definite MI patients received thrombolysis within 60 minutes and 78% within 2 hours of arrival (Fig 1). No patient with a definite MI received thrombolysis within 30 minutes of presentation to the A&E.

Over the 15 months when the thrombolysis nurse was on duty, 67 patients presented to the A&E with acute MI, of whom 45 had a definite MI. The time to thrombolysis improved dramatically, with 91% of patients receiving thrombolysis within 45 minutes and 100% within 60 minutes of presentation to the A&E (Fig 1). Furthermore, after the thrombolysis nurse post had been established for a year, 92% of patients received thrombolysis within 30 minutes and 100% within 45 minutes of arrival. No patients received thrombolysis inappropriately when the thrombolysis nurse was on duty.

When the thrombolysis nurse was off duty during these

15 months, 241 patients were treated with thrombolysis for acute MI, of whom 203 had a definite MI. Thrombolysis times were longer than when the thrombolysis nurse was on-duty, with 43% receiving thrombolysis within 60 minutes and 90% within two hours of arrival in the A&E (Fig 1), but there was a minor improvement compared with the period before her appointment.

Median door-to-needle time for thrombolysis was 66 (interquartile range: 60–92) minutes for the pre-thrombolysis nurse group, falling dramatically to 30 (20–40) minutes when the thrombolysis nurse was on duty – a highly significant saving of 36 minutes (*p*=0.0001). Median door-to-needle time was 65 (51–94) minutes when the thrombolysis nurse was off duty (*p*=0.0001 compared to when the nurse was on duty). There was no statistical difference between door-to-needle times pre-thrombolysis nurse and those when the thrombolysis nurse was off duty (*p*=0.29).

The median pain-to-needle time was less than two hours (110 (85–200) minutes) when the thrombolysis nurse was on duty and just under three and a half hours (205 (135–380) minutes) when she was off duty. There was a highly significant saving of 95 minutes in the median pain-to-needle time (*p*=0.0001).

In 76 patients, thrombolysis was legitimately delayed for a variety of reasons. Table 2 shows the reasons for these delays in the pre-thrombolysis nurse and thrombolysis nurse on duty groups. The data are comparable: atypical history, non-diagnostic first ECG and treatment of other conditions prior to thrombolysis accounted for most of the delays in both groups. Chest x-rays were legitimately ordered prior to thrombolysis when other diagnoses were considered. Early in the study, two patients were assessed and thrombolysis was prescribed by the doctors without the thrombolysis nurse being involved even though she was on

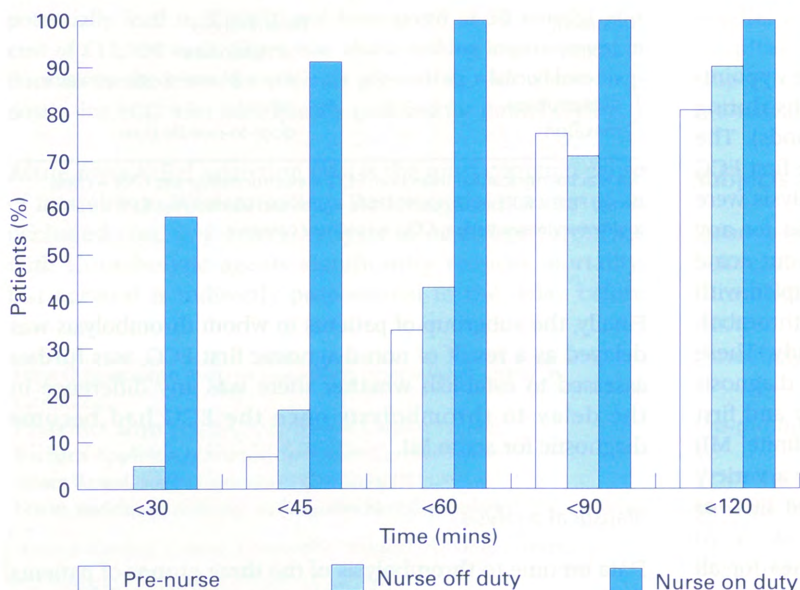


Fig 1. Door-to-needle times for administering thrombolytic therapy in patients with 'definite' acute myocardial infarction during the pre-thrombolytic nurse period, and when the thrombolytic nurse was on and off duty.

**Table 2. Reasons for legitimate delays to thrombolysis in pre-thrombolysis nurse and thrombolysis nurse on duty groups.**

Reason	During pre-thrombolysis nurse period <i>n</i> =16	Thrombolysis nurse on-duty <i>n</i> =22
Non-diagnostic ECG	7	8
Atypical history	4	5
Chest x-ray (appropriate)	2	2
Hypertension	1	2
Cardiogenic shock	1	2
Cardiac arrest	1	0
Senior review required*	0	1
Thrombolysis nurse not involved before thrombolysis	–	2

\*Patient with recent history of probable transient ischaemic attacks.

duty. These patients were not included in the 'thrombolysis nurse on duty' group as she was not involved in their management.

Further analysis of the subgroup of patients with delays due to non-diagnostic first ECG at presentation revealed that once the ECG became diagnostic for acute MI, the median time to thrombolysis was 61.5 (47–99) minutes during the three months before the appointment of the thrombolysis nurse (six patients). This delay dropped to just 25.5 (19–41) minutes when the thrombolysis nurse was on-duty (eight patients), a statistically significant saving of 36 minutes ( $p=0.02$ ).

A further 919 patients with other acute cardiac problems or non-cardiac chest pain were seen, assessed and treated by the thrombolysis nurse during the 15-month period of her appointment: 454 patients with angina, 19 with cardiac failure, 92 with cardiac arrhythmias, and 333 with non-cardiac chest pain. The thrombolysis nurse also attended and provided help and advice in 21 patients with cardiac arrest.

## Discussion

Although mechanisms for achieving short door-to-needle (and pain-to-needle) times for thrombolysis are in place in most hospitals, unacceptable delays are still common. Our study confirms that even with a well-established protocol in place, there may still be long delays. We have demonstrated that a specialist cardiac nurse can have a dramatic effect, with a saving of 36 minutes in median door-to-needle times (comparing the pre-thrombolysis nurse and thrombolysis nurse on duty groups) and a highly significant saving of 95 minutes in median pain-to-needle times (comparing thrombolysis nurse on and off duty). The latter may, however, be partly attributable to the delay in patients seeking medical advice or reaching hospital during the night (mostly not covered by the thrombolysis nurse's shift) rather than during the day.

Delays to thrombolysis were also much shorter in the subgroup of patients presenting with a non-diagnostic first ECG, who subsequently qualified for thrombolysis. Such patients often have inappropriate delays to thrombolysis, despite already being in hospital. However, in this study, once the ECG had become diagnostic, there was a saving of 36 minutes in median door-to-needle time when the nurse was on duty compared to the pre-thrombolysis nurse period.

The reasons for the striking reduction in delays to thrombolysis are multifactorial. The nurse's experience in this field enabled a prompt and confident diagnosis of acute MI from clinical findings and ECG. Indeed, in our experience, the nurse was often more accurate and correct at ECG interpretation in this setting than any A&E doctor, regardless of grade of seniority. The thrombolysis nurse's recognition of the need for prompt therapy and her availability to focus on the cardiac ischaemic patient without having to deal with competing pressures in the A&E, were likely to have been key factors. Undoubtedly she was an additional 'pair of hands' in the A&E, but it is very unlikely that the improved results could be attributed solely to this fact.

The role of our thrombolysis nurse was not limited to diagnosing MI and initiating early thrombolysis. With her specialised training in cardiology, she played a valuable role in the A&E in the management of other patients with cardiac emergencies and non-cardiac chest pain. In total, she reviewed a further 919 patients, mostly with angina (454) and non-cardiac chest pain (333); approximately one such case was seen every 3.5 hours and 4.5 hours respectively. Whether her actions affected mortality and morbidity in this additional patient group without acute MI could not be deduced from this study, but early diagnosis and appropriate triage with more prompt processing of the patient and discharge from A&E was undoubtedly facilitated.

The nurse also played an important role in continuing education in cardiology through regular formal teaching sessions, and her experience also helped maintain standards of care during the changeover of junior doctors in February and August. She facilitated the introduction of new research-based management in MI into the clinical arena and was involved in clinical audit.

Initiating thrombolysis as early as possible has been the corner-stone of treatment for MI. The Grampian Region Early Anistreplase Trial (GREAT) investigators illustrated that in patients presenting two hours after onset of symptoms, each hour of delayed thrombolysis led to the loss of 21 lives at 30 days and to the loss of 69 lives at 30 months per 1,000 patients treated<sup>3</sup>. They therefore concluded that in terms of potential lives saved, early thrombolysis was more urgent than resuscitation from cardiac arrest. In our study, the presence of a thrombolysis nurse resulted in a saving of 36 minutes in median door-to-needle time. Using the data from GREAT, this would lead to 41 additional lives saved per 1,000 patients treated.

In this project a single thrombolysis nurse was employed at a cost of £22,500 per annum. However, covering just one

shift, she saw only 18.2% of the definite acute MI patients. If thrombolysis nurse cover were extended to 24 hours, then 4.48 nurse whole-time-equivalents would be required at a cost of £100,800 per annum. This could save approximately eight additional lives at 30 months, at a cost of £12,300 per additional life saved. This figure compares favourably with other established therapies, such as coronary artery bypass grafting for triple vessel disease or renal dialysis, which have been calculated respectively at £12,000 and £25,000 per life saved.

The potential number of additional lives saved and hence the cost-effectiveness of such a strategy will vary between hospitals. In our hospital, delays in the pre-thrombolysis nurse period were clearly suboptimal despite attempts to keep them short. Nevertheless, such delays remain commonplace and are likely to be representative of door-to-needle times in many hospitals in the UK.

Furthermore, these cost-effectiveness calculations do not take into account benefits and potential lives saved in patients without definite MI. The thrombolysis nurse improved median times to thrombolysis in patients presenting with a non-diagnostic first ECG, who subsequently qualified for thrombolysis. There were also non-quantifiable benefits of having a specialist cardiac nurse offering advice on other cardiac emergencies in A&E.

A thrombolysis nurse can dramatically shorten delay to thrombolysis in a busy DGH, and so reduce anticipated mortality in these patients. This appears to be a cost-effective way of maximising health gain from the use of thrombolytic therapy in acute MI. Such a strategy should be widely applicable to most DGHs in the UK.

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