Implementing paramedic thrombolysis – an overview

Tom Quinn, Andrew Butters, Ian Todd

The UK Government has made improvements in cardiac care a high priority. The publication in 2000 of the National Service Framework for Coronary Heart Disease and the NHS Plan set out national standards for the management of suspected heart attack, including challenging targets for reducing treatment delays for administration of thrombolytic therapy. This paper discusses the background, evidence base and challenges of implementing one component of the Government’s drive to improve cardiac care: the NHS Plan commitment to a three year programme to equip and train ambulance paramedics to safely provide thrombolysis for appropriate patients. © 2002 Elsevier Science Ltd. All rights reserved.

Introduction

The importance of early administration of thrombolytic treatment to eligible patients with acute myocardial infarction (MI) is highlighted in current Government policy in the United Kingdom including the National Service Framework (NSF) for Coronary Heart Disease (Department of Health 2000a) and the NHS Plan (Department of Health 2000b).

Thrombolytic therapy has been an established treatment for MI for over two decades. The benefits of prompt treatment have been well documented in large randomised trials (Fibrinolytic Therapy Trialists’ (FTT) Collaborative Group 1994; Boersma et al. 1996). Mortality benefit has been shown to be maintained for at least 10 years following treatment with streptokinase (Baigent et al. 1998).

A clear message from the trials is that the benefits associated with thrombolysis are inversely proportional to the delay in commencing treatment (Boersma et al. 1996). In patients seen within the first few hours from symptom onset, each minute’s delay is reportedly associated with 11 days of life lost – thus each half an hour’s delay equated to a year of life lost (Rawles 1997). It has subsequently been recommended that in terms of its potential for saving lives, action to initiate thrombolytic therapy in eligible patients should be afforded urgency similar to that given to management of cardiac arrest (Cannon et al. 1994).

A recent meta-analysis (Morrison et al. 2000) of six randomized controlled trials of pre-hospital versus in-hospital thrombolysis concluded that pre-hospital treatment significantly decreases the time to thrombolysis (patients given pre-hospital thrombolysis received treatment 58 min earlier than those treated in hospital) and all-cause hospital mortality. Benefit was apparent irrespective of provider qualifications (e.g., physician or paramedic), although in the single trial of paramedic thrombolysis included in the analysis, the electrocardiogram (ECG) was transmitted by ambulance crew to a receiving hospital for physician advice and treatment given accordingly (Weaver et al. 1993).
National standards for heart attack care

The NSF (Department of Health 2000a) standard for heart attack care requires all NHS organizations to take steps to reduce treatment delays with the ultimate goal that patients commence treatment within 60 min of the call for professional help. Such steps include:

- Improving ambulance response times so that 75% of life threatening emergency calls receive a response within 8 min.
- Reducing ‘on scene’ times to the minimum necessary to safely assess the patient and provide immediately life saving interventions and pain relief.
- Minimising delays in transporting patients to hospital – the aim being to reach hospital within 30 min of the call for help.
- Optimising hospital assessment and treatment processes so that 75% of eligible patients commence treatment within 30 min of hospital arrival by April 2002 (and 20 min by 2003).

The NSF also states that, where the time from receipt of call for help to arrival at hospital within 30 min is difficult to achieve then alternative measures (e.g. pre-hospital thrombolysis) must be considered. This approach is in accordance with advice from respected authorities including recommendations of a Task Force of the European Society of Cardiology and the European Resuscitation Council (1998).

The NHS Plan (Department of Health 2000b) takes this a stage further, announcing a three-year programme to train and equip ambulance paramedics to safely provide thrombolysis for appropriate patients with the aim of saving an hour on average in treatment delays, with the potential if fully implemented to save up to 3000 lives per annum.

The legal framework

The regulations governing drug administration were amended by Parliament in November 2000 to broaden the range of medicines that could be administered by ambulance paramedics. Following a period of public consultation and review involving the Medicines Commission, Committee on Safety of Medicines and the Medicines Control Agency (MCA), responding to submissions from the Joint Royal Colleges Ambulance Liaison Committee (JRCALC), a range of medicines, including streptokinase, morphine and frusemide were added to the list of medicines approved for paramedic use without the need first to seek medical authorisation.

Streptokinase was approved for the treatment of MI under specific circumstances outlined in the JRCALC submission, based on the large body of experience with this agent, which remains the most commonly used thrombolytic in English acute hospitals (Royal College of Physicians 2001).

Despite its addition to the ‘approved’ list for administration by ambulance paramedics, streptokinase has not been adopted by any UK ambulance service for pre-hospital use, largely because of perceived practical difficulties in preparing and administering the necessary intravenous infusion, necessitating additional expenditure and training in the use of electronic infusion pumps. Nonetheless, this agent has previously been successfully used by the ambulance service in Rotterdam for a number of years (Grijsels et al. 1995).

Alternative agents to streptokinase are available but are not covered by the regulatory changes outlined above. Reteplase, alteplase, and tenecteplase are newer generation thrombolytic agents, which require less complex administration (and in the latter case, a single bolus injection) but are up to 10 times more expensive than streptokinase.

Administration of these alternative agents is, however, possible under Patient Group Direction (as set out in the Health Service Circular, HSC 2000/026).

A number of ambulance services have taken advantage of the flexibility afforded by Patient Group Directions to introduce paramedic thrombolysis, but experience to date remains limited with a small number of UK services providing thrombolysis at the time of writing. Plans for delivery of paramedic thrombolysis in an increasing number of ambulance services are, however, at an advanced stage.

While the concept of paramedic thrombolysis has received wide support (e.g.
during the consultation exercise preceding regulatory change, in the recent Ambulance Service Association review of the future role of the ambulance service (Nicholl et al. 2001) and at professional society meetings, the strategy is not without its critics. Anecdotally, some senior clinicians argue that thrombolysis should always be given in hospital. Others, that while patients with long travel times to hospital might benefit, those in urban settings will not – and that the risks of treatment (principally intracranial haemorrhage) outweigh any potential benefits. Clearly the debate will continue for some time, while implementation of the Government’s policy gathers pace.

These issues are being addressed at national level under the aegis of a joint working group of JRCALC, the British Cardiac Society, the Ambulance Service Association and the Department of Health. This group has drawn up a national model protocol setting out the indications and contraindications for paramedic thrombolysis (available at www.jrcalc.org.uk) which ambulance Trusts are required to take into consideration when developing local policies. It will be noted that the threshold for commencing thrombolysis in the pre-hospital setting suggested by the working group is somewhat higher than in hospital, and that paramedic thrombolysis is only recommended for patients who present very early (within 3 hours of symptom onset), where there is clear ECG evidence of ST segment elevation, travel time to hospital is likely to exceed the 30 min ‘call-to-hospital’ target and where a range of contraindications have been excluded. Relaxation of these constraints to bring pre-hospital practice in line with hospital procedures may take place following careful evaluation of initial experience by ambulance services and professional bodies.

Current performance against the NSF ‘60 min’ standard

A number of steps have been taken across England to minimize delays to commencing thrombolytic treatment. Ambulance services are working to achieve the 8-min response time standard set out in the NSF and NHS Plan. Every effort is made to reduce ‘on scene’ time. Median ‘call-to-hospital’ time was reduced from 60 min in 1993 to 45 min in 2001 (Dr John Birkhead, personal communication). Acute Trusts are working hard to reduce door-to-needle time through the development of care pathways and a process of service redesign looking in particular at the role of A&E (where the majority of UK heart attack patients are first seen on hospital arrival) and many hospitals are introducing nurse-initiated thrombolysis (Quinn 1995; Wilmshurst et al. 2000; Quasim et al. 2002).

In spite of this only a minority of patients eligible for thrombolysis are treated within the 60 min ‘call-to-needle’ standard. Unpublished data from the West Midlands Thrombolysis Project undertaken from 1995 to 1998 report only 20% of 5155 eligible MI patients admitted to 23 participating hospitals receiving thrombolysis within 60 min of the call for help following optimisation of hospital processes (data on file). This performance, however, compares favourably with the 14.5% reported by Birkhead (1999) from an earlier multicentre audit.

While efforts continue to minimize delays in ‘door-to-needle’ time once the patient reaches hospital, it is clear that the patient presenting in a rural setting presents particular challenges.

An iterative process is now in train across England which will, over time, see more ambulance personnel trained in the recording, interpretation and transmission to hospital of 12 lead ECGs, an approach proven to speed up ‘door-to-needle’ times. A by-product of this training and experience will be the identification of selected ambulance paramedics who will receive additional training and assessment in the provision of thrombolysis, under the supervision of the ambulance services’ medical advisers, local cardiologists and senior cardiac nurses together with their A&E colleagues. These issues are discussed in more detail below.

Equipping emergency ambulances with 12 lead ECG machines

An increasing number of emergency ambulances are being equipped with 12 lead ECG machines, in many instances enabling data to be transmitted to the receiving hospital prior to admission. This strategy has been shown in several published series to reduce
overall ‘call-to-needle time’ at the expense of a small increase in on-scene time. Importantly, the availability of information derived from an ECG performed by ambulance personnel has been shown to markedly reduce treatment delays once the patient reaches hospital (Grim et al. 1987; Karagounis et al. 1990; Kudenchuck et al. 1991; Millar-Craig et al. 1997).

 Provision of 12 lead ECG machines on ambulances is now UK Government policy, with resources being made available for services to begin to purchase this equipment with the aim of universal coverage in England by early 2003. Making 12 lead ECG machines available on emergency ambulances is a strategy strongly endorsed by respected authorities including the European Society of Cardiology and European Resuscitation Council (1998); American Heart Association (2000) and the United States’ National Heart Blood and Lung Institute (1993) in their published guidelines.

Competencies and training issues

The introduction of new technology into any setting necessitates additional training for potential users, which in this case include ambulance personnel and also their clinical colleagues in receiving hospital departments. Identifying competencies required (as opposed to the job title and grade of the staff member) for the safe delivery of thrombolysis is a key step for the professional bodies involved. Suggested competencies are given in Table 1. Nurses and medical staff in CCU will in most cases be familiar with the recording and interpretation of the 12 lead ECG, paramedic staff less so. Hospital staff will require instruction in the operation of receiving stations, and a clear understanding of their roles and responsibilities in response to a request from ambulance staff to transmit data.

Ambulance personnel will, for the most part, be familiar with the principles of ECG monitoring and arrhythmia recognition since these are key components of their training and practice. They will often be less familiar with aspects of the 12 lead ECG including lead placement, recording, transmission and interpretation of ECG data. Recent experience from some UK services (Millar-Craig et al. 1997, Whitbread et al. 2002) demonstrates the feasibility of training ambulance personnel in these additional aspects of cardiac care.

Evidence that ambulance paramedics can safely identify patients suitable for pre-hospital thrombolysis without recourse to physician advice is also emerging (Pitt 2002). Many ambulance services have embarked on a programme of ECG training for ambulance personnel. Responsibility for approving the content of this course for local

<table>
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<th>Competency</th>
<th>How assessed</th>
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<tr>
<td>Able to demonstrate understanding of pathophysiology of coronary heart disease and myocardial infarction</td>
<td>Multiple choice questions</td>
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<tr>
<td>Able to demonstrate proficiency in basic and advanced life support</td>
<td>Resuscitation Council (UK) advanced life support provider certificate or equivalent (e.g., in-house assessment to national standard)</td>
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<tr>
<td>Able to demonstrate ability to record, transmit and interpret the 12 lead ECG in the context of suspected myocardial infarction (recognition of ST segment elevation associated with MI being principle focus) Knowledge of basic pharmacology of thrombolytic agents</td>
<td>Supervised practice with CCU, A&amp;E staff ECG interpretation using clinical ‘vignettes’ Maintaining portfolio of ECGs recorded and interpreted</td>
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<td>Able to demonstrate clinical assessment skills in determining patients’ suitability for thrombolysis</td>
<td>Viva voce examination with cardiologist, senior CCU/A&amp;E nurse and/or pharmacist MCQ and viva as above Clinical ‘vignettes’ Supervised practice, portfolio</td>
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<tr>
<td>Able to discuss key issues around consent</td>
<td>Viva voce</td>
</tr>
<tr>
<td>Able to identify important side effects and complications of treatment and their management</td>
<td>Viva voce</td>
</tr>
<tr>
<td>Able to demonstrate understanding of the importance of careful documentation, communication and handover to colleagues following administration of thrombolysis</td>
<td>Supervised practice, portfolio</td>
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Table 1 Suggested competencies for safe delivery of thrombolysis
use rests with the ambulance trust management in collaboration with other professionals involved in overseeing delivery of the NSF within the Local Implementation Team or cardiac network, where these are in place. Potential candidates for further training in pre-hospital thrombolysis are arguably likely to be identified during such courses; these individuals could then undergo additional preparation and assessment similar to that provided for ‘thrombolysis nurses’ as described in a recent paper from Shrewsbury (Wilmshurst et al. 2000).

**Thrombolysis-specific training**

Training in safe delivery of thrombolytic treatment requires ambulance staff to build on existing skills of patient assessment, ECG interpretation, knowledge of the indications and contraindications to thrombolytic treatment, and the practicalities of drug administration. A further important aspect of training will be management of the patient who has received a thrombolytic drug – for example, recognition and management of adverse effects including hypotension, arrhythmia, and haemorrhage. It is recognized that ambulance staff already regularly provide care for patients with suspected MI who will be at risk of haemodynamic and rhythm disturbances, the management of which is arguably no different whether or not the patient has received a thrombolytic agent.

While not essential to the successful introduction of thrombolysis, a period of in-hospital training may be considered to enable ambulance paramedics to experience at first hand the assessment, treatment and observation of patients undergoing thrombolysis in A&E or CCU. In particular, exposure to patients in the period immediately following drug administration will be gained, with the opportunity to identify and manage any adverse effects, and recognise ECG and rhythm changes associated with reperfusion. An option under consideration in some services is the administration of thrombolysis by an ambulance paramedic on arrival at hospital, under CCU or A&E staff supervision, or supported by a general practitioner (the so-called ‘dual response’). Current arrangements for routine hospital refresher placements for ambulance paramedics will need to be reviewed to take account of changing training needs. In-service training with an ambulance service mentor alone is not considered appropriate until further experience in providing thrombolysis has been gained – support in the meantime from hospital-based colleagues (including where possible ‘in service’ support provided by experienced hospital staff accompanying selected crews on calls) will be important. The resource constraints associated with in-hospital training (for example, the ‘opportunity cost’ of taking front line staff away from their duties for training might adversely affect the service’s ability to meet the response time standards) need careful consideration by the relevant managers and commissioners.

**Balancing benefit and risk**

The main cause of concern about the administration of thrombolytic therapy outwith the hospital setting is the risk of intracranial haemorrhage (ICH). ICH following thrombolysis appears more common in older patients, those less than 60 kg body weight and in people with longstanding hypertension (Simoons et al. 1993). A recent meta-analysis of phase III ‘megatrials’ involving several different thrombolytic agents suggests an excess risk of ICH associated with the use of bolus-administered agents (Mehta et al. 2000). The use of weight-adjusted dosing of tenecleplase has been shown to lower the risk of ICH compared to use of alteplase (Gibson & Marble 2001).

The JRCALC guidelines seek to balance risks of treatment with risks of ICH and other major haemorrhagic complications. A conservative approach has been taken: the list of contraindications is lengthy, and the threshold for pre-hospital thrombolysis on the basis of autonomous decision making by paramedics is considerably higher than for hospital treatment initiated by a physician. This approach will be subject to review in the light of experience as more ambulance Trusts begin to provide thrombolysis.
Clinical governance

The introduction of thrombolytic treatment by ambulance Trusts in England will come under close scrutiny by the Department of Health, Medicines Control Agency, and relevant professional bodies including JRCALC. A key component of the introduction of pre-hospital thrombolysis must therefore be careful audit of the management of patients with suspected heart attack to demonstrate adherence to treatment protocols, with clear documentation and reporting of protocol variances (e.g., on the direction of an appropriate clinician), adverse events, and times to treatment – the latter being required to demonstrate achievement of NSF and NHS Plan commitments.

The existing ambulance case report form (CRF) forms the basis of documentation of patients receiving paramedic-administered thrombolysis. The development of an Integrated Care Pathway (ICP) for acute chest pain provides additional means of guiding and documenting care provided across the pre-hospital/hospital interface. Consideration of further integration of CRF data (and print-outs of 12 lead ECGs undertaken in the pre-hospital setting) with the ICP should be a priority at local level. As a key first step, it is recommended that the hospital copy of the CRF and any transmitted data be routinely attached to the ICP once the patient enters hospital, forming part of the ongoing clinical record.

The participation of ambulance services and acute Trusts in the Myocardial Infarction National Audit Project (MINAP) provides an opportunity for sharing of performance data (call-to-hospital time, call-to-needle time, etc.) with ambulance colleagues. It is recommended that regular reports from MINAP are made available by the hospital audit departments to the ambulance service on a routine basis within the regulatory framework safeguarding patient confidentiality.

Where a patient receives thrombolysis from an ambulance paramedic, the documentation of the event should be reviewed by the appropriate medical adviser at the earliest opportunity. Where paramedic or hospital staff have concerns about thrombolytic treatment provided to an individual patient, these should be raised with the designated manager.

Consent to treatment

The clinician providing treatment is responsible for ensuring that the patient has given valid consent before treatment begins, although the consultant responsible for the patient’s care will remain ultimately responsible for the quality of medical care provided (Department of Health 2001). In the case of treatments provided by ambulance staff, the ‘responsible clinician’ is likely to be the ambulance service medical adviser (increasingly, ambulance Trusts are employing part-time medical directors). There is a debate to be had, however, about the validity of the consent obtained from patients with heart attack and related conditions during the acute phase of illness (Kucia & Horowitz 2000; Sugarman 2000; Agard et al. 2001).

Resources

The introduction of paramedic thrombolysis is not ‘cost neutral’ and a large amount of public money is being invested in provision of new equipment, drugs, and training to speed up the process of administering thrombolysis safely. The main cost pressures include ‘back fill’ funds to ensure that response times continue to be met while front line ambulance staff are being trained in the elements set out in paras above, together with the costs of the thrombolytic agents used.

According to a recent survey undertaken by the Royal College of Physicians (2001) streptokinase remains the most commonly used thrombolytic agent in English hospitals, with alternative agents (reteplase, tenecteplase or alteplase) administered in locally defined circumstances. The National Institute of Clinical Excellence (NICE) is currently undertaking an appraisal of the array of thrombolytic drugs available in England and Wales (www.nice.nhs.uk) and will shortly issue guidance to commissioners which will support purchasing decisions.
Next steps
A number of key ‘next steps’ are required if ambulance services are to implement pre-hospital thrombolysis. These include:

- Securing ‘agreement in principle’ from relevant clinicians and managers (in particular local cardiologists and A&E consultants and their nursing colleagues) in the context of NSF delivery mechanisms.
- Identifying (e.g., through isochrone analysis and data derived from audit) geographical areas and populations that may be priorities for introduction of pre-hospital thrombolysis.
- Undertaking a detailed cost analysis of potential training and drug costs in time for inclusion in funding negotiations with relevant commissioners.
- Agreeing selection criteria for ambulance paramedics to undergo additional ‘thrombolysis training’ (and subsequent assessment of competence and ‘sign off’ by senior clinicians).
- Clarifying the roles and responsibilities of receiving hospital staff when ECG data are transmitted ‘from the field’.
- Securing funding for ECG equipment on all emergency ambulances (and completing subsequent procurement and installation).
- Securing agreement on the model(s) of service provision to be applied locally
- Obtaining legal advice on the complex area of consent for treatment.
- Gaining approval for ambulance Trust policies and procedures including Patient Group Directions where appropriate, and audit arrangements.
- Communicating the strategy to colleagues and the public across the health economy.

Conclusion
Despite recent improvements in emergency cardiac care across England (and similar progress being made across the rest of the United Kingdom) a minority of patients eligible to receive thrombolytic therapy begin treatment within the NSF standards of 60 min ‘call-to-needle’ time.

Administration of thrombolytic therapy by ambulance paramedics is a Government commitment as set out in the NHS Plan. The new legal framework enables a range of models to be adopted according to local circumstances.

A range of strategies covering equipment, training and organisational issues are being addressed across the country to support the introduction of paramedic thrombolysis. An iterative approach is in train which will, over time, see more ambulance staff equipped with, and trained to use, 12 lead ECG machines, transmitting important data to the receiving hospital where this is the preferred local strategy.

It is possible in the long-term that pre-hospital thrombolysis will become the norm, and that in future the majority of paramedic staff will undergo training in thrombolysis, with subsequent assessment of competence leading to practice under Patient Group Direction. The question of whether percutaneous intervention is superior to earlier thrombolysis remains unresolved and a large randomized trial comparing the two strategies with conventional care would provide important new information to guide future policy decisions.

Clinician support – particularly from local cardiologists, A&E doctors and their nursing and pharmacy colleagues – is vital to the safe, successful introduction of this expanded role for the ambulance service which has the potential to save many lives following heart attack.

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