Recognition of ST elevation by paramedics

M Whitbread, V Leah, T Bell, T J Coats

Emerg Med J 2002;**19**:66–67

See end of article for authors' affiliations

Correspondence to:
Mr T J Coats, Accident and
Emergency Department,
Royal London Hospital,
Whitechapel, London
E1 1BB, UK;
t.j.coats@mds.qmw.ac.uk

Accepted for publication
11 May 2001

Objective: To define the ability of UK paramedics to recognise ST segment elevation using a prehospital 12 lead electrocardiogram (ECG).

Methods: Analysis of the diagnostic ability of seven paramedics 12 months after a two day training course, using interpretation of a 12 lead ECG by two cardiologists as the criterion standard. Comparison of paramedic and A&E SHO diagnosis to determine accuracy, specificity, sensitivity, negative predictive value, and positive predictive value of paramedic interpretation.

Results: Paramedics showed a median accuracy of 0.95 (95% CI 0.88 to 0.98), a specificity of 0.91 (95% CI 0.53 to 1.0), a sensitivity of 0.97 (95% CI 0.94 to 0.99), a NPV of 0.77 (95% CI 0.62 to 0.92) and a PPV of 0.99 (95% CI 0.92 to 1.0). This was not significantly different from a group of experienced A&E SHOs.

Conclusions: UK paramedics can recognise ST elevation using a 12 lead ECG. Radio transmission of an ECG may not be necessary to pre-alert the hospital.

Early diagnosis of acute myocardial infarction (AMI) is a priority during the in hospital management of the patient with chest pain, to enable early thrombolysis.¹ A logical extension of early diagnosis is prehospital recognition of the ECG criteria for thrombolysis by ambulance service paramedics.

There are two methods of recognising ECG criteria for thrombolysis before the patient arrives at the hospital. Either the 12 lead electrocardiogram (ECG) is transmitted to a doctor who makes a diagnosis (and may communicate this diagnosis back to the ambulance crew), or alternatively ambulance paramedics are trained to interpret the 12 lead ECG. Transmission of an ECG requires technology at both ends of the transmission, a fault free line, the immediate availability of a senior doctor to make the diagnosis, and a system for communicating the diagnosis back to the ambulance crew. This system has a one in five chance of problems with communication, may result in delay and requires expensive technology.² These problems are avoided if the paramedic can recognise ST segment elevation. The ability of UK paramedics to interpret the 12 lead ECG, and the training required to acquire and maintain this skill has not been established.

This study was designed to test the recognition of ST elevation by paramedics 12 months after a short training course in the interpretation of the 12 lead ECG.

METHODS

A group of 10 London Ambulance Service paramedics were trained over two days, learning how to record a 12 lead ECG, how to recognise ST elevation (and bundle branch block) and how to communicate their diagnosis to the receiving accident and emergency (A&E) department. The paramedics were taught to recognise a normal ECG, anterior myocardial infarction, inferior myocardial infarction, and left bundle branch block (QRS complex > 0.1s with no "R" wave in V1 and no "Q" wave in V6). The criteria for of patients potentially requiring thrombolysis were ST elevation of 2 mm or more in two consecutive precordial leads, or 1 mm or more in two consecutive limb leads, or new left bundle branch block.

Paramedics were tested 12 months later, after taking part in a study of the effect of prehospital diagnosis on door to needle time. Each paramedic was given 100 minutes to classify whether significant ST elevation (as defined above) was present on 100 prehospital 12 lead ECGs. The same ECGs were

Table 1 Overall performance (95% confidence intervals) for paramedics and SHOs

	Paramedic	A&E SHO
Sensitivity	0.97 (0.94 to 0.99)	0.97 (0.96 to 0.99)
Specificity	0.91 (0.53 to 1.0)	0.67 (0.58 to 0.73)
Accuracy	0.95 (0.88 to 0.98)	0.93 (0.90 to 0.94)
Negative predictive value	0.77 (0.62 to 0.92)	0.85 (0.77 to 0.92)
Positive predictive value	0.99 (0.92 to 1.0)	0.93 (0.91 to 0.95)

also classified in the same way by a group of A&E SHOs towards the end of a six month A&E post. To provide a criterion (gold) standard each ECG was also classified by two consultant cardiologists, with an emergency physician providing a third opinion where there was disagreement.

The medians with 95% confidence intervals were calculated for sensitivity, specificity, accuracy, negative predictive value (NPV) and positive predictive value (PPV) of paramedic and SHO classifications.

RESULTS

Of the 10 paramedics initially trained seven remained at the same ambulance station after a year and were tested. The sensitivity, specificity, accuracy, NPV and PPV of classification of ECGs by paramedics and SHOs are shown in table 1.

DISCUSSION

Prehospital recognition of patients who may benefit from thrombolysis is not an established part of prehospital care in the UK. The role of prehospital diagnosis (if any) has yet to be defined. There are two questions that need to be answered: (1) Is prehospital recognition practical? (2) Is prehospital recognition worthwhile?

Abbreviations: AMI, acute myocardial infarction; ECG, electrocardiogram; PPV, positive predictive value; NPV, negative predictive value

The transmission of a prehospital diagnosis before the arrival of the patient enables the hospital to "gear up" to provide a swift response once the patient arrives. Several studies have shown that this decreases the door to needle time.³⁻⁶ A prehospital diagnosis is also required if prehospital thrombolysis is contemplated.⁷ These studies have shown that prehospital recognition of patients who may benefit from thrombolysis is worthwhile in the American systems examined. A similar benefit could be expected in Britain.

There are many differences in training between British and American paramedics. This study shows that British paramedics, after a short training course, are able to recognise significant ST elevation on a 12 lead ECG. This study was performed using a group of well motivated and enthusiastic paramedics from a single ambulance station with a close connection to a teaching hospital. The same results might not be obtained if all paramedics were trained in this skill.

Some skills are performed so infrequently by paramedics that there are major concerns about skill retention.⁸ As patients with both non-cardiac chest pain and AMI are common, prehospital diagnosis is a skill that will be frequently practised. There is therefore likely to be good skill retention. As the ambulance service works closely with A&E staff, immediate feedback is available to paramedics, which may make re-training unnecessary. The need for re-training could be easily assessed using a similar method to that used in this study.

There is little difference between paramedics and SHOs in this study apart from the trend towards lower specificity in the SHO group. Decision making is influenced by the perceived risks and benefits of different outcomes. A&E SHOs may be rather afraid of missing an AMI and therefore be more suspicious of marginal ST changes, leading to a larger number of false positives and a lower specificity. The doctors may also be unconsciously answering the question "Does this patient have an acute myocardial infarction?" rather than "Does this ECG show ST elevation?", or using a different set of ST segment elevation criteria for the diagnosis of AMI.⁹

These data are useful in planning a system for alerting the hospital prior to arrival of a patient with AMI. Diagnosis by paramedic may remove both the need for transmission of ECGs and the requirement that a senior doctor is immediately available to interpret the transmitted document. This would reduce both the cost and the organisational change required for prehospital diagnosis. The equipment change required is already occurring, with new cardiac monitors being able to record a 12 lead ECG. The training requirement would be a short course for all paramedics. No change would be required to the current system for transmitting messages from ambulance crews to the hospital.

These data are also useful in the debate about paramedic administration of prehospital thrombolysis, as the ability to recognise significant ECG changes has been defined. However, it is important to emphasise that this study did not examine the ability of a paramedic to diagnose AMI. Diagnosis of AMI is more complex than simply identifying ST elevation on a 12 lead ECG. Much more work would have to be done before any statement could be made about the diagnostic abilities of a paramedic. In particular the probable number of diagnostic errors must be known before any risk/benefit calculation can be made about prehospital thrombolysis.¹⁰

The effect of widespread introduction of prehospital recognition of ST elevation has not been established. It can be argued that if there was an efficient in hospital response to every patient a prehospital diagnosis would be unnecessary, however many hospitals still give a less than ideal response to these patients.^{11 12} No single intervention will universally provide early thrombolysis. All parts of the chain of care from initial symptoms onwards should be optimised to provide early

treatment. This study has shown that prehospital identification of ST elevation by paramedics is possible in the UK. The effect of the introduction of this technique now requires assessment.

This study has shown that prehospital recognition of ECG criteria for thrombolysis by paramedics is practical. UK paramedics can recognise significant ST elevation in a prehospital ECG with a sensitivity of 97% and a specificity of 91%. This information contributes to the analysis of the role of prehospital diagnosis in the treatment of patient with AMI. Only relatively small changes in ambulance training and equipment would be required to enable routine prehospital identification of patients with chest pain and significant ST changes.

ACKNOWLEDGEMENTS

We would like to thank Professor Douglas Chamberlain and Dr Peter Mills for their assistance in providing our gold standard. This project was supported by a grant from the medical audit department of the Royal Hospitals NHS Trust. Equipment was loaned by Physio-Control UK Ltd. This study would not have been possible without the enthusiastic support of the London Ambulance Service Paramedics of Poplar Ambulance Station.

Contributors: Mark Whitbread initiate the study, discussed core ideas, participate in protocol design, taught the paramedics, oversaw data collection and assisted with writing of the paper. Vicki Leah discussed core ideas, participate in protocol design, taught the paramedics, participated in data analysis and assisted with writing the paper. Tim Bell participated in data collection, assisted in data analysis and editing of the paper. Tim Coats discussed core ideas, participate in protocol design, oversaw data analysis and wrote the paper. Tim Coats is the guarantor of the paper.

Authors' affiliations

M Whitbread, Resuscitation Service, Royal Hospitals NHS Trust, London, UK

V Leah, Resuscitation Service, Joyce Green Hospital, Dartford, UK

T Bell, **T J Coats**, Department of Accident and Emergency, St Bartholomew's and the Royal London School of Medicine, Queen Mary and Westfield College, London, UK

REFERENCES

- Fibrinolytic Therapy Trialists' (FFT) Collaborative Group**. Indications for fibrinolytic therapy in suspected acute myocardial infarction: collaborative overview of early mortality and major morbidity results from all randomised trials of more than 1000 patients. *Lancet* 1994;**343**:311-22.
- Aufderheide TP**, Hendley GE, Woo J, *et al*. A prospective evaluation of prehospital 12-lead ECG application in chest pain patients. *J Electrocardiol* 1992;**24** (suppl):8-13.
- Foster DB**, Dufendach JH, Barkdoll CM, *et al*. Prehospital recognition of AMI using independent nurse/paramedic 12-lead evaluation: Impact on in-hospital time to thrombolysis in a rural community hospital. *Am J Emerg Med* 1994;**1**:25-31.
- Kennedy JW**, Weaver WD. The potential for prehospital thrombolytic therapy. *Clin Cardiol* 1990;**13**:23-6.
- Karagounis L**, Ipsen SK, Jessop MR, *et al*. Impact of field-transmitted electrocardiography on time to in-hospital thrombolytic therapy in acute myocardial infarction. *Am J Cardiol* 1990;**66**:786-91.
- Gibler WB**, Kereiakes DJ, Dean EN. Prehospital diagnosis and treatment of acute myocardial infarction: a North-South perspective. *Am Heart J* 1991;**121**:1-11.
- Weaver WD**, Cerqueira M, Hallstrom AP. Prehospital-initiated vs hospital-initiated thrombolytic therapy. The Myocardial Infarction Triage and Intervention Trial. *JAMA* 1993;**270**:1211-16.
- Latman LS**, Wooley K. Knowledge and skill retention of emergency care attendants, EMT-As and EMT-PS. *Ann Emerg Med* 1980;**9**:183-9.
- Otto LA**, Aufderheide TP. Evaluation of ST segment elevation criteria for the prehospital electrocardiographic diagnosis of acute myocardial infarction. *Ann Emerg Med* 1994;**23**:17-24.
- Aufderheide TP**, Haselow WC, Hendley GE, *et al*. Feasibility of prehospital r-tPA therapy in chest pain patients. *Ann Emerg Med* 1992;**21**:379-83.
- Hood S**, Birnie D, Swan L, *et al*. Questionnaire survey of thrombolytic treatment in accident and emergency departments in the United Kingdom. *BMJ* 1998;**316**:274.
- Birkhead JS**. Time delays in provision of thrombolytic treatment in six district hospitals. *BMJ* 1992;**305**:445-8.