An evaluation of technologies for identifying acute cardiac ischemia in the emergency department: a report from a National Heart Attack Alert Program Working Group

Authors' objectives
To assess the technologies for identifying acute cardiac ischaemia (ACI), both acute myocardial infarction (MI) and unstable angina pectoris (AP), in the emergency department.

Searching
MEDLINE (search terms not stated) and related electronic literature were searched. The authors supplemented the searches with panellists' knowledge of the literature and ongoing research. The search was restricted to English language publications.

Study selection
Study designs of evaluations included in the review
No inclusion criteria relating to the study design were specified. Details of the included studies were not reported.

Specific interventions included in the review
No inclusion criteria relating to the tests assessed were stated. The included studies were of 14 technologies directed at the diagnosis of ACI in the emergency department:

- standard electrocardiogram (ECG);
- pre-hospital ECG;
- continuous 12-lead ECG;
- non-standard ECG and body-surface mapping;
- ECG exercise stress test;
- original ACI predictive instrument;
- ACI time insensitive predictive instrument (ACI-TIPI);
- Goldman chest pain protocol;
- other computer-based decision aids;
- creatine kinase;
- other biochemical tests;
- echocardiogram;
- thallium scanning; and
- sestamibi and other technetium-99m perfusion agents.

Methods which were primarily directed at prognostic or risk stratification were excluded.

Reference standard test against which the new test was compared
No inclusion criteria relating to the reference standard were specified. The methods the included studies used to establish diagnosis were not reported.

Participants included in the review
No inclusion criteria relating to the patient characteristics were described. The review referred to emergency room patients with symptoms consistent with ACI. However, the characteristics of the participants in the included studies were not described.

Outcomes assessed in the review
No inclusion criteria relating to the outcome measures were described. The technologies were assessed for their accuracy in: emergency department diagnostic performance; and demonstrated emergency department clinical impact.

The diagnostic performance and the magnitude of its demonstrated clinical impact were rated as: very accurate/large clinical impact (+++), moderately accurate/medium impact (++), modestly accurate/small impact (+), not known (NK), or not effective (NE).

How were decisions on the relevance of primary studies made?
Three group members independently reviewed the studies for inclusion.

Assessment of study quality
The members of the review group assessed the included studies on a scale of A, B, C and NK. A was assigned to prospective controlled clinical studies of high quality (e.g. large multicentre trials with concurrent controls); B to substantial clinical studies; C to limited studies of evidence (e.g. case studies, small clinical studies); and NK to not known (e.g. expert opinion or case reports only).

The group also scored the included studies using an independent rating of study quality which assessed 26 items, divided into 4 groups for scoring. For each item the article being rated was scored from 0 to 4 points. The scores were summed for each article and then standardised to a maximum possible score of 100 points. Three group members independently scored the included studies using the study quality rating forms prior to assigning the A, B, C and NK quality ratings at a review meeting. The scoring showed a statistically significant Spearman rank correlation of 0.73 between the ratings by the multi-item explicit quality rating system and the rating by the Working Group; this supported the validity of the A, B, C, NK quality rating system.

Data extraction
Three group members independently extracted the data using a structured format. Data were extracted for three main categories.

1. Summary of technology.

2. Critique: scientific basis; clinical practicality; data from prospective clinical trials in the emergency department setting (studies of test sensitivity and specificity, and studies of the clinical impact of the test's actual use); data from other clinical studies; generalisability to different settings; applicability to population subgroups, including women and minorities; cost considerations; special concerns; primary advantages.


Methods of synthesis
How were the studies combined?
The studies were combined in a narrative review structured around the categories specified in the data extraction.

How were differences between studies investigated?
The authors did not state how differences between the studies were investigated, and differences were not discussed in the text.
Results of the review
Seventy-eight studies were included. The total number of participants was not stated.


Continuous 12-lead ECG. Diagnostic performance: quality of evidence NK; accuracy NK. Clinical impact: quality of evidence NK; impact NK.

Non-standard ECG. Diagnostic performance: quality of evidence C; accuracy +. Clinical impact: quality of evidence NK; impact NK.

Body-surface mapping. Diagnostic performance: quality of evidence NK; accuracy NK. Clinical impact: quality of evidence NK; impact NK.


Goldman chest pain protocol. Diagnostic performance: quality of evidence A; accuracy +++ for acute MI and NE for unstable AP. Clinical impact: quality of evidence B; impact NK-NE.

Other computer-based decision aids. Diagnostic performance: quality of evidence B; accuracy +. Clinical impact: quality of evidence NK; impact NK.

Creatine kinase - single tests. Diagnostic performance: quality of evidence A; accuracy + for acute MI and NE for unstable AP. Clinical impact: quality of evidence NK; impact NK.

Creatine kinase - multiple tests. Diagnostic performance: quality of evidence A; accuracy +++ for acute MI and NE for unstable AP. Clinical impact: quality of evidence NK; impact NK.

Other biochemical tests - for troponin-T and troponin-I. Diagnostic performance: quality of evidence B; accuracy ++ for acute MI and NE for unstable AP. Clinical impact: quality of evidence NK; impact NK.

Other biochemical tests - for myoglobin. Diagnostic performance: quality of evidence B; accuracy + for acute MI and NE for unstable AP. Clinical impact: quality of evidence NK; impact NK.


Thallium scanning. Diagnostic performance: quality of evidence C; accuracy NK-NE. Clinical impact: quality of evidence NK; impact NK.


Cost information
The standard ECG represents an inexpensive and readily available clinical test at approximately $15 to $50 per test.

Cost data for pre-hospital ECG were unavailable in the included studies. However, a standard defibrillator-monitor with 12-lead ECG capability costs approximately $3,500 to $4,000 more per unit than one without 12-lead ECG capability. An additional $300 investment per electrocardiograph machine is required to purchase a cellular telephone.

Continuous 12-lead ECG monitors cost approximately $8,000 per bed, while central monitor stations cost approximately $15,000.

The original ACI predictive instrument costs were stated as very low, but were not specifically stated.

The costs of ACI-TIPI were stated as negligible.

The costs of creatine kinase were not stated, but the authors predicted these would be time consuming and potentially expensive.

The costs of other biochemical tests costs were stated as uncertain at present.

The costs of echocardiogram were stated as significant (an echocardiography machine costs more than $200,000).

Thallium scanning would increase the costs of the evaluation of a patient with chest pain by $500 to $800. Thus, such imaging should be considered only in selected patient subgroups. This was approximately $150 less than the cost of a similar study with sestamibi.

The costs of sestamibi and other technetium-99m perfusion agents were similar to thallium scanning.

The costs of non-standard ECG, body-surface mapping, ECG exercise stress test, Goldman chest pain protocol, and other computer-based decision aids were not stated in the included studies.

**Authors’ conclusions**

Recommendations regarding the use of a technology should be based on both emergency department diagnostic performance and clinical impact data obtained in high-quality or substantial studies. Of the various diagnostic technologies evaluated in the 14 sections, only 5 met this highly desirable standard of evaluation: the original ACI predictive instrument; the ACI-TIPI; the pre-hospital ECG; the Goldman chest pain protocol; and the ECG exercise stress test. The original ACI predictive instrument was excellent for diagnostic performance and substantial clinical impact and, therefore, could be recommended for general use in practice. On the basis of the currently available evidence, the general use of the other technologies assessed in the review cannot be recommended.

**CRD commentary**

This is an abstract of an extensive narrative review. It is strongly recommended that the reader refer to the original publication for full details of the data analysis and evaluation.

The authors clearly stated their research question, although their inclusion and exclusion criteria were not explicitly defined. The reporting of the literature search was poor and omitted details of the search strategy, the dates of the search, and the names of the databases searched. It is possible that the authors may have missed additional relevant studies.

The quality of the included studies was assessed using two sets of criteria. The authors reported in detail how the articles were selected, and how many of the reviewers were involved in the data selection and extraction processes. The data extraction was reported in tabular format and in the text, and the narrative synthesis was appropriate. Details of the individual included studies were very limited. There were no tests for heterogeneity, but the authors discussed methodological and data limitations of the included studies.

The authors’ conclusions appear to follow from the results, but should be viewed with caution given the stated
methodological limitations of the review.

**Implications of the review for practice and research**
The authors stated that further diagnostic trials are needed to address both the accuracy and impact of these technologies. In addition, the evaluation of diagnostic approaches integrating multiple technologies (such as panels of different biochemical markers) or of multiple modalities (such as combining ECG, imaging and biochemical tests) is needed. Further research to understand the incremental contributions of each modality is also needed.

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