Appendix D - Clinical Evidence Extractions
Question: What are the education and information needs in adults presenting with chest pain to optimise their understanding of the diagnostic process and their participation in decisions about their investigations?
Information sheets for patients with acute chest pain: randomised controlled trial

**Study Type**  
Randomised Controlled Trial  

**Number of participants**  
Intervention group, n=349; Control group n=351. Total n=700.

**Inclusion/Exclusion Criteria**  
Subjects were patients who were investigated for chest pain of possible cardiac origin, were aged over 25, had no changes for acute coronary syndrome on a diagnostic electrocardiogram, had no suspected life threatening non-cardiac disease and did not have known coronary heart disease presenting with recurrent or prolonged episodes of cardiac type chest pain. Patients were excluded if they were unable to read or comprehend the trial documentation.

**Patient Characteristics**  
The study population had a mean age of 48.6 years, and 61.6% were men. Information sheets were deemed suitable for 19 patients with a diagnosis of angina (mean age 69.58%, men) 162 with a diagnosis of definite benign non-cardiac pain (mean age 43, 65% men), 61 with a diagnosis of uncertain cause requiring further cardiology investigation (mean age 52, 49% men), and 458 with a diagnosis of uncertain cause suitable for expectant management (mean age 49, 62% men).

**Recruitment**  
The aim was to recruit 700 consecutive patients who had been investigated for suspected acute coronary syndrome. The chest pain nurses identified eligible patients.

**Setting**  
Chest pain unit, emergency centre, Sheffield

**Interventions/Test/Factor being investigated**  
The objective was to determine whether providing an information sheet to patients with acute chest pain reduces anxiety, improves health related quality of life, improves satisfaction with care or alters subsequent symptoms or actions. Four separate information sheets were developed: definite angina, definite benign non-cardiac chest pain, uncertain cause requiring further cardiology investigation and uncertain cause suitable for expectant management.

**Comparisons**  
This study compared those receiving standard verbal advice with those receiving advice and an information sheet.

**Length of Study/Follow-up**  
One month after recruitment all patients were sent a questionnaire by post. Questionnaires were resent to non-responders at six and eight weeks.

**Outcome measures studied**  
The primary outcome was scores on the anxiety subscale of the hospital anxiety and depression scale. Secondary outcomes included the depression and SF-36 scores; satisfaction; further symptoms; life style changes.

**Results**  
494 of 700 (70.6%) responses. Compared with those receiving standard verbal advice those receiving advice and an information sheet had significantly lower anxiety scores 7.61 versus 8.63 (95% CI 0.20 to 1.84, p=0.015) and depression scores 4.14 versus 5.28 (95% CI 0.41 to 1.86, p=0.002). On the anxiety subscale, intervention was associated with a shift from mild or moderate anxiety to no anxiety; on the depression subscale the intervention was associated with a shift towards lower scores among those with no depression and also a reduction in the proportion with moderate depression. The number needed to treat to avoid one case of anxiety was 9.0 and the NNT for depression was 13.1. Patients in the intervention group had significantly higher scores for mental health (p<0.007) and general health perception (p<0.006) on the SF-36 than those in the control group. There were no other significant differences between the two groups.

**Safety and adverse effects**  
None reported
| **Does the study answer the question?** | Provision of an information sheet to patients with acute chest pain can reduce anxiety and depression and improve mental health and perception of general health but does not alter satisfaction with care or other outcomes. The authors of the study conclude that as the information sheets are simple to administer and outcomes were on balance positive, the use of these sheets should be recommended in patients receiving diagnostic assessment for acute chest pain. |
| **Effect due to factor in study?** | There are some limitations which may bias the outcome of this study: it is not blinded; there was a 30% non response rate to the questionnaire; there was potential for contamination between groups by the nurses giving the information on the information sheet verbally to the control group. |
| **Consistency of results with other studies?** | There are no other studies in this field. |
| **Directly applicable to guideline population?** | This study population excluded all patients who could not read English. Thus it may not be generalisable to all individuals with chest pain. |
| **Internal Validity** | Subjects are not blinded; 29% non response |
Question: What is the incremental benefit and cost effectiveness of a clinical history, risk factors and physical examination in evaluation of individuals with acute chest pain of suspected cardiac origin?
Signs and symptoms in diagnosing acute myocardial infarction and acute coronary syndrome: a diagnostic meta-analysis

Funding
Not reported

Study Type
Systematic Review

Number of participants
28 prospective and retrospective observational studies

Inclusion/Exclusion Criteria
Studies had to describe at least 1 of the 10 signs and symptoms for diagnosing ACS or AMI, and based on original data

Patient Characteristics
Patients with signs and symptoms for the diagnosis of acute MI, unstable angina or ACS.

Recruitment
Secondary and primary care

Interventions/ Test/ Factor being investigated
The signs and symptoms considered were pain in left arm and/or shoulder, pain in right arm and/or shoulder, pain in both arms, pain in neck, pain in back, epigastric pain, oppressive pain, vomiting and/or nausea, sweating or absence of chest wall tenderness

Comparisons
Signs and symptoms to diagnose chest pain

Length of Study/ Follow-up

Outcome measures studied

Results
The results of the meta-analysis showed that absence of chest wall tenderness was highly sensitive for AMI and ACS (92% and 94% respectively). It was seen that when the patient presented with pain on palpation the chance of an AMI or ACS was greatly reduced (LR+: 0.23 and 0.17 respectively). The analysis showed that oppressive pain had a sensitivity of 60% and specificity of 58% and had almost no influence on the likelihood of the patient having an AMI. The other signs and symptoms considered in the study had lower sensitivity and specificity and therefore could not be used to exclude an AMI or ACS.

Safety and adverse effects
None reported

15 September 2009  Page 6 of 199
5606 papers were initially identified of these 28 papers met the inclusion criteria for the use of 10 signs and symptoms, the studies included were prospective and retrospective observational studies, more than half of the studies were published since Mant et al's selection for the HTA published in 2004. A total of 46,908 patients were included in the review. The signs and symptoms considered were pain in left arm and/or shoulder, pain in right arm and/or shoulder, pain in both arms, pain in neck, pain in back, epigastric pain, oppressive pain, vomiting and/or nausea, sweating or absence of chest wall tenderness. Of the 28 papers, 11 were set in the emergency department, 10 were set in coronary care unit or the patients had been admitted to hospital, 3 were on the paramedics in an ambulance, 2 were set in GPs, 1 was carried out by a cardiologist and 1 was in a chest pain observational unit. 16 of the studies had non-selected patients, 11 had selected patients and 1 was from a chest pain observation unit. Selected patients were those who were recruited by coronary care units and cardiologists. All studies included patients had chest pain, in two studies patients also had pulmonary oedema. The mean age of the participants in all the studies was 53-71 years old, and the % of males was from 40-71%.

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The sensitivity of absence of tenderness was high, namely 92% (95% CI = 85.5 to 96.4) for acute myocardial infarction and 94% (95% CI = 91.4 to 96.1) for acute coronary syndrome. Oppressive pain followed with a sensitivity of 60% (95% CI = 53.7 to 66.0 for acute myocardial infarction). Sweating had the highest LR+, namely 2.92 (95% CI = 1.97 to 4.32 for acute myocardial infarction). The LR+ of right arm or shoulder pain was 2.89 (95% CI = 1.40 to 5.98) for acute myocardial infarction (one study). The other LR+ fluctuated between 1.05 and 1.49 for acute coronary syndrome. Absence of tenderness had a LR- of 0.23 (95% CI = 0.18 to 0.29) for acute myocardial infarction and 0.17 (95% CI = 0.11 to 0.26) for acute coronary syndrome. Other LR- varied between 0.69 (oppressive pain and sweating for acute myocardial infarction) and 0.98 (epigastric pain) for acute coronary syndrome.

The authors concluded that it was not possible to define an important role for signs and symptoms in the diagnosis of AMI or ACS. Only chest wall tenderness on palpation largely ruled out AMI or ACS.

See tables in guideline for detailed results. (NB pleuritic pain not considered).

Does the study answer the question?

Yes

Effect due to factor in study?

Consistent

Consistency of results with other studies?

Directly applicable to guideline population?

Correct population

Internal Validity

Mant J;McManus RJ;Oakes RL;Delaney BC;Barton PM;Deeks JJ;Hammersley L;Davies RC;Davies MK;Hobbs FR;

Systematic review and modelling of the investigation of acute and chronic chest pain presenting in primary care

Ref ID 728 Health technology assessment 1 to 158 2004

Study Type Systematic Review

Funding NHS R&D Health Technology Assessment Programme

15 September 2009 Page 7 of 199
The signs and symptoms considered were pleuritic pain, sharp pain, positional pain, pain on palpation, crushing pain, central pain, left-sided radiation pain, right-sided radiation pain, any radiation of pain, pain duration of longer than 1 hour, previous MI/angina, nausea/vomiting, sweating, pulmonary crackles, systolic blood pressure under 80 mmHg or a third heart sound.

Signs and symptoms to diagnose chest pain

Number of participants
21 observational studies

Inclusion/Exclusion Criteria
Papers used at least one of the signs and symptoms in the diagnosis of chest pain

Patient Characteristics

Recruitment
8 secondary care, 10 A&E, 3 primary secondary care

Interventions/ Test/ Factor being investigated
The signs and symptoms considered were pleuritic pain, sharp pain, positional pain, pain on palpation, crushing pain, central pain, left-sided radiation pain, right-sided radiation pain, any radiation of pain, pain duration of longer than 1 hour, previous MI/angina, nausea/vomiting, sweating, pulmonary crackles, systolic blood pressure under 80 mmHg or a third heart sound.

Comparisons
Signs and symptoms to diagnose chest pain

Length of Study/ Follow-up
None of the signs and symptoms in isolation were found to be particularly useful: no sign or symptom achieved an LR of <0.1 or >10.22. Indeed, only one of the upper limits of the 95% CIs exceeded 10 – for right-sided radiation of pain in diagnosis of ACS – which was based on only one study. Similarly, only one of the lower limits (for pain on palpation) was <0.1. The results for presence of a sign or symptom (LR+) were more informative than those for the absence of a symptom or sign (LR−) which were non-contributory to making a diagnosis in every case. Systolic hypotension, the presence of a third heart sound and right-sided radiation of chest pain, achieved the highest positive LRs (LR+ 3.21–2.59) for diagnosis of MI. Where the reference standard was MI or unstable angina, right-sided radiation was associated with a higher positive LR (6.68). Clinical features most helpful in ruling out the diagnosis were the presence of pleuritic, sharp or positional pain, and pain produced by palpation (LR+ 0.19–0.32). It should be noted that there was considerable heterogeneity in the results, particularly (although not exclusively) for the negative LRs. This makes the summary statistics difficult to interpret. Nevertheless, there is no evidence that any single symptom or sign taken in isolation is of much value in the diagnosis of acute chest pain.

Safety and adverse effects
None reported

Does the study answer the question?

10862 papers were initially identified of these 21 papers met the inclusion criteria for the use of 16 difference clinical signs and symptoms. A total of 38638 patients were included in the review. The signs and symptoms considered were pleuritic pain, sharp pain, positional pain, pain on palpation, crushing pain, central pain, left-sided radiation pain, right-sided radiation pain, any radiation of pain, pain duration of longer than 1 hour, previous MI/angina, nausea/vomiting, sweating, pulmonary crackles, systolic blood pressure under 80 mmHg or a third heart sound. Of the 21 papers, 8 were set in secondary care, 10 in A&E, and 3 in primary and secondary care. The mean age of the participants in all the studies was 50-73 years old, and the % of males was from 50-71%.

None of these in isolation were found to be particularly useful: no sign or symptom achieved an LR of <0.1 or >10.22. Indeed, only one of the upper limits of the 95% CIs exceeded 10 – for right-sided radiation of pain in diagnosis of ACS – which was based on only one study. Similarly, only one of the lower limits (for pain on palpation) was <0.1. The results for presence of a sign or symptom (LR+) were more informative than those for the absence of a symptom or sign (LR−) which were non-contributory to making a diagnosis in every case. Systolic hypotension, the presence of a third heart sound and right-sided radiation of chest pain, achieved the highest positive LRs (LR+ 3.21–2.59) for diagnosis of MI. Where the reference standard was MI or unstable angina, right-sided radiation was associated with a higher positive LR (6.68). Clinical features most helpful in ruling out the diagnosis were the presence of pleuritic, sharp or positional pain, and pain produced by palpation (LR+ 0.19–0.32).
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Effect due to factor in study? Yes
Consistency of results with other studies? Consistent
Directly applicable to guideline population? Correct population

Internal Validity

Mant J, McManus RJ, Oakes RL, Delaney BC, Barton PM, Deeks JJ, Hammersley L, Davies RC, Davies MK, Hobbs FR;

Systematic review and modelling of the investigation of acute and chronic chest pain presenting in primary care

Ref ID 728

Study Type Systematic Review
Funding NHS R&D Health Technology Assessment Programme

Number of participants 21 Cohort studies

Inclusion/Exclusion Criteria papers used at least one of the signs and symptoms in the diagnosis of chest pain

Patient Characteristics

Recruitment

Setting 8 secondary care, 10 A&E, 3 primary&secondary care

Interventions/Test/Factor being investigated The signs and symptoms considered were pluritic pain, sharp pain, positional pain, pain on palpation, crushing pain, central pain, left-sided radiation pain, right-sided radiation pain, any radiation of pain, pain duration of longer than 1 hour, previous MI/angina, nausea/vomiting, sweating, pulmonary crackles, systolic blood pressure under 80 mmHg or a third heart sound

Comparisons Signs and symptoms to diagnose chest pain

Length of Study/Follow-up

Outcome measures studied

Results

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Safety and adverse effects

Does the study answer the question?

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Effect due to factor in study?

Yes

Consistency of results with other studies?

Consistent

Directly applicable to guideline population?

Correct population

Internal Validity

Swap CJ; Nagurney JT;

Value and limitations of chest pain history in the evaluation of patients with suspected acute coronary syndromes

Study Type: Systematic Review

Funding: Not reported

Number of participants: 28 prospective and retrospective observational studies and systematic reviews

Inclusion/Exclusion Criteria: Studies needed to be observational studies including at least 80 patients. Studies needed to include at least 1 chest pain characteristic and make a diagnosis of ACS or AMI with appropriate diagnostic tests

Patient Characteristics: Patients described at least on chest pain characteristic which was diagnosed as ACS or AMI.

Recruitment

Setting

15 September 2009 Page 10 of 199
The studies considered the following chest pain characteristics: quality, location, radiation, size of area or distribution, severity, time of onset and is it continuing, duration, first occurrence frequency, similar to previous cardiac ischemic episodes and the following precipitating or aggravating factors: pleuritic, positional, palpable, exercise, emotional stress, relieving factors, associated symptoms.

Chest pain characteristics for diagnosing chest pain

28 papers were initially identified that were relevant to the evaluation of chest pain using signs and symptoms, the studies included were prospective and retrospective observational studies and systematic reviews, considering both predictors of AMI and ACS. The studies considered the following chest pain characteristics: quality, location, radiation, size of area or distribution, severity, time of onset and is it continuing, duration, first occurrence frequency, similar to previous cardiac ischemic episodes and the following precipitating or aggravating factors: pleuritic, positional, palpable, exercise, emotional stress, relieving factors, associated symptoms.

Certain chest pain characteristics decrease the likelihood of ACS or AMI, namely, pain that is stabbing, pleuritic, positional, or reproducible by palpation (likelihood ratios [LRs] 0.2 to 0.3). Conversely, chest pain that radiates to one shoulder or both shoulders or arms or is precipitated by exertion is associated with LRs (2.3 to 4.7) that increase the likelihood of ACS. The chest pain history itself has not proven to be a powerful enough predictive tool to obviate the need for at least some diagnostic testing. Combinations of elements of the chest pain history with other initially available information, such as a history of CAD, have identified certain groups that may be safe for discharge without further evaluation, but further study is needed before such a recommendation can be considered reasonable.

Risk stratification for ACS according to components of chest pain history:
Low risk: pain that is pleuritic, positional, or reproducible with palpation or is described as stabbing
Probable low risk: pain not related to exertion or that occurs in a small inframammary area of the chest wall
Probable high risk: pain described as pressure, is similar to that of prior MI or worse than prior anginal pain or is accompanied by nausea, vomiting or diaphoresis
High risk: pain that radiates to one or both shoulders or arms or is relate to exertion

The authors concluded that although certain elements of the chest pain history are associated with increased (LR = 2.3 to 4.7) or decreased (LR = 0.2 to 0.3) likelihoods of a diagnosis of ACS or AMI, none of them alone or in combination identify a group of patients that can be safely discharged without further diagnostic testing (see table in guideline for detailed results).

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

Consistency of results with other studies?
Directly applicable to guideline population?

Correct population

Internal Validity
Grading: 2++  High-quality systematic reviews of case–control or cohort studies
High-quality case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal

Conti A; Paladini B; Toccafondi S; Magazzini S; Olivotto I; Galassi F; Pieroni C; Santoro G; Antonucci D; Berni G;

Effectiveness of a multidisciplinary chest pain unit for the assessment of coronary syndromes and risk stratification in the Florence area

Ref ID 926  American heart journal  630 to 635  2002

Study Type  Cohort  Funding  Italian Ministry for Scientific and Technological Research

Number of participants  13 762 patients

Inclusion/Exclusion Criteria
- Inclusion: over 18 years old, chest pain defined as pain in the thoracic region, independent of duration, radiation, or relation to exercise, occurring in the last 24 hours and lasting minutes to hours

Patient Characteristics
- The mean age was 65±18 years and 43% were women
- Those who were categorised as being at high risk (21%) had a mean age of 63±10 years, 33% were female, 35% smoked, 25% had diabetes, 38% had hypertension, 13.4% died during the follow up.
- Those who were categorised as being at intermediate risk (47%) had a mean age of 64±11 years, 38% were female, 33% smoked, 28% had diabetes, 41% had hypertension, 2.2% died during the follow up.
- Those who were categorised as being at low risk (32%) had a mean age of 38±15 years, 66% were female, 12% smoked, 8% had diabetes, 22% had hypertension, 0.2% died during the follow up.

Recruitment
- Admitted to emergency department with chest pain as described above

Setting
- ED. Careggi General Hospital, Florence, Italy

Interventions/Test/Factor being investigated
- Diagnosing chest pain

Comparisons
- The chest pain score was based on: location of pain, radiation of pain, character of pain, history of angina

Length of Study/Follow-up
- 6 months

Outcome measures studied
- Effectiveness of chest pain score in diagnosing chest pain

Results
- The chest pain score was based on the following elements each of which was given a value: location of pain: substernal or precordial = +3, left chest, neck, lower jaw or epigastrium = +1, apex = -1; radiation of pain: arm, shoulder, back, neck or lower jaw = +1; character of pain: crushing, pressing or heaviness = +2 sticking, pleuritic or pinprick = -1; associated symptoms: dyspnea, nausea or diaphoresis = +2; history of angina = +3. The mean age was 65±18 years. Patients were classified into 1 of 4 groups.
- 1) Patients at low risk with obvious noncardiac causes of chest pain, chest pain score <4, normal ECG, and normal serum markers of cardiac injury obtained at least 6 hours from symptoms, were sent home and followed up. (2672 patients)
- 2) Patients at low risk with chest pain score ≥ 4, normal ECG, normal serum cardiac markers, independent of age or coexisting coronary risk factors, were not admitted and underwent a second-line evaluation and short-term observation in the CPU area, including chest radiography, serial 12-lead ECG, serial troponins and cardiac enzymes, echocardiography and arterial blood gas analysis. When at least one of these tests or procedure results was found to be suggestive of AMI, unstable angina or CAD or left ventricular failure was detected these patients were considered for angiography with no additional testing. After an observation period up to 6 hours

15 September 2009
Of the patients with a chest pain score > 4 and normal electrocardiogram results, 20% (885 patients) had documented coronary artery disease, defined as known stable angina, previous myocardial infarction, or angiographically documented CAD.

At six month follow up 0.2% of these patients were recognised as having nonfatal coronary artery disease, hence, the negative predictive value of a chest pain score of < 4 and normal ECG was > 99%

Of the patients with a chest pain score ≥ 4 and normal or non diagnostic electrocardiogram results (1755 patients, 40%), 20% of the low risk group with chest pain score < 4 (group 1) (885 patients) had documented coronary artery disease, 18% of which were by recurrent angina, delayed ECG changes, late rise in markers, the other 2% was by positive stress test.

There were 9335 intermediate and high risk patients, of which 2420 patients (26%) had an MI, 3764 patients (40%) had unstable angina, 129 (1.4%) had aortic dissection and 408 (4%) had pulmonary embolism, other major cardiovascular conditions were diagnosed, including aortic arch dissection, pulmonary embolism, pneumothorax, and acute pericarditis. 2256 patients had atypical chest pain diagnosed as multi-organ disease including chronic and stable ischemic heart disease, defined as known stable angina, previous myocardial infarction, or angiographically documented CAD.

The authors concluded that the chest pain score screening programme was effective and could significantly reduce admissions and optimise the care of those with an intermediate or high risk score. The authors also concluded that the screening programme could aid the diagnosis of alternative causes of chest pain in patients who do not have evidence of coronary artery disease.
Grading: 2+  
Well-conducted case–control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal

Schillinger M; Sodeck G; Meron G; Janata K; Nikfardjam M; Rauscha F; Laggner AN; Domanovits H;

Acute chest pain—identification of patients at low risk for coronary events. The impact of symptoms, medical history and risk factors

Ref ID: 735  
Wiener klinische Wochenschrift  
pp. 83 to 89  
2004

Study Type  
Cohort  

Funding  
Not reported

Number of participants  
1288 patients

Inclusion/Exclusion Criteria  
Inclusion criteria: all patients presenting with acute chest pain, onset in previous 24 hours, at a non-trauma emergency department

Patient Characteristics  
The mean age of the population was 49±17 years, 41% were women, 29% had hypertension, 9% had diabetes mellitus, 35% had hyperlipidaemia, 32% were current smokers, 26% were obese (BMI>28), 20% had a family history of MI, 15% had a history of prior MI, 23% had a history of coronary artery disease, 2% had a history of congestive heart failure, 3% had valvular heart disease

Recruitment  
Patients presenting with chest pain at a non-trauma emergency department

Setting  
University hospital in Helsinki, Finland

Interventions/ Test/ Factor being investigated  
Diagnosing chest pain

Comparisons  
Seven pre-defined criteria are evaluated and were assigned as either typical or atypical

Length of Study/ Follow-up  
6 months

Outcome measures studied  
Prediction or exclusion of acute MI and major adverse coronary events (MACE) at six months

Results  
Seven pre-defined criteria are evaluated and were assigned as either typical or atypical; namely, location of chest pain (typical: left sided, atypical: right sided), character of pain (typical: crushing / sneezing / burning / tightness, atypical: stabbing / single spot / superficial), radiation (typical to the left or both arms, neck, back, atypical: not radiating), appearance of chest pain (typical: exercise induced / undulating / relieved with rest or nitroglycerin, atypical: inducible by pressure / abrupt palpitations / sustained / position dependent / respiration dependent / cough dependent), vegetative signs (typical dyspnea / nausea / diaphoresis atypical; absence of vegetative signs), history of coronary artery disease (typical: MI / PTCA / CABD, atypical: none) and risk factors for coronary artery disease namely; smoking, obesity, hypertension, diabetes, hyperlipidaemia, and family history all typical, atypical was defined as absence or only one risk factor. The positive predictive value (PPV) and LR of typical and atypical criteria were evaluated for prediction or exclusion of acute MI and major adverse coronary events (MACE) at six months.

Thirteen percent (168 patients) of patients had an acute MI and 19% (240 patients) had a MACE (CVD, percutaneous coronary interventions, bypass surgery or MI) at six months follow up.

From the typical symptoms or history the likelihood ratios (LR) to predict an MI were:
1 typical symptom or history LR = 1.15; 2 typical symptoms and/or history LR = 1.32; 3 typical symptoms and/or history LR = 1.48; 4 typical symptoms and/or history LR = 1.77; 5 typical symptoms and/or history LR = 1.88; 6 typical symptoms and/or history LR = 1.85

15 September 2009  
Page 15 of 199
From the typical symptoms or history the LR to predict a cardiac adverse event in the following 6 months were:
1 typical symptom or history LR = 1.15; 2 typical symptoms and/or history LR = 1.34; 3 typical symptoms and/or history LR = 1.58; 4 typical symptoms and/or history LR = 1.87; 5 typical symptoms and/or history LR = 2.11; 6 typical symptoms and/or history LR = 1.54

From the atypical symptoms or history the LR to exclude an MI were:
1 atypical symptom or history LR = 1.05; 2 atypical symptoms and/or history LR = 1.25; 3 atypical symptoms and/or history LR = 1.76; 4 atypical symptoms and/or history LR = 2.22; 5 atypical symptoms and/or history LR = 3.19; 6 atypical symptoms and/or history LR = 3.00
From the atypical symptoms or history the LR to exclude a cardiac adverse event in the following 6 months were:
1 atypical symptom or history LR = 1.04; 2 atypical symptoms and/or history LR = 1.29; 3 atypical symptoms and/or history LR = 1.85; 4 atypical symptoms and/or history LR = 3.02; 5 atypical symptoms and/or history LR = 4.87; 6 atypical symptoms and/or history LR = 4.58

The presence of four or more typical criteria was associated with a PPV of 0.21 (95% CI 0.17 to 0.25) to predict acute MI and 0.30 (95% CI 0.25 to 0.35) for 6 month MACE. Increasing numbers of atypical chest pain criteria was associated with increasing PPVs for excluding acute MI and 6 month MACE. The presence of four or more typical criteria was associated with a PPV of 0.94 (95%CI 0.92 to 0.96) to exclude acute MI and 0.93 (95% CI 0.90 to 0.96) for 6 month absence of MACE. The authors concluded that the evaluation of criteria atypical for MI may identify patients suitable for early discharge; however criteria typical of MI have little diagnostic value

Safety and adverse effects
None reported

Does the study answer the question?
Yes

Effect due to factor in study?
Consistent

Consistency of results with other studies?
Consistent

Directly applicable to guideline population?
Correct population

Internal Validity
Well covered

Schillinger M; Sodeck G; Meron G; Janata K; Nikfardjam M; Rauscha F; Laggner AN; Domanovits H;
Acute chest pain--identification of patients at low risk for coronary events. The impact of symptoms, medical history and risk factors
Ref ID: 735
Wiener klinische Wochenschrift pg 83 to 89 2004

Study Type
Cohort

Number of participants
1288 patients

Inclusion/Exclusion Criteria
Inclusion criteria: all patients presenting with acute chest pain, onset in previous 24 hours, at a non-trauma emergency department

Funding
Not reported
The mean age of the population was 49±17 years, 41% were women, 29% had hypertension, 9% had diabetes mellitus, 35% had hyperlipidaemia, 32% were current smokers, 26% were obese (BMI>28), 20% had a family history of MI, 15% had a history of prior MI, 23% had a history of coronary artery disease, 2% had a history of congestive heart failure, 3% had valvular heart disease.

Recruitment
Patients presenting with chest pain at a non-trauma emergency department

Setting
University hospital in Helsinki, Finland

Interventions/ Test/ Factor being investigated
Diagnosing chest pain

Comparisons
Seven pre-defined criteria are evaluated and were assigned as either typical or atypical

Length of Study/ Follow-up
6 months

Outcome measures studied
Prediction or exclusion of acute MI and major adverse coronary events (MACE) at six months

Results
Seven pre-defined criteria are evaluated and were assigned as either typical or atypical: namely, location of chest pain (typical: left sided, atypical: right sided), character of pain (typical: crushing / sneezing / burning / tightness, atypical: stabbing / single spot / superficial), radiation (typical to the left or both arms, neck, back, atypical: not radiating), appearance of chest pain (typical: exercise induced / undulating / relieved with rest or nitroglycerin, atypical: inducible by pressure / abrupt palpitations / sustained / position dependent / respiration dependent / cough dependent), vegetative signs (typical dyspnea / nausea / diaphoresis atypical: absence of vegetative signs), history of coronary artery disease (typical: MI / PTCA / CABD, atypical: none) and risk factors for coronary artery disease namely: smoking, obesity, hypertension, diabetes, hyperlipidemia, and family history all typical, atypical was defined as absence or only one risk factor. The positive predictive value (PPV) and LR of typical and atypical criteria were evaluated for prediction or exclusion of acute MI and major adverse coronary events (MACE) at six months.

Thirteen percent (168 patients) of patients had an acute MI and 19% (240 patients) had a MACE (CVD, percutaneous coronary interventions, bypass surgery or MI) at six months follow up.

From the typical symptoms or history the likelihood ratios (LR) to predict an MI were:
1 typical symptom or history LR = 1.15; 2 typical symptoms and/or history LR = 1.32; 3 typical symptoms and/or history LR = 1.48; 4 typical symptoms and/or history LR = 1.77; 5 typical symptoms and/or history LR = 1.88; 6 typical symptoms and/or history LR = 1.85
From the typical symptoms or history the LR to predict a cardiac adverse event in the following 6 months were:
1 typical symptom or history LR = 1.15; 2 typical symptoms and/or history LR = 1.34; 3 typical symptoms and/or history LR = 1.58; 4 typical symptoms and/or history LR = 1.87; 5 typical symptoms and/or history LR = 2.11; 6 typical symptoms and/or history LR = 1.54

From the atypical symptoms or history the LR to exclude an MI were:
1 atypical symptom or history LR = 1.05; 2 atypical symptoms and/or history LR = 1.25; 3 atypical symptoms and/or history LR = 1.76; 4 atypical symptoms and/or history LR = 2.22; 5 atypical symptoms and/or history LR = 3.19; 6 atypical symptoms and/or history LR = 3.00
From the atypical symptoms or history the LR to exclude a cardiac adverse event in the following 6 months were:
1 atypical symptom or history LR = 1.04; 2 atypical symptoms and/or history LR = 1.29; 3 atypical symptoms and/or history LR = 1.85; 4 atypical symptoms and/or history LR = 3.02; 5 atypical symptoms and/or history LR = 4.87; 6 atypical symptoms and/or history LR = 4.58

The presence of four or more typical criteria was associated with a PPV of 0.21 (95% CI 0.17 to 0.25) to predict acute MI and 0.30 (95% CI 0.25 to 0.35) for 6 month MACE. Increasing numbers of atypical chest pain criteria was associated with
The presence of four or more typical criteria was associated with a PPV of 0.21 (95% CI 0.17 to 0.25) to predict acute MI and 0.93 (95% CI 0.90 to 0.96) for 6 month absence of MACE. The authors concluded that the evaluation of criteria atypical for MI may identify patients suitable for early discharge; however criteria typical of MI have little diagnostic value.

<table>
<thead>
<tr>
<th>Safety and adverse effects</th>
<th>None reported</th>
</tr>
</thead>
</table>

**Internal Validity**

- Well covered

**Does the study answer the question?**

- Yes

**Effect due to factor in study?**

- Consistent

**Consistency of results with other studies?**

- Correct population

**Directly applicable to guideline population?**

- Correct population

---

Increasing PPVs for excluding acute MI and 6 month MACE. The presence of four or more typical criteria was associated with a PPV of 0.94 (95% CI 0.92 to 0.96) to exclude acute MI and 0.93 (95% CI 0.90 to 0.96) for 6 month absence of MACE. Increasing numbers of atypical chest pain criteria was associated with increasing PPVs for excluding acute MI and 6 month MACE. The presence of four or more typical criteria was associated with a PPV of 0.94 (95% CI 0.92 to 0.96) to exclude acute MI and 0.93 (95% CI 0.90 to 0.96) for 6 month absence of MACE. The authors concluded that the evaluation of criteria atypical for MI may identify patients suitable for early discharge; however criteria typical of MI have little diagnostic value.
Question: What is the diagnostic utility of pain relief with nitrates in the identification of patients with acute chest pain of cardiac origin.
Grading: 2++

High-quality systematic reviews of case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal.

Steele R; McNaughton T; McConahy M; Lam J;

Chest pain in emergency department patients: if the pain is relieved by nitroglycerin, is it more likely to be cardiac chest pain?

Ref ID: 7099

CJEM: The Journal of the Canadian Association of Emergency Physicians

Pages 164 to 170

2006

Study Type: Diagnostic

Number of participants

Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/Test/Factor being investigated

Comparisons

Length of Study/Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

The study directly addresses the question of the diagnostic value of nitroglycerin pain relief.

The sensitivity of nitroglycerin as a diagnostic test was 72% (95% CI 64% to 80%). The specificity was 37% (95% CI 34% to 41%). The positive likelihood was 1.1 (95% CI 0.96 to 1.34). Nitroglycerin as a diagnostic tool was not found to be statistically significant in differentiating between patients with and without cardiac chest pain (using Pearson statistic, $P = 0.12$)

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Patient population directly applicable, patients with chest pain of suspected cardiac origin.

Internal Validity
**Grading:** 2+  
Well-conducted case–control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal

<table>
<thead>
<tr>
<th>Study Type</th>
<th>Diagnostic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of participants</td>
<td>122 patients (18%)</td>
</tr>
<tr>
<td>Inclusion/Exclusion Criteria</td>
<td>68 had acute MI and 54 had unstable angina</td>
</tr>
<tr>
<td>Patient Characteristics</td>
<td></td>
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<tr>
<td>Recruitment</td>
<td></td>
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<tr>
<td>Setting</td>
<td></td>
</tr>
<tr>
<td>Interventions/Test/Factor being investigated</td>
<td>Changes in the numeric descriptive scale for pain after sublingual nitroglycerin do not predict cardiac etiology of chest pain</td>
</tr>
<tr>
<td>Comparisons</td>
<td></td>
</tr>
<tr>
<td>Length of Study/Follow-up</td>
<td></td>
</tr>
<tr>
<td>Outcome measures studied</td>
<td></td>
</tr>
<tr>
<td>Results</td>
<td></td>
</tr>
<tr>
<td>Safety and adverse effects</td>
<td></td>
</tr>
<tr>
<td>Does the study answer the question?</td>
<td>The primary outcome of cardiac-related chest pain was found in 122 patients (18%), of which 68 had acute MI and 54 had unstable angina. An initial pain score of &gt; 5 was documented in 478 patients (71%), and in this group the primary outcome of cardiac-related chest pain was found in 82 patients (17%). An initial pain score of equal to or less than 5 was documented in 186 patients (29%), and in this group the primary outcome of cardiac-related chest pain was found in 40 patients (17%). In the total patient population, 125 (19%) patients had no change in pain, 206 (31%) patients had minimal pain reduction, 145 (22%) had moderate pain reduction, and 188 (28%) patients had significant or complete pain reduction. A change in the numeric descriptive scale score was not associated with a diagnosis of coronary artery disease in any of these 4 subgroups (using Pearson statistic = 1.0, P = 0.76). The study shows that nitroglycerin pain relief is not a useful diagnostic tool for identifying cardiac-related chest pain.</td>
</tr>
<tr>
<td>Effect due to factor in study?</td>
<td></td>
</tr>
<tr>
<td>Consistency of results with other studies?</td>
<td></td>
</tr>
</tbody>
</table>

Diercks DB; Boghos E; Guzman H; Amsterdam EA; Kirk JD;
Internal Validity

Patient population directly applicable, patients with chest pain of suspected cardiac origin.

Henrikson CA; Howell EE; Bush DE; Miles JS; Meininger GR; Friedlander T; Bushnell AC; Chandra-Strobos N;

Chest pain relief by nitroglycerin does not predict active coronary artery disease

Ref ID 7172 Ann Intern Med

Study Type Diagnostic

Funding National Heart, Lung and Blood Institute Training grant for CA Henrikson, USA.

Number of participants

Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

The study is directly applicable to the question of the utility of nitroglycerin pain relief in the diagnosis of chest pain of cardiac origin. The sensitivity and specificity of chest pain relief with nitroglycerin for the presence of active coronary artery disease were 35% and 58%, respectively. The positive and negative likelihood ratios were 0.85 and 1.4, respectively. Further analysis was conducted in 3 pre-specified subgroups for chest pain relief with nitroglycerin for the presence of active coronary artery disease. For troponin negative patients the sensitivity, specificity, positive likelihood ratio and negative likelihood ratio were 39%, 58%, 0.88 and 1.1, respectively. For patients with a history of coronary artery disease the sensitivity, specificity, positive likelihood ratio and negative likelihood ratio were 30%, 63%, 0.84 and 1.3, respectively. For patients with no history of coronary artery disease, the sensitivity, specificity, positive likelihood ratio and negative likelihoods were 40%, 56%, 0.87 and 1.1, respectively. ROC curves were constructed for chest pain relief by nitroglycerin and active coronary artery disease. For ROC curves of both reduction in pain intensity and absolute changes in pain intensity the plotted points closely approximated to a likelihood of 1.0. Hence regardless of which definition is used, either percentage chest pain reduction or absolute pain reduction, the test of chest pain with nitroglycerin has no value in determining the presence or absence of coronary artery disease.
Consistency of results with other studies?

**Directly applicable to guideline population?**

Patient population directly applicable, patients with chest pain of suspected cardiac origin.

Internal Validity
**Grading:** 2-

Case–control or cohort studies with a high risk of confounding bias, or chance and a significant risk that the relationship is not causal*

Shry EA; Dacus J; Van De GE; Hjelkrem M; Stajduhar KC; Steinhubl SR;

Usefulness of the response to sublingual nitroglycerin as a predictor of ischemic chest pain in the emergency department

<table>
<thead>
<tr>
<th>Ref ID</th>
<th>Am J Cardiol</th>
</tr>
</thead>
<tbody>
<tr>
<td>7214</td>
<td></td>
</tr>
</tbody>
</table>

**Study Type**  Diagnostic

**Number of participants**

**Inclusion/Exclusion Criteria**

**Patient Characteristics**

**Recruitment**

**Setting**

**Interventions/ Test/ Factor being investigated**

**Comparisons**

**Length of Study/ Follow-up**

**Outcome measures studied**

**Results**

**Safety and adverse effects**

**Does the study answer the question?**

The study was conducted retrospectively, hence, it is open to selection bias. With this caveat, it provides information on the diagnostic utility of nitroglycerin in diagnosing chest pain of cardiac origin.

Ninety percent, 199 out of 223 patients responded to nitroglycerin (at least a 2 unit reduction in chest pain based on the 10 point scale). Of the patients diagnosed with chest pain attributable to coronary artery disease, 88% responded to nitroglycerin, while 92% of the non cardiac chest pain group responded to nitroglycerin. Seventy percent of patients (52 out of 74 patients) with cardiac chest pain had complete pain resolution with nitroglycerin versus 73% of patients (108 out of 149 patients) with non cardiac chest pain had complete resolution (P = 0.85).

**Effect due to factor in study?**

**Consistency of results with other studies?**

**Directly applicable to guideline population?**

Patient population directly applicable, patients with chest pain of suspected cardiac origin.
Internal Validity
Question: Are the symptoms and description of the symptoms different in women presenting with acute chest pain of suspected cardiac origin compared with men
Insights from the NHLBI-Sponsored Women's Ischemia Syndrome Evaluation (WISE) Study: Part I: gender differences in traditional and novel risk factors, symptom evaluation, and gender-optimized diagnostic strategies

Ref ID 10303 J Am Coll Cardiol S4 to S20 2006

Study Type Systematic Review

Funding National Heart, Lung and Blood institute; National Centre for Research Resources; Gustavus and Louis Pfeiffer Research Foundation; Womens Guild of Cedars-Sinai Medical Centre; Ladies Hospital Aid Society of Western Pennsylvania

Number of participants 195 Studies,

Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

The study reviews papers on the presenting symptoms and links to MI and obstructive coronary disease. The review suggests, despite there being differences in the symptoms women present with; symptoms evaluation in women had not been fully evaluated due to studies often applying typical angina definitions which were defined through male populations to females. These differences are seen in the frequency, type and quality of symptoms. The study reviews evidence which shows that initial symptoms in women often include fatigue, sleep disturbance, and shortness of breath.

The review states that a recent study reported no differences in the accuracy of typical symptoms, defined as chest pain or discomfort, dyspnea, diaphoresis, and arm or shoulder pain between men and women when diagnosing ACS. However chest pain/discomfort and diaphoresis were the most commonly presented symptoms in women who had a confirmed diagnosis of ACS. Women were also more likely to
report acute initial symptoms but up to half of the women had no prior chest pain symptoms when diagnosed with AMI. The review reports that women are less likely to present with exertional chest pain (typical angina) than men but were more likely to be admitted to hospital for chest pain than men (4 million visits for women vs. 2.4 million for men). The review suggests from this evidence that when assessing chest pain in women the effect exertion has on symptoms should be taken into account for defining typical angina. The review states that the Yale group’s definition of angina (which includes chest pain or distress, dyspnea, diaphoresis, and arm or shoulder pain) gives an accurate method of identifying unstable angina, however other studies have included exertional components to the symptoms which leads to more accurate diagnosis.

The review states that older women are more likely to present with symptoms similar to men compared with younger women, which could be explained by the fact that older women have more typical angina. There are no differences in the rate of diagnosis of ACS in older men and women; however women aged under 65 are more likely to be discharged without a diagnosis of unstable angina, who are also less likely to have ST-segment elevation MI. The review suggests that this can protract their time to diagnosis and the intensity of management and can lead to poorer outcomes.

The review went on to analyse the presenting symptoms which are suggestive of MI, women were less likely to have obstructive CAD than men on angiography, which was first highlighted by Diamond and Forrester in the 1980’s. This study showed that women with typical and atypical chest pain symptoms have been used to calculate the probably of a woman having obstructive CAD being considerably less than that for a man. The review gives the example of “typical exertional angina in a 55 year old man has a probability of obstructive CAD of approximately 90% as compared with a wide range from 55-90% for a 55 year old woman”. The recent reports that this leads the conclusion that the use of chest pain symptoms to diagnose obstructive CAD in a woman is not as accurate as for a man. This conclusion and trend of symptoms being inaccurate at diagnosing obstructive CAD by Diamond and Forrester has been reported in other research with other female populations, especially in women with a history of diabetes. The review states that this could be due to the descriptors of symptoms used by women, as those who report stable or intermittent chest pain, the description of the chest pain is a doctor’s most important diagnostic tool which may lead to less intensive management.

The review highlights 2 questions to be answered which current evidence is unable to do: “can current symptom evaluation tools be improved for more accurate detection of obstructive CAD in women? Do symptom differences suggest s gender-specific pathophysiology such that gender-specific new tools should be developed for the assessment of IHD in women?”

The review stated that the most women who had a coronary angiography which did not show obstructive CAD continued to have symptoms which lead to a poor quality of life and who continued to require repeated health investigations. The study reported that this required many doctors to use cardiac imaging to differentiate cardiac and noncardiac symptoms. The review concludes that this method does not give a technique to identify and manage myocardial ischemia in women who do not have significant obstructive CAD.

The review continued to assess postmenopausal women to show that they are likely to have a cluster of risk factors including hypertension, obesity and dyslipidemia. The study suggests this could be related to gender-specific differences in metabolic rate which is increased due the hormonal imbalances caused by the menopause. This shows a cluster of risk conditions which include insulin resistance (with or without glucose intolerance), dyslipidemia (elevated triglycerides, small LDL particles, or low HDL cholesterol), hypertension, and obesity. The study refers to the National Cholesterol Education Program Adult Treatment Panel-III which has a simplified the definition of clustering risk factors to the presence of 3 or more of “1) waist circumference >35 inches; 2) fasting triglycerides >150 mg/dl; 3) HDL cholesterol <50 mg/dl; 4) hypertension (systolic blood pressure ≥130mmHg, diastolic blood pressure ≥85 mmHg, or use of antihypertensive drug therapy); or 5) a fasting glucose measurement ≥110mg/dl”. The authors state the evidence has shown that obesity is not an independent predictor of cardiovascular disease but the metabolic syndrome leads to a link between cardiovascular disease and obesity.
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect due to factor in study?</td>
<td>Yes</td>
</tr>
<tr>
<td>Consistency of results with other studies?</td>
<td>Consistent</td>
</tr>
<tr>
<td>Directly applicable to guideline population?</td>
<td></td>
</tr>
<tr>
<td>Internal Validity</td>
<td></td>
</tr>
</tbody>
</table>
Grading: 2++  High-quality systematic reviews of case–control or cohort studies High-quality case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal

Estimating the likelihood of significant coronary artery disease

<table>
<thead>
<tr>
<th>Ref ID</th>
<th>Number of participants</th>
<th>Inclusion/Exclusion Criteria</th>
<th>Patient Characteristics</th>
<th>Recruitment</th>
<th>Setting</th>
<th>Interventions/ Test/ Factor being investigated</th>
<th>Comparisons</th>
<th>Length of Study/ Follow-up</th>
<th>Outcome measures studied</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>10283</td>
<td>3627 in training population, 1811 in test population</td>
<td>Patients had progressive chest pain in the frequency, severity or duration had increased in the 6 weeks prior to catheterisation or preinfarctional chest pain which had a very unstable pain pattern that resulted in admission to the coronary care unit for evaluation of the possible MI</td>
<td>Patient characteristics which were collected were: History: age, sex, chest pain history (pain type, severity, frequency, nocturnal, progressive, preinfarctional), duration of CAD, previous history of MI, congestive heart failure, history of vascular disease Risk factors: smoking, hyperlipidaemia, hypertension, diabetes, family history Physical examination: ventricular gallop, systolic blood pressure ECG: ST-T wave changes, electrocardiographic premature ventricular contractions, Electrocardiographic Q waves Chest X-Ray: cardiomegaly</td>
<td>Patients admitted for cardiac catheterisation between 1969 and 1982.</td>
<td>Secondary care, USA</td>
<td>Diagnosis of chest pain.</td>
<td>Patient characteristics which give a probability of disease</td>
<td></td>
<td>Probability of disease</td>
<td></td>
</tr>
</tbody>
</table>

The study had a training population of 3627 patients who were seen between 1969 and January 1979, from these patients a stepwise logistic regression analysis was used to develop a model for predicting the probability of significant CAD. A test population of 1811 patients seen between January 1969 and January 1982, in this population the model developed in the test population was used to predict the probability of CAD for each patient.

The authors then tested the model in other populations (from CASS study) to estimate the prevalence of disease in subgroups of the patients in the literature (external validation)

Results from training population:
Clinically Important Characteristics and the Chi-squared: Pain type (typical, atypical or nonanginal) – 1091 Previous MI – 511 Sex – 187 Age – 119 Smoking – 79 Hyperlipidaemia – 26 ST-T wave changes – 28 Diabetes – 12
The results from the training population showed the type of chest pain (typical, atypical or nonanginal) was the most important characteristic followed by previous MI, sex, age, smoking, hyperlipidaemia, ST-T wave changes on ECG, diabetes. The table shows the 4 significant interactions which were found.

The study also showed that in men the effect of an increasing age was more important than in women, smoking was more important for women than men, and that smoking and hyperlipidaemia were more important at younger ages. The results for the other characteristics which were found to have small or nonsignificant effects on the prevalence of disease are shown under “Poor Clinical Predictors of Significant CAD and the Chi-squared”

The authors then validated the model in the test population which showed that the predicted probability of disease is nearly identical to the observed prevalence. This was with the exception of the group with predicted estimates of 0.475 to 0.525 (this group 8 out of 34 patients, with significant disease). The median prediction for patients with disease was 94% compared with a median prediction of 33% for patients without disease. A predicted probability of significant disease > 0.83 was found in 75% of patients with disease and in less than 10% of patients with disease. A probability of significant disease < 0.33 was found in nearly 50% of patients without disease and in less than 5% of patients with disease.

The authors then externally validated using the population from the CASS study. There was disagreement on patients classified as having nonanginal chest pain (where the greatest difference in predicted disease compared to observed disease was seen), but the predicted estimates from the model were nearly equal to the observed prevalence of disease. The predicted estimates from the model of the probability of significant disease were nearly identical to the observed prevalence for subgroups based on “age, sex and history of MI” or “age, sex and pain type”

None

The results from the training population showed the type of chest pain (typical, atypical or nonanginal) was the most important characteristic followed by previous MI, sex, age, smoking, hyperlipidaemia, ST-T wave changes on ECG, diabetes. The study also showed that in men the effect of an increasing age was more important than in women, smoking was more important for women than men, and that smoking and hyperlipidaemia were more important at younger ages. The study also found some characteristics to have small or nonsignificant effects on the prevalence of disease.

The authors then validated the model in the test population which showed that the predicted probability of disease is nearly identical to the observed prevalence. When comparing the model to an external population the study showed that the predicted estimates from the model were nearly equal to the observed prevalence of disease.
The predicted estimates from the model of the probability of significant disease were nearly identical to the observed prevalence for subgroups based on “age, sex and history of MI” or “age, sex and pain type”. However the greatest difference in predicted disease compared to observed disease was seen in patients with nonanginal chest pain.

Effect due to factor in study? Yes

Consistency of results with other studies? Consistent

Directly applicable to guideline population? Patients had chest pain, directly applicable to guideline.

Internal Validity Well covered
**Grading:** 2+

Well-conducted case–control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal

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G riffiths DH; Pokorny ME; Bowman JM;

Differences in African American and white women with myocardial infarction: history, presentation, diagnostic methods, and infarction type

**Ref ID:** 1293

**American journal of critical care : an official publication American Association of Critical Care Nurses**

**Pages:** 101 to 104 1999

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**Study Type** | Cohort | **Funding** | Not reported
---|---|---|---

**Number of participants** | 46, of which 18 were african-american, 28 were white

**Inclusion/Exclusion Criteria** | women diagnosed with MI between January and June 1995

**Patient Characteristics** | The average age for african-american women was 66.6±14.3 years and for white women 69.1±14.2 years, the age range for all patients was 39-94 years.

**Recruitment** | Patients who presented with chest pain to a tertiary care facility in North Carolina, USA

**Setting** | tertiary care facility in North Carolina, USA

**Interventions/ Test/ Factor being investigated** | differences in african-american and white women with MI

**Comparisons** | differences in african-american and white women with MI

**Length of Study/ Follow-up** | Not reported

**Outcome measures studied** | Risk factors and ECG changes

**Results**

Patients were initially diagnosed with a 12-lead ECG, if the initial ECG was non-diagnostic other methods included subsequent ECG, echocardiography, coronary angiography, measurement of serum levels of cardiac enzymes and other methods.

Admitting diagnosis of:

- MI – 33% African American, 36% White, 35% total
- Rule out MI – 11% African American, 32% White, 24% total
- Angina – 17% African American, 11% White, 13% total
- Other 39% African American, 21% White, 28% total

Types of MI and diagnostic methods:

- Initial 12-lead ECG – Q wave 6 African American, 13 White, non-Q wave 12 African American, 15 White
- Subsequent ECG – Q wave 1 African American, 1 White, non-Q wave 0 African American, 2 White
- Echocardiography – Q wave 1 African American, 1 White, non-Q wave 0 African American, 0 White
- Coronary angiography – Q wave 0 African American, 0 White, non-Q wave 1 African American, 0 White
- Measurement of cardiac enzyme levels – Q wave 1 African American, 1 White, non-Q wave 10 African American, 11 White
- Other – Q wave 0 African American, 1 White (sudden ventricular fibrillation), non-Q wave 0 African American, 1 White (history and physical examination)

Medical history variables:

- Previous MI – 28% African American, 29% White, (P=1.000)
- Angina – 11% African American, 29% White, (P=0.300)
24 patients presented with chest pain (52%), 9 of the 18 African American women (50%) and 15 of 28 white women (54%), this difference was not significant. The results for the diagnosis on admission to hospital were MI in 16 patients, rule out MI in 11 patients, angina in 6 patients and other 13 patients. The other diagnosis included 1 patients with congestive heart failure 1 with a hip fracture, 1 with decreased level of consciousness and 10 with unspecified n=10. There were no significant differences were found between African American and white women in the diagnosis on admission.

In the whole sample population those with a history of MI were more likely to have a non-Q wave than Q wave MI (n=13). In white women those with a history of MI or a history of congestive heart failure had a higher occurrence of non-Q wave then Q wave MI (both n=8). In African American women those with a history of angina had a higher occurrence of Q wave than non-Q wave MI (n=2).

At the time of admission 2 of the medical history variables were shown to be significantly different: stroke (P=0.027) and hypertension (P=0.002).

Safety and adverse effects
None

Does the study answer the question?
Yes

Consistency of results with other studies?
Consistent

Effect due to factor in study?
Yes

Directly applicable to guideline population?
52% presented with chest pain. On admission, 16 patients had AMI, 11 to rule out AMI, 6 angina, 1 congestive heart failure, 1 hip fracture, 1 decreased level of consciousness, 10 other diagnosis

Internal Validity
Well covered

McSweeney JC; Cody M; Sullivan P; Elberson K; Moser DK; Garvin BJ;

Women's early warning symptoms of acute myocardial infarction
Ref ID 10299 Circulation 2619 to 2623 2003

Study Type Cohort
Funding National Institute of Nursing Research

Number of participants 515 women
Inclusion/Exclusion Criteria Women who were diagnosed with AMI and discharged in the previous 4-6 months from 5 sites in Arkansas, North Carolina and Ohio. Patients needed to be cognitively intact, speak english, and have telephone access

Patient Characteristics The study included 515 women with an average age of 66.4±12 years. Of the 515 women 93% were white, 6.2% black, 2% Native American. For 72% of the women had no prior history of MI, the other 28% gave details of their most recent AMI.

Recruitment Patients were those diagnosed with AMI and discharged in the previous 4-6 months from 5 sites in Arkansas, North Carolina and Ohio

Setting Secondary care, USA

15 September 2009 Page 34 of 199
The study included 515 women with an average age of 66.4±12 years. Of the 515 women 93% were white, 6.2% black, 2% Native American. For 72% of the women had no prior history of MI, the other 28% gave details of their most recent AMI.

The study considered both initial (prodromal) symptoms and acute symptoms. The average number of initial symptoms experienced was 5.71±4.36, with the most common being unusual fatigue, sleep disturbance, shortness of breath, indigestion, and anxiety. 44% of those reporting sleep disturbances and 42% of those reporting fatigue described them as severe. 29.7% of women reported chest pain/discomfort (aching, tightness, pressure, burning, sharpness fullness or tingling), with the location and descriptors used not being mutually exclusive. 78% of women reported having had at least one of their initial symptoms daily or several times a week for more than 1 month. The average number of acute symptoms experienced was 7.3±4.8, with the most common being shortness of breath, weakness, unusual fatigue, cold sweat, and dizziness. The women reported discomfort in their back and high chest as the most common locations of pain. Again chest pain/discomfort was reported by women (pressure, ache, and tightness), mostly being described as severe pain/discomfort. Over all 43% of women reported no chest pain/discomfort.

The study also considered the risk factors; most women had a family history of cardiovascular disease, a history of cardiovascular disease and had diabetes. The average BMI was 28.6±6.5 and less than half of the women did regular exercise before having their AMI.

The study carried out multiple regression analysis to assess if the acute score could be predicted from the prodromal score. “The prodromal score accounted for an additional 33.2% of the variance in acute symptom scores after control for risk factors which accounted for only 9.9% of the variance”.

The study also carried out a T test to determine the association of symptoms with risk factors. The T test showed that there was significant association between initial symptoms and all risk factors except age >50 years, hypertension and hyperlipidemia. The T test also showed that there was significant association between acute symptoms and all risk factors except hypertension, hyperlipidemia and second hand smoke.

Effect due to factor in study? Yes
Consistency of results with other studies? Consistent
Directly applicable to guideline population? Patients had AMI
Internal Validity Well covered

Meischke H; Larsen MP; Eisenberg MS;
### Study Type
Cohort

### Number of participants
4,497, 2,970 men and 1,527 women

### Inclusion/Exclusion Criteria
Patients with a confirmed MI, admitted between January 1991 and February 1993 to the coronary care units of 16 King County hospitals. Those who had cardiac arrest, coma, and shock were excluded.

### Patient Characteristics
- Gender – 66% men, 34% women
- Median age – 64 years men, 73 years women (P=<0.001)
- White – 91% men, 93% women
- Black – 4% men, 4% women
- Asian/Pacific Islander – 5% men, 3% women

### Recruitment
Consecutive patients admitted between January 1991 and February 1993 to the coronary care units of 16 King County hospitals with AMI were assessed for inclusion.

### Setting
Secondary Care, USA

### Interventions/Test/Factor being investigated
Risk factors and medical history of men and women with AMI

### Comparisons
Risk factors and medical history of men and women with AMI

### Length of Study/Follow-up
Not reported

### Outcome measures studied
Risk factors (gender, age, race, history of AMI, history of diabetes) medical history (chest pain symptoms, diaphoresis, dyspnea, epigastric pain, nausea/vomiting, syncope)

### Results
Univariate comparison of medical history and symptoms:
- Gender – 66% men, 34% women
- Median age – 64 years men, 73 years women (P=<0.001)
- White – 91% men, 93% women
- Black – 4% men, 4% women
- Asian/Pacific Islander – 5% men, 3% women
- History of AMI – 30% men, 26% women (P=0.021)
- History of diabetes – 19% men, 25% women (P=<0.001)
- Chest pain symptoms – 92% men, 89% women (P=<0.001)
- Diaphoresis – 54% men, 44% women (P=<0.001)
- Dyspnea – 46% men, 52% women (P=<0.001)
- Epigastric pain – 11% men, 11% women, Not significant
- Nausea/vomiting – 35% men, 44% women (P=<0.001)
- Syncope – 3% men, 3% women, Not significant

Beta and P value regression for medical history and symptoms:
- Age – β 0.096, P=<0.001
- Gender – β 0.053, P=0.002
- History of AMI – β -0.064, P=<0.001
- History of diabetes – β 0.048, P=0.004
- Diaphoresis – β -0.147, P=<0.001
- Chest pain – β -0.059, P=<0.001
- Syncope – β -0.039, P=0.02
- Dyspnea – β -0.024, Not significant
- Epigastric pain – β 0.03, Not significant
- Nausea/vomiting – β 0.014, Not significant

### Safety and adverse effects
None

### Does the study answer the question?
This study showed that women were significantly older than men and were more likely to have a history of diabetes. Women were also more likely to report sweating and nausea, this difference persisted after adjustment for age and history of diabetes. Women were also more likely to report shortness of breath, especially...
younger women and those who had a history of diabetes. Men were more likely to have a history of AMI than women. There was no difference between men and women in presentation of chest pain, this similarity persisted after adjustment for age and history of diabetes.

Effect due to factor in study?  Yes
Consistency of results with other studies?  Consistent
Directly applicable to guideline population?  Patients had a confirmed AMI
Internal Validity  Well covered

Milner KA; Funk M; Arnold A; Vaccarino V;

Typical symptoms are predictive of acute coronary syndromes in women

Ref ID 10301  Am Heart J  pages 283 to 288  2002

Study Type  Cohort  Funding  Part funded by Ethel F. Donoghue Women's Health Investigation Program at Yale

Number of participants  522 in total, 246 women and 276 men

Inclusion/Exclusion Criteria  aged 45 years or older, reported at least one prespecified set of typical or a typical symptoms suggestive of ACS

Patient Characteristics  The mean age for women with ACS was 69 ± 15 years, the mean age for women without ACS was 64 ± 15 years,

Recruitment  Patients who were seen in the emergency department with suspected ACS

Setting  Secondary Care, USA

Interventions/ Test/ Factor being investigated  risk factors and symptoms of women and men presenting with suspected ACS

Comparisons  risk factors and symptoms of women and men presenting with suspected ACS

Length of Study/ Follow-up  Not reported

Outcome measures studied  Risk factors and clinical history of patients

Results  Baseline characteristics:
White race – 36% women with ACS, 46% men with ACS
History of coronary heart disease – 44% women with ACS, 48% men with ACS
Systemic hypertension – 38% women with ACS, 49% men with ACS
Obesity – 38% women with ACS, 46% men with ACS
History of MI – 49% women with ACS, 51% men with ACS
Diabetes – 47% women with ACS, 46% men with ACS
Hypercholesterolemia – 41% women with ACS, 50% men with ACS
Other cardiac problems – 39% women with ACS, 35% men with ACS
History of heart failure – 40% women with ACS, 45% men with ACS
Current smoker – 26% women with ACS, 42% men with ACS

Relationship between typical symptoms and ACS:
Chest pain/discomfort present in – 36% women with ACS, 49% men with ACS
Dyspnea present in – 44% women with ACS, 41% with ACS
The study showed that older women and men were both significantly more likely to be diagnosed with ACS than younger men. Women with a history of coronary heart disease, MI or diabetes were also significantly more likely to be diagnosed with ACS compared to those without the risk factors. Men without a history of ACS were more likely to be diagnosed with ACS. Women who were diagnosed with ACS had a higher number of symptoms than those without (3.36±1.74 compared to 2.78±1.46 P=0.006), however there was no difference in the number of symptoms for men with ACS compared to men without ACS. Typical symptoms in men were not significantly related to a diagnosis of ACS, however those with dizziness or fainting were less likely to be diagnosed with ACS. Women with typical symptoms (chest pain or discomfort, diaphoresis, dyspnea and arm or shoulder pain) were significantly more likely to be diagnosed with an ACS. A multivariate analysis of independent predictors of ACS showed that diaphoresis was strongest in predicting ACS in women, followed by chest pain or discomfort (81% higher risk for ACS) and arm or shoulder pain had a (60% higher risk for ACS). The model for male patients was a poor fit, the authors suggested that this meant that patients symptoms were not a useful predictor of ACS.

The study went on to compared men and women, which showed that there was no difference in the typical symptoms for men and women. The study showed that there were no sex differences through comparing the adjusted the relative risks for ACS in women with typical symptoms and in with men with typical symptoms which was both close to 1.

Arm or shoulder pain present in – 38% women with ACS, 47% with ACS
Diaphoresis present in – 53% women with ACS, 44% with ACS
Neck or jaw pain present in – 41% women with ACS, 53% with ACS

Relationship between atypical symptoms and ACS:
Nausea or vomiting present in – 39% women with ACS, 48% men with ACS
Dizziness present in – 36% women with ACS, 32% men with ACS
Indigestion present in – 38% women with ACS, 45% men with ACS
Fatigue present in – 36% women with ACS, 41% men with ACS
Chest fullness, stabbing, numbness,
burning or right chest pain present in – 34% women with ACS, 50% men with ACS
Midback pain present in – 50% women with ACS, 17% men with ACS
Palpitations present in – 35% women with ACS, 29% men with ACS
Upper-extremity numbness present in – 29% women with ACS, 33% men with ACS
Unable to take a deep breath present in – 9% women with ACS, 29% men with ACS
Cough present in – 25% women with ACS, 40% men with ACS

Symptom predictors of ACS in women and men by logistic regression analysis:
(relative risk – RR)
Women
Chest pain or discomfort – RR – 1.81, 95% CI 0.95 to 3.42, P=0.069
Neck or jaw pain – RR – 1.60, 95% CI 0.83 to 3.10, P=0.163
Diaphoresis – RR – 2.53, 95% CI 1.17 to 5.48, P=0.019
Men
Chest pain or discomfort – RR – 1.56, 95% CI 0.86 to 2.82, P=0.142
Neck or jaw pain – RR – 0.69, 95% CI 0.40 to 1.19, P=0.182
Diaphoresis – RR – 0.49, 95% CI 0.26 to 0.93, P=0.028

Relative risk of ACS for typical symptoms in women relative to men:
Chest pain or discomfort – RR – 0.83, 95% CI 0.66 to 1.06, P=0.129
Neck or jaw pain – RR – 0.69, 95% CI 0.40 to 1.15, P=0.141
Diaphoresis – RR – 1.18, 95% CI 0.87 to 1.59, P=0.384
Arm or shoulder pain – RR – 0.91, 95% CI 0.64 to 1.30, P=0.612
Dyspnea – RR – 1.00, 95% CI 0.74 to 1.35, P=0.993

None

Safety and adverse effects

Does the study answer the question?
Yes

Consistency of results with other studies?
Consistent
Patients had symptoms suggestive of ACS

Internal Validity
Well covered

Penque S; Halm M; Smith M; Deutsch J; Van RM; McLaughlin L; Dzubay S; Doll N; Beahrs M;

Women and coronary disease: relationship between descriptors of signs and symptoms and diagnostic and treatment course

Ref ID 10292 American journal of critical care : an official publication American Association of Critical Care Nurses 175 to 182 1998

Study Type Cohort 98 patients, of which 51 were women and 47 were men

Funding Not reported

Number of participants

Inclusion/Exclusion Criteria
Included: primary medical diagnosis of MI, at least 21 years old, English speaking, admission via emergency department, directly from physician's office or by transfer from rural hospital within 6 hours of MI. Exclusion: patients who had sudden cardiac death events. A history of coronary artery disease was not a reason for exclusion and so the population is mixed

Patient Characteristics
The mean age for all patients was 59 years. For the women the mean age was 61 years (range 41-89 years), for the men the mean age was 56 years (range 37-79 years). 3% of all patients were uninsured (measure of socio economic status)

Recruitment
admitted to the hospital during a period of 12 months, with a primary diagnosis of MI

Setting secondary care, USA

Interventions/ Test/ Factor being investigated differences between men and women in signs and symptoms of MI

Comparisons Mena and women

Length of Study/ Follow-up Not reported

Outcome measures studied risk factors, signs and symptoms

Results
Cardiovascular risk factor profile
Family history of heart disease – women 56%, men 51%
Past or current history of smoking – women 57%, men 81%
Hypertension – women 41%, men 46%
Hyperlipidaemia – women 49%, men 55%
Diabetes – women 20%, men 17%

Precipitating factors for chest pain
Rest – women 53%, men 55% (P=0.89)
Exertion – women 63%, men 40% (P=0.09)
Sex – women 10%, men 6% (P=0.40)
Stress – women 51%, men 34% (P=0.10)

Time elapsed after cardiac-related signs or symptoms were first experienced before treatment was sought
Less than 24 hours – women 15%, men 22%
1-2 days – women 8%, men 9%
3-7 days – women 15%, men 17%
8-30 days – women 15%, men 15%
2-6 months – women 6%, men 13%
6-12 months – women 6%, men 0%
More than 1 year – women 38%, men 24%

Descriptors of associated signs and symptoms
Fatigue – women 71%, men 70% (P=0.90)
Rest pain – women 71%, men 72% (P=0.80)
The study considered the descriptors of signs and symptoms. The study showed that chest discomfort was the most common initial symptom reported by both men (51%) and women (49%) as an initial symptom, 99% at some point) and (women (49% as an initial symptom, 94% at some point). The 4 most reported symptoms for men and women were fatigue, rest pain, weakness, and shortness of breath, however women reported dizziness and men reported arm pain as the next common symptom. Women were more likely to suffer from loss of appetite, paroxysmal nocturnal dyspnea and back pain than men. These differences were significant: loss of appetite (chi-squared=4.48), paroxysmal nocturnal dyspnea (chi-squared=3.80), and back pain (chi-squared=7.60).

The study considered the length of time from initial symptoms to seeking medical help. There was no significant difference between men (5.3 hours) and women (4.2 hours), with the majority of men and women first having symptoms in the preceding 24 hours, the previous 3 days to 1 month or more than 1 year before. The study also considered the mean number of words used to describe signs, there was no significant difference between men (58) and women (55).

The study concluded that “chest pain was the first sign or symptom of MI reported by both men and women”. Women were more likely to report back pain, loss of appetite, and paroxysmal nocturnal dyspnea as symptoms than men and were less likely than men to have diagnostic angiography and to receive IV nitroglycerin, heparin, and thrombolytics as part of their management.

Safety and adverse effects

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Does the study answer the question?

Yes

Consistency of results with other studies?

Consistent

Directly applicable to guideline population?

Patients had a primary diagnosis of MI

Internal Validity

Well covered
Grading: 2-

Case–control or cohort studies with a high risk of confounding bias, or chance and a significant risk that the relationship is not causal*

De S; Searles G; Haddad H;

The prevalence of cardiac risk factors in women 45 years of age or younger undergoing angiography for evaluation of undiagnosed chest pain

Ref ID 923 The Canadian journal of cardiology 945 to 948 2002

Study Type Cohort Funding Not reported

Number of participants 187 in total, 55 in group A (those with significant CAD) 132 in group B (those without significant CAD)

Inclusion/Exclusion Criteria Women aged under 45 years, who were referred for coronary angiography due to chest pain and who had no known history of CAD

Patient Characteristics Not reported. Patients were women aged under 45 who did not have a known history of CAD

Recruitment Patients referred for coronary angiography due to chest pain during a 4 year period (February 1997–December 2000) at Queen Elizabeth II Health Sciences Centre in Halifax, Nova Scotia

Setting Secondary care, Nova Scotia, Canada

Interventions/ Test/ Factor being investigated Risk factors in women with and without significant CAD

Comparisons Risk factors - obesity, dyslipidemia, diabetes, hypertension, premature family history of CAD, current smoker, past smoker

Length of Study/ Follow-up Not reported

Outcome measures studied Diagnosis of CAD

Results Risk factors:

Obesity – 45% group A, 46% group B, P=0.92

Dyslipidemia – 72% group A, 47% group B, P=0.002

Diabetes – 29% group A, 9% group B, P=<0.001

Hypertension – 40% group A, 28% group B, P=0.13

Family history of premature CAD – 65% group A, 67% group B, P=0.79

Current smoker – 55% group A, 35% group B, P=0.03

Past smoker – 13% group A, 15% group B, P=0.03

Safety and adverse effects None

Does the study answer the question? The women included were aged <45 years that were referred for coronary angiography due to chest pain but had not been diagnosed and had no history of CAD, the patients were subsequently divided into two groups; dependant upon the presence of CAD or absence. Group A had significant CAD, and group B were without significant CAD. Group B (those without significant CAD) was subdivided into those with noncritical CAD (8%) and those with normal coronary arteries (92%). Group A were significantly more likely to have dyslipidemia (72% group A, 47% group B, P=0.002), diabetes (29% group A, 9% group B, P=0.001), and to smoke (67% group A, 50% group B, P=0.03). There was no significant difference between group A and B in the rates of obesity, hypertension, and family history of premature CAD.

The study concluded that women with CAD were more likely to have dyslipidemia, diabetes and smoking. However for women with and without CAD the commonest
A risk factor was a family history of CAD (67%), followed by smoking (55%) and dyslipidemia (55%).

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
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<tbody>
<tr>
<td>Effect due to factor in study?</td>
<td>Yes</td>
</tr>
<tr>
<td>Consistency of results with other studies?</td>
<td>Consistent</td>
</tr>
<tr>
<td>Directly applicable to guideline population?</td>
<td>Patients had chest pain</td>
</tr>
<tr>
<td>Internal Validity</td>
<td>Well covered</td>
</tr>
</tbody>
</table>
Question: Are the symptoms and description of the symptoms different in Black and Ethnic Minorities presenting with acute chest pain of suspected cardiac origin compared with Caucasians.
Effect of race on the presentation and management of patients with acute chest pain.

**Patient Characteristics**

- **Number of participants**: Final study population was 3031 after exclusions.
- **Inclusion/Exclusion Criteria**: Inclusion: patients presenting to the emergency department with a chief complaint of anterior, percordial, or left lateral chest pain that could not be explained by obvious local trauma or abnormalities on a chest X ray. Patients that experienced cardiac arrest in the emergency department were excluded from the study. During the study period, 4173 potentially eligible patient visits occurred, and the final study population was 3031 after exclusions (11 due to incomplete data, 531 consent not obtained, 204 inadequate follow-up, 158 race not identified, and 238 as race was Asian or Hispanic).
- **Setting**: Emergency department USA, Dec 1983 to Oct 1988.
- **Interventions/Test/Factor being investigated**: History, risk factors and signs and symptoms.
- **Comparisons**: African Americans versus Caucasians with suspected acute MI.
- **Length of Study/Follow-up**: Not applicable.
- **Outcome measures studied**: History, risk factors and signs and symptoms.
- **Results**: African American patients with a final diagnosis of acute MI had similar presenting signs and symptoms compared with the Caucasian patients. Comparing the two racial groups clinical characteristics of acute MI, the odds ratios were all greater than 1.0 for chest pain greater than or equal to 30 min, pressure type chest pain, radiation of pain to left arm, left shoulder, neck or jaw, diaphoresis and rales on physical examination for both racial groups but these were not statistically different between the groups. While it was found that African American patients were less likely to have a final diagnosis of acute MI (P < 0.0001), there was no longer a statistical association with race and acute MI after adjustments for were made for presenting signs and symptoms using logistical regression analysis. The odds ratio for acute MI outcomes for African Americans compared with Caucasians was 0.77 (95% CI 0.54 to 1.1).
### Safety and adverse effects
- Not applicable

### Does the study answer the question?
- Yes, African Americans had a similar clinical presentation of acute MI compared with Caucasians

### Effect due to factor in study?
- Yes

### Consistency of results with other studies?
- Consistent

### Directly applicable to guideline population?
- Acute chest pain population therefore directly applicable

### Internal Validity
- Adequately addressed

Klingler D; Green WR; Nerenz D; Havstad S; Rosman HS; Cetner L; Shah S; Wimbush F; Borzak S;

Perceptions of chest pain differ by race

**Reference**

Ref ID 10300 Am Heart J 2002

**Funding**

National Institute of Aging, the National Institute of Nursing Research and the Office of Minority Health of the NIH

### Study Type
- Cohort

### Number of participants
- 215 in total, 157 African American, 58 white

### Inclusion/Exclusion Criteria
- Patients admitted with suspected acute MI. Patients were included if English was their primary language and they could recall pre-hospital events. Patients were excluded if they were of a race other than African American or Caucasian, were aged <18 years, had known mental impairment, were pregnant, had a MI subsequent to admission, had a previous interview prior to admission, or had significant emergency data missing from their medical records.

### Patient Characteristics
- Mean age - 59±14 years African American, 62±15 years white (P=0.13)
- Male – 46% African American, 57% white (P=0.15)

### Recruitment
- Patients who were admitted with acute MI between April 1999 and August 1999 to the ED chest pain unit

### Setting
- Secondary care, USA

### Interventions/ Test/ Factor being investigated
- Comparison of Medical history and risk factors between African American and white patients with acute MI

### Comparisons
- Medical history and risk factors of African American and white patients

### Length of Study/ Follow-up
- Not reported

### Outcome measures studied
- Medical history and risk factors

### Results
- Characteristics:
  - Mean age - 59±14 years African American, 62±15 years white (P=0.13)
  - Male – 46% African American, 57% white (P=0.15)
  - Diabetes – 28% African American, 16% white (P=0.05)
  - Hypertension – 67% African American, 55% white (P=0.12)
  - Hypercholesterolemia – 28% African American, 34% white (P=0.5)
  - Angina – 8% African American, 3% white (P=0.37)
  - Heart attack – 27% African American, 16% white (P=0.06)
  - Congestive heart failure – 12% African American, 12% white (P=0.99)

15 September 2009 Page 45 of 199
Patients were interviewed from April 1999 to August 1999. Patients were identified through a floor census and screened for eligibility. Of the 588 patients who were approached, 215 met the inclusion criteria and were enrolled in the study. A structured questionnaire was developed to assess the contextual, emotional, and behavioural factors in patients seeking medical help. The questionnaire was adapted from existing questionnaires, after external validation by a group of experts it was piloted on 10 patients and altered accordingly.

Demographics and medical history:
27% were white and 73% were African American, there were no significant differences between the two groups’ age, sex and insurance status (suggestive of socioeconomic status).
African Americans were significantly more likely to have diabetes (P=0.05) and to be taking calcium-channel blockers (P=0.005), however white patients were more likely to have had coronary artery bypass surgery (P=0.01) and to have had a previous stomach complaint (P=0.03).

Symptoms at presentation:
Those who were diagnosis as not having an MI were more likely to have had stomach pain (P=0.03) and sweating (P=0.05) at presentation. No significant differences were found between African American and white patients in the objective symptoms. There was no significant difference in the one worst reported symptom (respiratory, cardiac, gastrointestinal, other, unable to identify) between African American and white patients. There was also no significant difference in the location of pain (above diaphragm, below diaphragm, both, other), the timing of the pain (constant, intermittent, wax/wane) and the median discomfort and control of pain between African American and white patients.

Safety and adverse effects
Not applicable

Does the study answer the question?
Coronary angiography – 15% African American, 10% white (P=0.4)
Coronary artery bypass graph – 8% African American, 21% white (P=0.01)
Smoker – 29% African American, 31% white (P=0.74)
Prior stomach complaints – 16% African American, 29% white (P=0.03)

Symptoms:
Cardiac
Chest pain – 78% African American, 79% white (P=0.88)
Chest pressure – 62% African American, 76% white (P=0.06)
Chest tightness – 51% African American, 58% white (P=0.37)
Chest discomfort – 64% African American, 59% white (P=0.5)
Palitations – 40% African American, 26% white (P=0.07)
Any of the above – 97% African American, 93% white (P=0.16)
Gastrointestinal
Stomach pain – 22% African American, 17% white (P=0.47)
Heartburn – 26% African American, 21% white (P=0.41)
Indigestion – 26% African American, 22% white (P=0.58)
Gas pain – 33% African American, 28% white (P=0.49)
Stomach problem – 22% African American, 19% white (P=0.59)
Any of the above – 57% African American, 59% white (P=0.86)
Associated symptoms
Nausea/vomiting – 44% African American, 41% white (P=0.74)
Arm/shoulder pain – 41% African American, 38% white (P=0.68)
Back pain – 30% African American, 33% white (P=0.69)
Jaw pain – 12% African American, 12% white (P=0.9)
Headache – 37% African American, 29% white (P=0.29)
Neck pain – 29% African American, 28% white (P=0.86)
Numbness/tingling – 33% African American, 32% white (P=0.96)
Shortness of breath – 62% African American, 60% white (P=0.85)
Cough – 38% African American, 26% white (P=0.09)
Dizziness – 54% African American, 48% white (P=0.5)
Sweating – 50% African American, 53% white (P=0.68)
Weakness/fatigue – 68% African American, 60% white (P=0.29)
(constant, intermittent, wax/wane) and the median discomfort and control of pain between African American and white patients.

African Americans were as likely as Caucasian patients to report typical objective symptoms but were marginally more likely to attribute their symptoms to a gastrointestinal source rather than a cardiac source ($P = 0.05$). Of 157 Caucasian patients, 11 patients were diagnosed as having had an MI (11%), while 27 out of 58 Caucasian patients (47%) were diagnosed with acute MI ($P < 0.001$). However of those patients with a final diagnosis of MI, 61% of African Americans attributed their symptoms to a gastrointestinal source and 11% to a cardiac source versus 26% and 33%, respectively for Caucasian patients.

Effect due to factor in study? Yes
Consistency of results with other studies? Consistent
Directly applicable to guideline population? Acute chest pain population therefore directly applicable
Internal Validity Not addressed

Maynard C; Beshansky JR; Griffith JL; Selker HP;

Causes of chest pain and symptoms suggestive of acute cardiac ischemia in African-American patients presenting to the emergency department: a multicenter study

Ref ID 1424 Journal of the National Medical Association 665 to 671 1997

Study Type Cohort
Funding Agency for Health Care Policy and Research
Number of participants 10001, of which 3401 (34%) were African Americans, 6600 were white
Inclusion/Exclusion Criteria Included: aged greater or equal to 30 years presenting with chest or left arm pain, shortness of breath, or other symptoms suggestive of acute cardiac ischemia from 10 participating hospitals in east and midwest USA. Excluded: patients with chest pain/discomfort related to trauma, surgical emergencies, those with a clear non-cardiac cause, patients transferred from other hospitals

Patient Characteristics In the male group, the average age for African American patients was 52±14 years and 60±15 year for white patients ($P<0.0001$). The average time from symptom onset to emergency department arrival was 3 hours for African American patients and 2 hours for white patients ($P=0.0006$). 33% of African American men and 15% of white men were uninsured, 23% of African American men and 6% of white men had Medicaid, 28% of African Americans men and 44% of white men had Medicare; for all $P<0.0001$ (measure of socio economic status).
In the female group, the average age for African American patients was 55±15 years and 65±16 year for white patients ($P<0.0001$). The average time from symptom onset to emergency department arrival was 3.3 hours for African American patients and 3 hours for white patients ($P=0.045$). 26% of African Americans women and 12% of white women were uninsured, 24% of African Americans and 8% of white women had Medicaid, 33% of African Americans women and 56% of white women had Medicare; for all $P<0.0001$ (measure of socio economic status).

Recruitment Patients admitted to 10 hospitals in east and midwest USA
Setting Secondary care, USA
Interventions/ Test/ Factor being investigated If race is determinant in diagnosing acute MI or angina
Comparisons African Americans and white patients
Signs and symptoms and risk factors to diagnose acute MI or angina

The study found that there were differences in patients' medical history dependent upon racial background. African Americans were more likely to smoke and have hypertension compared with Caucasians, and African American women were more likely to have diabetes than Caucasian women. Caucasian patients were more likely to have a history of angina or MI and to take cardiac medications. There was no difference in the number of African Americans and Caucasian male patients who had chest pain as a primary symptom. There were a higher number of African American female patients than Caucasian female patients who had chest pain as a primary symptom. African American patients were more likely to report additional symptoms of shortness of breath, abdominal pain, nausea, vomiting and dizziness. African Americans were more likely to have a diastolic blood pressure of > 90mmHg when admitted to hospital compared to Caucasian patients, and the authors stated that this is consistent with the finding of more previous systemic hypertension in African Americans.
Acute MI and angina was less likely to be diagnosed in African American men compared with Caucasian men (acute MI; 6% versus 12%, respectively; angina 8% compared to 20%). Non cardiac diagnoses were confirmed in almost half of African American men compared with one third of Caucasian men. Similarly only 4% of African American women had a final diagnosis of acute MI compared with 8% in Caucasian women, and angina was diagnosed in 12% of African American women compared with 17% of Caucasian women. Non cardiac diagnoses were confirmed in almost half of African American women compared with 39% of Caucasian women.

Logistic regression in 74% of the patients examined the racial differences in the diagnoses, using the following variables; medical history, sociodemographic factors, signs and symptoms, and the hospital the patient was admitted to. African American patients compared to Caucasian patients were half as less likely to develop acute MI (odds ratio 0.54, 95% CI 0.41 to 0.68).

Effect due to factor in study? Yes
Consistency of results with other studies? Consistent
Directly applicable to guideline population? Patients with chest pain, left arm pain, shortness of breath or symptoms suggestive of acute cardiac ischemia, directly applicable.
Internal Validity Not addressed

Teoh M; Lalondrelle S; Roughton M; Grocott-Mason R; Dubrey SW;

Acute coronary syndromes and their presentation in Asian and Caucasian patients in Britain

Study Type Cohort
Number of participants 2905 patients, 604 (21%) were Asian and 2301 (79%) were Caucasian
Inclusion/Exclusion Criteria Consecutive patients requiring hospital admission for ACS recruited by a senior cardiac nurse. Patients of races other than Asian or Caucasian were excluded
Patient Characteristics Asians mean age 60.6 (SD 12.7) years, Caucasians 68.9 (SD 13.9) years (P < 0.001). Asians 66% male, Caucasians 62%
Recruitment Consecutive by nurse in emergency department
Setting Emergency department UK
Interventions/ Test/ Factor being investigated Signs and symptoms, risk factors
Comparisons Asians versus Caucasian
Length of Study/ Follow-up Not applicable
Outcome measures studied Signs and symptoms, risk factors
Results Frontal upper body discomfort was reported by 94% of Asian patients versus 89% of Caucasian patients (P < 0.001), while almost twice as many Asian patients reported pain on the rear of their body compared with Caucasian patients (46% versus 25%, respectively, P < 0.001). The character of the discomfort as described by the Asian patients was 'weight' (34%), followed by 'squeeze' (28%), and 'ache' (14%). For Caucasian patients the most common term was 'weight' (28%), followed by 'ache' (23%), and 'squeeze' (20%).
There was a small but statistically significant difference in the intensity of discomfort reported, with Asian patients reporting a median pain rating of 7.5 compared with 7.0 in Caucasian patients (P < 0.002). Twenty four percent of Asian patients rated their discomfort at the maximum value of 10 compared with 19% of Caucasian patients. A smaller percentage of Asian patients (6%) reported feeling no discomfort at presentation (silent MI) compared with Caucasian patients (13%) (P = 0.002). These patients were identified by a combination of symptoms, including fatigue, shortness of breath, collapse and resuscitation following cardiac arrest. Logistic regression analysis was performed to determine which factors contributed to patients reporting a silent episode, and the most significant factor was a patient’s diabetic status, they were more than twice as likely to report that they felt no pain during presentation compared with non-diabetics (odds ratio 2.08, 95% CI 1.56 to 2.76). Analysis showed that Caucasian patients (odds ratio 1.61, 95% CI 1.08 to 1.10) were also more likely to feel no discomfort compared with Asian patients. Analysis with age as a continuous variable was also associated with silent episode.

<table>
<thead>
<tr>
<th>Safety and adverse effects</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the study answer the question?</td>
<td>Yes. Asian patients were younger, more likely to be diabetic and they tended to report greater intensity of pain over a greater area of the body, and more frequent discomfort over the rear of their upper thorax than Caucasian patients.</td>
</tr>
<tr>
<td>Effect due to factor in study?</td>
<td>Yes</td>
</tr>
<tr>
<td>Consistency of results with other studies?</td>
<td>Consistent</td>
</tr>
<tr>
<td>Directly applicable to guideline population?</td>
<td>Acute chest pain population therefore directly applicable</td>
</tr>
<tr>
<td>Internal Validity</td>
<td>Not addressed</td>
</tr>
</tbody>
</table>
Grading: 2-  Case–control or cohort studies with a high risk of confounding bias, or chance and a significant risk that the relationship is not causal*

Barakat K; Wells Z; Ramdhany S; Mills PG; Timmis AD;

Bangladeshi patients present with non-classic features of acute myocardial infarction and are treated less aggressively in east London, UK

<table>
<thead>
<tr>
<th>Patient Characteristics</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years) – Bangladeshi 63±12; Whites 68±19 (P&lt;0.0001)</td>
<td>Nature of chest pain and interpretation of symptoms by racial group: (Bangladeshi n=32, Whites n=31)</td>
</tr>
<tr>
<td>Male sex – 87% Bangladeshi; 70% Whites (P=0.002)</td>
<td>Central pain – 40.6% Bangladeshi, 87.1% White (P=0.0006)</td>
</tr>
<tr>
<td>Smoking – 71.3% Bangladeshi; 70.3% Whites (P=0.85)</td>
<td>Left sided pain – 34.4% Bangladeshi, 3.2% White (P=0.0006)</td>
</tr>
<tr>
<td>Hypertension – 43.5% Bangladeshi; 38.4% Whites (P=0.36)</td>
<td>Other pain – 25% Bangladeshi, 97% White (P=0.0006)</td>
</tr>
<tr>
<td>Diabetes – 50% Bangladeshi; 15.2% Whites (P&lt;0.0001)</td>
<td>Typical character of pain – 25% Bangladeshi, 58.1% White (P=0.0132)</td>
</tr>
<tr>
<td>Family history of IHD – 13% Bangladeshi; 29.3% Whites (P=0.0005)</td>
<td>Non-classical character of pain – 75% Bangladeshi, 41.9% White (P=0.0132)</td>
</tr>
<tr>
<td>Previous acute MI – 28.7% Bangladeshi; 48% Whites (P=0.0014)</td>
<td>Interpreted as acute MI – 46.9% Bangladeshi, 45.2% White (P=0.99)</td>
</tr>
<tr>
<td>Inclusion/Exclusion Criteria</td>
<td>Interpreted as other – 53.1% Bangladeshi, 54.8% White (P=0.99)</td>
</tr>
</tbody>
</table>

Barakat K, Wells Z, Ramdhany S. Mills PG, Timmis AD; 2003

**Note:** The study was supported by an MRC Clinical Training Fellowship.

**Reference:**

ID 10302 Heart 276 to 279 2003
Multivariate analysis of the likelihood of Bangladeshi patients to present with typical central chest pain compared with white patients:
Crude – (OR 0.11; 95% CI 0.03 to 0.38; P=0.0006)
Adjustment for age and sex – (OR 0.10; 95% CI 0.03 to 0.39; P=0.0007)
Adjustment for age, sex and diabetes – (OR 0.12; 95% CI 0.03 to 0.49; P=0.0031)
Adjustment for age, sex, diabetes, hypertension, smoking, family history of IHD and hypercholesterolemia – (OR 0.11; 95% CI 0.02 to 0.58; P=0.0094)
Adjustment for age, sex, diabetes, hypertension, smoking, family history of IHD, hypercholesterolemia and proficiency in English – (OR 0.10; 95% CI 0.01 to 0.79; P=0.0285)

Multivariate analysis of the likelihood of Bangladeshi patients to present with typical cardiac chest pain compared with white patients:
Crude – (OR 0.25; 95% CI 0.09 to 0.74; P=0.0118)
Adjustment for age and sex – (OR 0.25; 95% CI 0.08 to 0.77; P=0.0154)
Adjustment for age, sex and diabetes – (OR 0.19; 95% CI 0.05 to 0.70; P=0.0124)
Adjustment for age, sex, diabetes, hypertension, smoking, family history of IHD and hypercholesterolemia – (OR 0.13; 95% CI 0.03 to 0.63; P=0.0116)
Adjustment for age, sex, diabetes, hypertension, smoking, family history of IHD, hypercholesterolemia and proficiency in English – (OR 0.05; 95% CI 0.04 to 0.46; P=0.0091)

Safety and adverse effects
Not applicable

Does the study answer the question?
The baseline characteristics of the study showed that Bangladesis were younger, more often male and diabetic, and more likely to report a previous acute MI than Whites. However Bangladesis were less likely to report a family history of ischaemic heart disease than whites. 1/3 of the Bangladeshi patients were assessed to be fluent in English.

Bangladesis were significantly less likely to report central chest pain (OR 0.11; 95% CI 0.03 to 0.38; P=0.0006) than whites. This significant difference remained after adjustment for difference in age, sex, risk factor profiles and fluency in English. Bangladesis were also more likely to offer non-classic descriptions (sharp, stabbing, pinching, burning) and less likely to report classic descriptions of the character of pain (heaviness, tightness, weight, pressure, band-like, gripping) (OR 0.25; 95% CI 0.09 to 0.74; P=0.0118). These differences persisted after adjustment for difference in age, sex, risk factor profiles and fluency in English.

The study concluded that Bangladeshi patients with an acute MI were more likely to present with atypical symptoms compared to white patients. The Authors stated that this may lead to slower triage in the emergency department and delay in treatment, this factor needs recognition by emergency department staff in order to reduce mortality rates in this high risk group.

Effect due to factor in study?
Not certain- selected patients with chest pain, hence directness to question may be inappropriate as in that patients with atypical symptoms not necessary included

Consistency of results with other studies?
Consistent

Directly applicable to guideline population?
Selected patients with chest pain, hence directness to question may be inappropriate as in that patients with atypical symptoms not necessary included

Internal Validity
Not addressed
Question: What is the utility (incremental value) and cost effectiveness of the resting ECG in evaluation of individuals with acute chest pain of suspected cardiac origin?
Grading: 1++ High-quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias

Mant J; McManus RJ; Oakes RL; Delaney BC; Barton PM; Deeks JJ; Hammersley L; Davies RC; Davies MK; Hobbs FR;

Systematic review and modelling of the investigation of acute and chronic chest pain presenting in primary care

Ref ID 728 Health technology assessment 159 1 to 158 2004

Study Type Systematic Review Funding NHS R&D Health Technology Assessment Programme

Number of participants In total fifty three cohorts

Inclusion/Exclusion Criteria Papers with patients with acute and stable chest pain of suspected cardiac origin

Patient Characteristics Patients with acute and stable chest pain of suspected cardiac origin

Recruitment

Setting Primary and secondary care

Interventions/ Test/ Factor being investigated Resting ECG. Diagnosis of acute MI and ACS.

Comparisons

Length of Study/ Follow-up

Outcome measures studied Diagnosis of acute MI, ACS and angina.

Results

The presence of ST elevation (commonly defined as 1 mm in at least two contiguous limb leads or 2 mm in two contiguous precordial leads) was the most discriminating single ECG for ruling in a diagnosis of acute MI in patients with acute chest with a positive LR of 13.1 (95% CI 8.28 to 20.60, P < 0.001). A completely normal ECG was reasonably useful at ruling out a MI (LR+ 0.14, 95% CI 0.11 to 0.20, P = 0.007) in patients with acute chest pain. The two next best changes were the presence of Q waves (LR+ 5.01, 95% CI 3.56 to 7.06) and ST depression (LR + 3.13, 95% CI 2.50 to 3.92). Reasonable discrimination of MI was possible when a number of features were combined, for example ST elevation, depression Q waves/ and or T waves (LR + 5.30 95% CI 3.66 to 7.70). A completely normal ECG was reasonably useful at ruling out a MI (LR+ 0.14, 95% CI 0.11 to 0.20). It was stated that the summary results were difficult to interpret because of significant heterogeneity in the studies but that a single ECG was an important for diagnostic information in the evaluation of acute chest pain. A further number of studies were identified that examined ECG in addition to some or all of the following evaluations that had been used in the emergency department: signs, symptoms, and investigations. These were defined as ‘black box’ studies. There were fifteen studies evaluating real time decision making on the initial information available to physicians. Analysis of black box studies was divided into 4 subgroups: interpretation of admission ECG for MI and acute coronary syndrome, interpretation of clinical data other than ECG, A&E initial diagnosis for MI and acute coronary syndrome, and A&E decisions to admit for MI and acute coronary syndromes. Clinical interpretation of admission ECG studies showed that there was a very high LR+ (145 in the best quality paper) for ruling in an MI, however the sensitivity was low (LR- 0.58). The one study that examined the exclusive use of signs and symptoms in diagnosis found that clinical evaluation was not helpful. For the studies evaluating A&E initial diagnosis for MI gave a LR+ of 4.48 (95% CI 2.82 to 7.12) and a LR- of 0.29 (95% CI 0.18 to 0.49). For the category of A&E decisions to
<table>
<thead>
<tr>
<th>Safety and adverse effects</th>
<th>None reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the study answer the question?</td>
<td>Yes</td>
</tr>
<tr>
<td>Effect due to factor in study?</td>
<td>Consistent</td>
</tr>
<tr>
<td>Consistency of results with other studies?</td>
<td>Correct population</td>
</tr>
<tr>
<td>Directly applicable to guideline population?</td>
<td></td>
</tr>
<tr>
<td>Internal Validity</td>
<td></td>
</tr>
</tbody>
</table>
Accuracy and clinical effect of out-of-hospital electrocardiography in the diagnosis of acute cardiac ischemia: a meta-analysis

Ioannidis JP; Salem D; Chew PW; Lau J;

Ref ID 198

Ann Emerg Med

pp. 461 to 470

2001

Study Type  Systematic Review

Funding  Not reported

Number of participants  8 prospective and retrospective cohort studies

Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

The review considered prospective and retrospective English language papers published between 1966 and December 1998 on the diagnostic accuracy of out-of-hospital ECG. 8 of the studies considered the diagnostic accuracy for AMI and 5 of the studies considered the diagnostic accuracy of acute cardiac ischemia (ACI).

See table in guideline.

The studies identified found that out-of-hospital ECGs for AMI have a diagnostic odds ratio (OR) of 104 and 95% CI 48 to 224 and for ACI OR of 23 and 95% CI 6.3 to 85.

The review reported that there was significant heterogeneity in the sensitivity and specificity results between the 8 studies which was possibly due to the difference in definition of an abnormal ECG. The review identified one study which compared computer interpreted ECG with physician interpreted ECG and showed the computer interpreted ECG had a better specificity (98% versus 95%) but a worse sensitivity (52% versus 66%) when compared to physician interpreted ECG. The review states that the diagnostic accuracy may be affected by the expertise interpreting the ECG but states that even experienced clinicians can miss a diagnosis.

The review concluded there was substantial data to show that out-of-hospital ECGs have similar diagnostic accuracy as standard ECGs for AMI and ACI. The authors suggest that an out-of-hospital ECG should be considered by paramedics in all chest pain patients.
Effect due to factor in study?
Consistency of results with other studies?
Directly applicable to guideline population?

Internal Validity

Morrison LJ; Brooks S; Sawadsky B; McDonald A; Verbeek PR;

Prehospital 12-lead electrocardiography impact on acute myocardial infarction treatment times and mortality: a systematic review

Patient Characteristics

Interventions/ Test/ Factor being investigated Comparisons Length of Study/ Follow-up Outcome measures studied

Funding

Does the study answer the question?

Effect due to factor in study?

Safety and adverse effects

Results

The pre-hospital on scene time for acute MI was not significantly different when comparing these studies (total patient number of 519) (pooled weighted mean difference of 1.19 (95% CI −0.84 to 3.21). The door to treatment interval was compared for 181 patients and decreased with PHECG and advanced notification compared with no PHECG (mean weighted difference of 36.1 minutes (95% CI -63.0 to -9.327). However considered heterogeneity was found in these studies (Q statistic 10.9, P < 0.01). Only one study examined all cause mortality. There was no difference all cause mortality when PHECG was compared with no advanced notification for patients with acute MI (PHECG: 8.4% versus control: 15.5%, P < 0.22)

Examines pre-hospital ECG recordings for accuracy with subsequent ECG in emergency department. Determines the accuracy of prehospital ECG in final diagnosis. Although not completely relevant to the ECG sensitivity / specificity in the diagnosis of coronary artery disease, informs on the setting of ECG.
Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity
Grading: 2++
High-quality systematic reviews of case–control or cohort studies. High-quality case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal.

The added diagnostic value of automated QT-dispersion measurements and automated ST-segment deviations in the electrocardiographic diagnosis of acute cardiac ischemia

<table>
<thead>
<tr>
<th>Study Type</th>
<th>Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of participants</td>
<td>1568 ECGs</td>
</tr>
<tr>
<td>Inclusion/Exclusion Criteria</td>
<td>The patients were aged over 18, who sought paramedic evaluation for chest pain which was non-traumatic or equivalent syndrome of presumed cardiac origin and who were classed as stable (a systolic blood pressure of 90mmHg or more, absence of second- or third-degree heart block, ventricular fibrillation or ventricular tachycardia on initial examination). Patients were excluded if the paramedic thought a pre-hospital ECG would affect treatment, and if the ECG showed QRS duration, heart rate, atrial fibrillation or flutter, heat block, or fully paced rhythms.</td>
</tr>
<tr>
<td>Patient Characteristics</td>
<td>The median age was 62 years and 45.3% were women</td>
</tr>
<tr>
<td>Recruitment</td>
<td>patients who had a prehospital ECG by paramedics</td>
</tr>
<tr>
<td>Setting</td>
<td>ambulance, USA</td>
</tr>
<tr>
<td>Interventions/ Test/ Factor being investigated</td>
<td>ECG diagnosis</td>
</tr>
<tr>
<td>Comparisons</td>
<td>ST segment, QT-end and QT-peak dispersion, physician and computer interpretation</td>
</tr>
<tr>
<td>Length of Study/ Follow-up</td>
<td></td>
</tr>
<tr>
<td>Outcome measures studied</td>
<td>sensitivity, specificity, PPV and NPV of ECG</td>
</tr>
<tr>
<td>Results</td>
<td>The study assessed the sensitivity and specificity of diagnosing AMI by assessment by both physicians of ST segment deviation. QT-end dispersion and QT-peak dispersion measurements independent of each other. The study showed the average sensitivity was 50.5% and specificity was 98%. The study went on to assess the sensitivity and specificity of diagnosing AMI by a computer through independent assessment of ST segment deviation, which showed a higher sensitivity of 90% but lower specificity of 56%. For independent assessment of QT-end and QT-peak dispersion the computer interpretation did not have a significant difference compared to the physicians' interpretation. The study went on to assess the sensitivity and specificity of diagnosing AMI when combining the information of QT-end and QT peak dispersions which showed that the physicians' significantly increased in sensitivity by 88% (90% versus 48%, P=&lt;0.001), but decreased in specificity by 44% (55% vs. 99% P=&lt;0.001) and PPV by 58% (40% vs. 95%, P=&lt;0.001). The sensitivity and specificity were also assessed when ST segment deviation was included in the analysis, which showed this lead to the physicians' highest sensitivity 65% (compared to 48%, P=&lt;0.001) and maintained specificity 97% (compared to 99%, P=&lt;0.001).</td>
</tr>
<tr>
<td>Funding</td>
<td>Not reported</td>
</tr>
</tbody>
</table>

Aufderheide TP; Xue Q; Dhala AA; Reddy S; Kuhn EM; J Electrocardiol 329 to 339 2000
but a lower specificity (66%). The study showed that for independent assessment of QT-end dispersion and QT-peak dispersion the computer had a higher sensitivity compared to the physicians (50-53% compared to 38-40%, P=<0.001), but the specificity, PPV, and NPV were all comparable. The study went on to assess the sensitivity and specificity of diagnosing ACI when combining the information of QT-end and QT peak dispersions which showed that the physicians’ significantly increased in sensitivity by 70% (65-68% versus %, P=<0.001) and NPV by 19% (68%-69% versus 58%, P=<0.001), but decreased in specificity (80-81% vs. 92%, P=<0.001) and PPV (79% vs. 85%, P=<0.001). The sensitivity and specificity were also assessed when ST segment deviation was combined with QT-end dispersion, which showed this lead to the physicians’ highest sensitivity 62% (compared to 40%, P=<0.001) and NPV to 68% (compared to 58%, P=<0.001) and maintained specificity 90% (compared to 92%, P=<0.001) and PPV 87% (compared to 85%, P=<0.05).

Safety and adverse effects

The study assessed the sensitivity and specificity of diagnosing AMI by assessment of ST segment deviation, QT-end dispersion and QT-peak dispersion measurements independent of each other. The study showed the computer interpretation had a higher sensitivity but lower specificity compared to physician interpretation. The study showed that when combining QT-end and QT-peak dispersion the physicians sensitivity increased but specificity and PPV decreased, when combining ST segment deviation as well the physicians’ reached its maximum sensitivity and maintained specificity.

The study assessed the sensitivity and specificity of diagnosing ACI by assessment of ST segment deviation, QT-end dispersion and QT-peak dispersion measurements independent of each other. The study showed the computer interpretation had a higher sensitivity but lower specificity compared to physician interpretation for ST segment deviation, and higher sensitivity but comparable specificity, PPV and NPV for QT-end and QT-peak. The study showed that when combining QT-end and QT-peak dispersion the physicians sensitivity and NPV increased but specificity and PPV decreased, when combining ST segment deviation and QT-end dispersion the physicians’ reached its maximum sensitivity and NPV and maintained specificity and PPV.

Does the study answer the question?

The study assessed the sensitivity and specificity of diagnosing AMI by assessment of ST segment deviation, QT-end dispersion and QT-peak dispersion measurements independent of each other. The study showed the computer interpretation had a higher sensitivity but lower specificity compared to physician interpretation. The study showed that when combining QT-end and QT-peak dispersion the physicians sensitivity increased but specificity and PPV decreased, when combining ST segment deviation as well the physicians’ reached its maximum sensitivity and maintained specificity.

Effect due to factor in study? Yes

Consistency of results with other studies? Consistent

Directly applicable to guideline population? Patients had chest pain

Internal Validity Well covered

Conti A;Paladini B;Toccafondi S;Magazzini S;Olivotto I;Galassi F;Pieroni C;Santoro G;Antoniucci D;Berni G;

Effectiveness of a multidisciplinary chest pain unit for the assessment of coronary syndromes and risk stratification in the Florence area

Ref ID 926 American heart journal 630 to 635 2002

Study Type Cohort Funding Italian Ministry for Scientific and Technological Research

Number of participants 13,762 patients

Inclusion/Exclusion Criteria

Inclusion: over 18 years old, chest pain defined as pain in the thoracic region, independent of duration, radiation, or relation to exercise, occurring in the last 24 hours and lasting minutes to hours

Patient Characteristics

The mean age was 65±18 years and 43% were women Those who were categorised as being at high risk (21%) had a mean age of 63±10 years, 33% were female, 35% smoked, 25% had diabetes, 38% had hypertension,
13.4 % died during the follow up. Those who were categorised as being at intermediate risk (47%) had a mean age of 64±11 years, 38% were female, 33% smoked, 28% had diabetes, 41% had hypertension, 2.2 % died during the follow up.

Those who were categorised as being at low risk (32%) had a mean age of 38±15 years, 66% were female, 12% smoked, 8% had diabetes, 22% had hypertension, 0.2 % died during the follow up.

Recruitment
Admitted to emergency department with chest pain as described above

Setting
ED. Careggi General Hospital, Florence, Italy

Interventions/ Test/ Factor being investigated
Diagnosing chest pain

Comparisons
The chest pain score was based on: location of pain, radiation of pain, character of pain, history of angina

Length of Study/ Follow-up
6 months

Outcome measures studied
Effectiveness of chest pain score in diagnosing chest pain

Results
The chest pain score was based on the following elements each of which was given a value: location of pain: substernal or precordial = +3, left chest, neck, lower jaw or epigastrum = +1, apex = -1; radiation of pain: arm, shoulder, back, neck or lower jaw = +1; character of pain: crushing, pressing or heaviness = +2 sticking, pleuritic or pinprick = -1; associated symptoms: dyspnea, nausea or diaphoresis = +2; history of angina = +3. The mean age was 65±18 years. Patients were classified into 1 of 4 groups.

1) Patients at low risk with obvious noncardiac causes of chest pain, chest pain score <4, normal ECG, and normal serum markers of cardiac injury obtained at least 6 hours from symptoms, were sent home and followed up. (2672 patients)

2) Patients at low risk with chest pain score ≥ 4, normal ECG, normal serum cardiac markers, independent of age or coexisting coronary risk factors, were not admitted and underwent a second-line evaluation and short-term observation in the CPU area, including chest radiography, serial 12-lead ECG, serial troponins and cardiac enzymes, echocardiography and arterial blood gas analysis. When at least one of these tests or procedure results was found to be suggestive of AMI, unstable angina or CAD or left ventricular failure was detected these patients were considered for angiography with no additional testing. After an observation period up to 6 hours patients without ongoing cardiovascular events underwent exercise tolerance test or SPECT or stress echocardiography. (1755 patients)

3) Patients at intermediate risk with clinical score ≥ 4 and abnormal ECG (ST-segment elevation <1mm or ST-segment depression <1mm at 60ms from J point) were admitted and managed in the CPU area.

4) Patients at high risk with ECG suggestive for AMI (defined as ST elevation ≥1 mm at 60ms from J point, ≥2 contiguous leads) were directly transferred to the coronary care unit and patients with suspected major cardiovascular disease, such as aortic arch dissection, pulmonary embolism, pneumothorax and acute pericarditis, were admitted and managed with arterial blood gas analysis, chest radiography, echocardiography, and thorax computed tomography if required by clinical assessment.

At six month follow up 0.2% of these patients were recognised as having nonfatal coronary artery disease, hence, the negative predictive value of a chest pain score of < 4 and normal ECG was > 99%

Of the patients with a chest pain score ≥ 4 and normal or non diagnostic electrocardiogram results (1755 patients, 40%), 20% of the low risk group with chest pain score < 4 (group 1) (885 patients) had documented coronary artery disease, 18% of which were by recurrent angina, delayed ECG changes, late rise in markers, the other 2% was by positive stress test.

There were 9335 intermediate and high risk patients, of which 2420 patients (26%) had an MI, 3764 patients (40%) had unstable angina, 129 (1.4%) had aortic dissection and 408 (4%) had pulmonary embolism, other major cardiovascular conditions were diagnosed, including aortic arch dissection, pulmonary embolism, pneumothorax, and acute pericarditis. 2256 patients had atypical chest pain
Of the patients with a chest pain score > 4 and normal electrocardiogram results, 20% (885 patients) had documented coronary artery disease. There were 9335 intermediate and high risk patients, of which 2420 patients (26%) had an MI, 3764 patients (40%) had unstable angina, 129 (1.4%) had aortic dissection and 408 (4%) had pulmonary embolism. Other multi-organ disease was found in 2256 patients.

The authors concluded that the chest pain score screening programme was effective and could significantly reduce admissions and optimise the care of those with an intermediate or high risk score. The authors also concluded that the screening programme could aid the diagnosis of alternative causes of chest pain in patients who do not have evidence of coronary artery disease.

| Effect due to factor in study? | Yes |
| Consistency of results with other studies? | Consistent |
| Directly applicable to guideline population? | Correct population |
| Safety and adverse effects | None reported |


| Study Type | Cohort |
| Number of participants | 706 patients |
| Inclusion/Exclusion Criteria | included: chest pain with suspected ACS |
| Patient Characteristics | The average age for category II was 57.3±11.3 years, 67.2% were men, 89.8% were Caucasian, 10.2% were African American, 62% had previous MI, 52.3% had previous PTCA/CABG. The average age for category III was 54.6±12.9 years, 61% were men, 76.6% were Caucasian, 22.8% were African American, 31.5% had previous MI, 25.2% had previous PTCA/CABG. The average age for category IV was 52.6±14.4 years, 49% were men, 67.9% were Caucasian, 29.8% were African American, 21.6% had previous MI, 15.4% had previous PTCA/CABG |
| Recruitment | Patients presented with chest pain of suspected ACS to the emergency department between August 1995 and August 1998 |
| Setting | Emergency department, USA |
| Interventions/Test Factor being investigated | Continuous ST segment monitoring |
| Comparisons | Sensitivity and specificity of serial ECG |
| Length of Study/Follow-up | 2000 |

15 September 2009
Sensitivity and specificity of serial ECG

Patients had an initial history, physical examination and ECG, and were subsequently classed in four different categories. Category I were patients with ACS with clinical and ECG criteria for emergency reperfusion therapy, category II were patients with probable ACS but without clinical and ECG criteria for emergency reperfusion therapy, category III were patients with possible ACS, category IV were patients with probable non-ACS chest pain but presence of pre-existing disease or significant risk factors for CAD. Category I were excluded from the study. The serial ECG was obtained at least every 10 minutes until the patient was taken for PTCA or for 2 hours.

See tables in guideline.

28 patients were placed in category I, 137 patients were placed in category II, 333 patients were placed in category III and 208 patients were placed in category IV.

Serial ECG for new injury or new/evolving ischemia had a sensitivity and specificity of 41.7% (95% CI 27.6 to 58.6) and 98.1% (95% CI 96.7 to 99) respectively for AMI and 15.5% (95% CI 10.6 to 21.5) and 94.4% (95% CI 98.2 to 99.9) for ACS. For AMI the serial ECG had a positive likelihood ratio (LR+) of 21.9 and negative likelihood (LR-) of 0.59 and for ACS a LR+ of 25.4 and LR- of 0.85. As a result of the serial ECG 26 patients had their treatment changed.

Safety and adverse effects

None reported

Does the study answer the question?

Serial ECG for new injury or new/evolving ischemia had a sensitivity and specificity of 41.7% (95% CI 27.6 to 58.6) and 98.1% (95% CI 96.7 to 99) respectively for AMI and 15.5% (95% CI 10.6 to 21.5) and 94.4% (95% CI 98.2 to 99.9) for ACS. For AMI the serial ECG had a positive likelihood ratio (LR+) of 21.9 and negative likelihood (LR-) of 0.59 and for ACS a LR+ of 25.4 and LR- of 0.85. As a result of the serial ECG 26 patients had their treatment changed.

Effect due to factor in study?

Yes

Consistency of results with other studies?

Consistent

Directly applicable to guideline population?

Patients had chest pain with suspected ACS

Internal Validity

Well covered

Ohlsson M; Ohlin H; Wallerstedt SM; Edenbrandt L;

Usefulness of serial electrocardiograms for diagnosis of acute myocardial infarction

Ref ID 1582 The American journal of cardiology 478 to 481 2001

Study Type Cohort

Funding Swedish Medical Research Council, Swedish Heart Lung Foundation, Medical Faculty at Lund University, Swedish Foundation for Strategic Research

Number of participants 902 ECGs were reviewed, each ECG was also reviewed with a previous ECG for the same patient

Inclusion/Exclusion Criteria ECG had to show an AMI, previous ECG had to be available from the clinical electrocardiographic database

Patient Characteristics The average age of the patients was 74±11 years, with 605% being men

Recruitment Patients with AMI who presented to emergency department between January 1990 and June 1997
The study recorded a 12 lead ECG by the use of computerized ECGs. During which the QRS duration, QRS area, Q, R and S amplitudes and 6 ST-T measurements (ST-J amplitude, ST slope, ST amplitude 2/8, ST amplitude 3/8, positive T amplitude and negative T amplitude) were recorded. For each measurement of the new ECG the same measurement was recorded from the previous ECG. The ECGs were interpreted for diagnosis AMI by artificial neutral network which used standard feed forward, multilayer, perceptron architecture, which consisted 1 input layer, 1 hidden layer and 1 output layer with 16 or 32 nodes, the ECGs were then interpreted independently by two physicians (one cardiologist and one intern), on two occasions, the first occasion only the new ECG was shown and the second occasion both ECGs were shown:

The study used ROC curves to evaluate the difference in interpretation and diagnosis of AMI when both ECGs were present compared to only the current ECG. The ROC curve showed that the neutral network performance was improved when both ECGs were present (area under ROC with current ECG = 0.85, area under ROC with both ECGs = 0.88; P = 0.02). The intern performed better when both ECGs were present (area under ROC with current ECG = 0.71, area under ROC with both ECGs = 0.78; P < 0.001) and diagnosed more AMI with both ECGs. The cardiologist performance did not have a statistically significant improve with both ECGs (area under ROC with current ECG = 0.79, area under ROC with both ECGs = 0.81; P = 0.36).

Safety and adverse effects
None reported

Does the study answer the question?
The study used ROC curves to evaluate the difference in interpretation and diagnosis of AMI when both ECGs were present compared to only the current ECG. The ROC curve showed that the neutral network performance was improved when both ECGs were present and diagnosed more AMI with both ECGs. The cardiologist performance did not have a statistically significant improve with both ECGs.

Effect due to factor in study?
Yes

Consistency of results with other studies?
Consistent

Directly applicable to guideline population?
Patients had AMI

Internal Validity
Well covered

Sanchis J; Bodý V; Llßcer A; N±ez J; Consuegra L; Bosch MJ; Bertomeu V; Ruiz V; Chorro FJ;

Risk stratification of patients with acute chest pain and normal troponin concentrations

<table>
<thead>
<tr>
<th>Ref ID</th>
<th>Heart (British Cardiac Society)</th>
<th>1013 to 1018</th>
<th>2005</th>
</tr>
</thead>
</table>

Study Type Cohort
Number of participants 609 patients

Funding Not reported
The mean age was 64±12 years, 33% were women, 20% were current smokers, 59% had hypertension, 53% had hypercholesterolemia, 25% had diabetes, 44% had a history of IHD, 13% had a family history of IHD, 7% had had coronary surgery, 12% had ST depression, 9% had T wave inversion.

**Recruitment**
Patients admitted to the emergency department in a teaching hospital in Spain.

**Setting**
ED, teaching hospital in Spain.

**Inclusions/Exclusions**
Inclusion: Patients with chest pain of suspected cardiac origin as determined by a cardiologist on call with a negative troponin I concentration (measured at baseline, at 6, 8 and 12 hours). Exclusion: ST elevation, Left Bundle Branch Block, and heart failure, Killip > 1.

**Diagnosing chest pain**

**Comparisons**
The chest pain score was based on: location, radiation, character, severity, what influenced the pain, associated symptoms, history of exertional angina. A clinical history, ECG, and for those in the low risk group an early (<24 hours) exercise test.

**Length of Study/Follow-up**
6 months.

**Outcome measures studied**
Effectiveness of chest pain score in diagnosing chest pain.

**Results**
An ECG was recorded in the emergency room and evaluated for ST segment depression (>1mm) and T wave inversion (peak inversion >1mm).

Troponin I concentrations were taken at arrival, 6 hours (if patient arrived within 2 hours of onset of pain), 8 hours and 12 hours after pain onset. All patients had normal troponin concentrations at each measurement.

Patients underwent a chest pain score assessment, an ECG, and for those in the low risk group an early (<24 hours) exercise test. The chest pain score was based on: location, radiation, character, severity, influenced by glyceryl trinitrate, stature, breathing, associated symptoms and history of exertional angina = +3. A clinical history was also taken.

During a 6 month follow-up, 25 patients (4.1%) had an acute MI, 9 (1.5%) died of cardiac causes and 29 (4.8%) had a major event (AMI or cardiac death).

Those who could not exercise had a negative exercise test had a very good prognosis compared to those who did not have a negative exercise test or those who could not exercise and do and exercise test.

For predictors of AMI the univariate and multivariate analysis showed: ST segment depression (univariate P = 0.004, multivariate P = 0.02, odds ratio (OR) 2.9, 95% CI 1.2 to 6.8), T-wave inversion (univariate P = 0.5, multivariate analysis could not be applied to T-wave inversion).

For predictors of a major event (AMI or cardiac death) the univariate and multivariate analysis showed: ST segment depression (univariate P = 0.003, multivariate P = 0.01, OR 2.8, 95% CI 1.3 to 6.3), T-wave inversion (univariate P = 0.7, multivariate analysis could not be applied to T-wave inversion).

The patients were stratified according to the four independent risk factors associated with a major event (AMI or cardiac death), these were chest pain score, diabetes, previous coronary surgery and ST-segment depression. The event rate increased with the number of risk factors: no risk factors 2.5% event rate, 1 risk factor 2.9% event rate, 2 risk factors 10.2% event rate, 3 or 4 risk factors 29.2% event rate. Three risk categories were defined: low risk: no or 1 risk factor 2.7% event rate, intermediate risk: 2 risk factors 10.2% event rate, high risk: 3 or 4 risk factors 29.2% event rate. The differences between the 3 categories were all significant: high and intermediate (P = 0.001), high and low (P = 0.0001), intermediate and low (P = 0.008).

**Safety and adverse effects**
None reported.
During a 6 month follow up, 25 patients (4.1%) had an acute MI, 9 (1.5%) died of cardiac causes and 29 (4.8%) had a major event (AMI or cardiac death). Multivariate analysis found that ST segment depression was an independent factors in predicting an acute MI (univariate $P = 0.004$, multivariate $P = 0.02$, OR 2.9, 95%CI 1.2 to 6.8), and major events (AMI or cardiac death) (univariate $P = 0.003$, multivariate $P = 0.01$, OR 2.8, 95%CI 1.3 to 6.3).

Further analysis found that the event rate increased progressively with the progression of the number of independent risk factors, with the event rate increasing with the number of risk factors: no risk factors 2.5% event rate, 1 risk factor 2.9% event rate, 2 risk factors 10.2% event rate, 3 or 4 risk factors 29.2% event rate. From this 3 risk categories, low intermediate and high, were formed with the difference between each being significant.

NB there is overlap of patients included in this study and the study Sanchis et al 2005, JACC (New Risk Score for Patients with Acute Chest Pain, Non-ST-Segment Deviation, and Normal Troponin Concentrations).

Effect due to factor in study? Yes
Consistency of results with other studies? Consistent
Directly applicable to guideline population? Correct population
Internal Validity Well covered

Sanchis J; Bod{Y} V; N{ê}ez J; Bertomeu G; G{è}mez C; Bosch MJ; Consuegra L; Bosch X; Chorro FJ; Li{ê}cer A;

New risk score for patients with acute chest pain, non-ST-segment deviation, and normal troponin concentrations: a comparison with the TIMI risk score

Ref ID 447 Journal of the American College of Cardiology 443 to 449 2005

Study Type Cohort Funding RECAVA-FIS
Number of participants 646 patients
Inclusion/Exclusion Criteria
Inclusion criteria: acute chest pain of possible cardiac origin
Exclusion: if the initial ECG showed ST-segment deviation ($\geq$1mm elevation or depression) or if they had troponin I elevation

Patient Characteristics
The mean age was 64±12 years and 32% were women. 20% were smokers, 59% had hypertension, 53% had hypercholesterolemia, 26% had diabetes mellitus, 7% insulin dependant diabetes mellitus, 12% had a family history of IHD, 13% had at least 3 risk factors, 24% had prior coronary stenosis $\geq$50%, 43% had used aspirin in the previous 7 days, 25% had a prior MI, 9% had prior PTCA, 8% had prior CABG, 2% had a history of heart failure. On ECG 100% had T-wave inversion, 9% had confounding ECG

Recruitment
Patients admitted with acute chest pain to the emergency department in a teaching hospital in Spain during a 34 month period between 15th January 2001 and 30th November 2003

Setting
ED in a teaching hospital in Spain

Interventions/ Test/ Factor being investigated
Diagnosing chest pain

Comparisons
The chest pain score and other variables, described in results

Length of Study/ Follow-up
1 year
The primary end point was all cause mortality or nonfatal myocardial infarction, the secondary end point was all cause mortality, nonfatal myocardial infarction or urgent revascularisation at 14 day follow up.

Results

Patients were excluded if they had ST-segment deviation (≥1mm elevation or depression) on the initial ECG or if they had troponin I elevation. All patients had T-wave inversion and 9% had confounding ECG (left branch bundle block of paced rhythm). An ECG was recorded in the emergency room.

Troponin I concentrations were taken at arrival, 6 hours (is patient arrived within 2 hours of onset of pain), 8 hours and 12 hours after pain onset. All patients had normal troponin concentrations at each measurement.

Patients underwent a chest pain score assessment based on: location, radiation, character, severity, influenced by glyceryl trinitrate, stature, breathing, associated symptoms and history of exertional angina. A clinical history and risk factor analysis was also taken.

At 1 year follow up, the primary end point (all-cause mortality or non-fatal MI) occurred in forty three patients (6.3%). At a 14 day follow up, the secondary end point (all-cause mortality or nonfatal myocardial infarction or urgent revascularisation) occurred in 35 patients (5.4%).

The univariate analysis showed that for: T-wave inversion (P = 0.4), confounding ECG (P = 0.09).

The multivariate analysis showed that for: confounding ECG (P = 0.3). The multivariate analysis did not give results for T-wave inversion or full results for confounding ECG.

The study showed from multivariate analysis ECG changes (T-wave inversion and confounding ECG) were not independent predictors of the primary end point.

Safety and adverse effects

None reported

Does the study answer the question?

Univariate analysis found that the following were independent factors in predicting all cause mortality or nonfatal myocardial infarction; t-wave inversion (P = 0.4), and confounding ECG (P= 0.09).

Multivariate analysis found that ECG changes were not independent factors in predicting all cause mortality or nonfatal myocardial infarction. Confounding ECG on multivariate analysis (P=0.3).

NB there is overlap of patients included in this study and the study Sanchis et al 2005, Heart J (Risk Stratification of Patients with Acute Chest Pain and Normal Troponin Concentrations).

Effect due to factor in study?

Yes

Consistency of results with other studies?

Consistent

Directly applicable to guideline population?

Correct population

Internal Validity

Well covered
Utilization and impact of pre-hospital electrocardiograms for patients with acute ST-segment elevation myocardial infarction: data from the NCDR (National Cardiovascular Data Registry) ACTION (Acute Coronary Treatment and Intervention Outcomes Network) Reg

**Study Type**: Cohort

**Number of participants**: Final population of 7098

**Inclusion/Exclusion Criteria**: Acute chest pain suspected to be acute MI and attending an ACTION participating hospital

**Patient Characteristics**: The final study population was 12,097 patients, of which 7098 patients (58.7%) were transported to ACTION-participating hospitals by the EMS. EMS transported patients were older, less commonly male, and more commonly had prior MI, prior congestive heart failure (CHF) or signs of CHF. They also had shorter times from symptom onset to hospital presentation compared with patients that self-presented to ACTION-participating hospitals. A pre-hospital ECG was used to facilitate patient transport decisions.

**Recruitment**: Consecutive

**Setting**: Ambulance and hospital

**Interventions/Test/Factor being investigated**: Use of out of hospital ECG to in-hospital ECG

**Comparisons**: Use of out of hospital ECG to in-hospital ECG

**Length of Study/Follow-up**: At 1 month

**Outcome measures studied**: Mortality, door to needle time, door to treatment time.

**Results**: The study found that patients with a pre-hospital ECG were more likely to undergo PCI, less likely to receive no reperfusion therapy, and more likely to receive aspirin, clopidogrel, and glycoprotein IIb/IIIa inhibitors within the first 24 hours compared with patients with an in-hospital ECG.

The door to needle time (DNT) and the door to balloon time (DTB) were faster in patients with a pre-hospital ECG compared with patients with an in-hospital ECG, which persisted after adjustment for confounders (DNT: pre-hospital ECG 19 min versus in-hospital ECG 29 min (P = 0.003), adjusted decrease time of 24.9%, 95% CI -38.1% to -9.0%, and DTB: pre-hospital ECG 61 min versus in-hospital ECG 75 min (P < 0.001), adjusted decrease time of 19.3%, 95% CI 23.1% to -15.2% (P = 0.003).

With respect to clinical outcomes in the total population, there was a trend for a decrease in mortality for pre-hospital ECG patients versus in-hospital ECG, 6.7% versus 9.5%, respectively, adjusted odds ratio 0.80 (95% CI 0.63 to 1.01 (P = 0.06). However, in patients who received any reperfusion therapy, there was no difference in the adjusted risk of mortality of pre-hospital ECG versus in-hospital ECG (4.6% versus 5.2%, respectively, P = 0.82). There was no significant difference for the clinical outcomes of CHF and cardiogenic shock comparing pre-hospital ECG patients versus in-hospital ECG patients in the total population, nor for cardiogenic shock in the reperfusion population. There was a trend for a decrease in the...
Yes it details the usefulness of obtaining an ECG prior to arrival at hospital

Effect due to factor in study?  Yes

Consistency of results with other studies?  Study not directly applicable as it is examining setting of ECG recording, ambulance versus hospital

Directly applicable to guideline population?  Directly applicable, acute chest pain population.

Internal Validity  Not applicable
Question: Are the symptoms and description of the symptoms different in women presenting with acute chest pain of suspected cardiac origin compared with men
**Grading:** 1+ Well-conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias

Canto JG; Goldberg RJ; Hand MM; Bonow RO; Sopko G; Pepine CJ; Long T;

Symptom presentation of women with acute coronary syndromes: myth vs reality

<table>
<thead>
<tr>
<th>Ref ID</th>
<th>Arch Intern Med</th>
<th>pgs</th>
<th>2405 to 2413</th>
<th>2007</th>
</tr>
</thead>
</table>

**Study Type** Systematic Review  
**Funding** Not reported

**Number of participants** Cohort, Surveys, Registries.

**Inclusion/Exclusion Criteria** Cohort, Surveys, Registries identified between 1970 to 2005

**Patient Characteristics** Patients with ACS

**Recruitment** Systematic review identified nine large cohort studies, and twenty smaller cohort or personal interview studies that provided information on ACS presentation with and without chest pain or discomfort according to sex

**Setting** Emergency departments

**Interventions/ Test/ Factor being investigated** Not applicable

**Comparisons** Signs and symptoms, men versus women

**Length of Study/ Follow-up** Not applicable

**Outcome measures studied**

**Results** Compared with men, 8 identified studies found that women are more likely to experience middle or upper back pain, 4 studies found that women are more likely to have neck pain, and 2 studies found that women are more likely to have jaw pain. Five studies found that women are more likely to have shortness of breath and five studies showed women are more likely to have nausea or vomiting. Loss of appetite, weakness and fatigue, and cough were identified as more common in women versus men in two studies each. Paroxysmal nocturnal dyspnea, indigestion and dizziness were reported as more common in women versus men in one study each. One study found that women appear to have a greater number of associated symptoms as part of their ACS presentation compared with men.

**Safety and adverse effects** Not applicable

**Does the study answer the question?** Yes. Women are significantly less likely to report chest pain or discomfort at presentation for ACS compared with men from accumulated data from 29 identified studies. The authors identified the following limitations of the review and other related studies; there is a lack of standardisation on data collection and reporting on women’s principal or associated ACS symptoms thus formal meta-analyses was not possible due to heterogeneity, a number of studies exclude patients that have ACS and no chest pain or discomfort, chest pain or discomfort is often lumped together with pain localised to other areas of the upper body in the absence of chest pain symptoms, hospital records are often very imprecise in characterising the presence of chest pain, as well as other associated symptoms, physician bias based on the patients pre-test probability in recording symptoms, survey bias when patients recollect symptoms retrospectively, the sensitivity of a particular symptom may be ascertained but the specificity of a symptom may not be considered, and the impact of potential association of co-morbid conditions (such as diabetes), with symptom
presentation has not been examined in the review due to the lack of currently available data although this is likely to be important.

Effect due to factor in study?
Yes

Consistency of results with other studies?
Consistent

Directly applicable to guideline population?
Directly applicable to the guideline

Internal Validity
Well covered

Fifteen studies were identified, four cohorts were in patients with all types of ACS and eleven cohorts were in patients with MI. The systematic review did not however provide a definition of ACS that was detailed in the selected studies.

Patel H; Rosengren A; Ekman I;

Symptoms in acute coronary syndromes: Does sex make a difference?

<table>
<thead>
<tr>
<th>Ref ID</th>
<th>Am Heart J</th>
<th>27 to 33</th>
<th>2004</th>
</tr>
</thead>
</table>

Study Type
Systematic Review

Funding
In part: Vardal institute research platform

Number of participants
Systematic review- 15 cohort studies identified

Inclusion/Exclusion Criteria
Studies from a search between 1980 to 2002

Patient Characteristics
Fifteen studies were identified, four cohorts were in patients with all types of ACS and eleven cohorts were in patients with MI. The systematic review did not however provide a definition of ACS that was detailed in the selected studies.

Recruitment
Not applicable

Setting
Emergency departments

Interventions/ Test/ Factor being investigated
Signs and symptoms

Comparisons
Signs and symptoms; men versus women

Length of Study/ Follow-up
Not applicable

Outcome measures studied
Signs and symptoms in ACS patients

Results
Yes. Analysis of the 4 studies identified in patients presenting with ACS found that women are more likely to experience back and jaw pain, nausea and / or vomiting, dyspnea, indigestion and palpitations compared with men. In the 4 ACS cohort studies no gender difference was found for the following symptoms: presence of chest pain (2 studies), arm and shoulder pain (2 studies), neck pain (2 studies), dizziness (3 studies). Analysis of the eleven cohort studies identified in patients with MI found that women are more likely to have back, jaw, and neck pain, and nausea and / or vomiting, dyspnea, palpitations, indigestion, dizziness, fatigue, loss of appetites and syncope. The following symptoms were not associated with gender differences in the presentation of acute MI; arm and shoulder pain (4 studies), epigastric discomfort, heartburn or abdominal pain (7 studies), throat pain (2 studies)

Safety and adverse effects
Not applicable

Does the study answer the question?
Cohort studies suggest that women exhibit different symptoms of ACS versus men, however, here was inconsistency in the gender-specific symptoms reported, in that no individual symptom was identified by all studies that examined the symptom. It is likely that the baseline characteristics of the populations varied, and the authors
stated that sex differences may disappear after controlling for variables such as age or co-morbid conditions. Some studies evaluated only a small number of symptoms, and may have missed other statistically significant symptoms.

<table>
<thead>
<tr>
<th>Effect due to factor in study?</th>
<th>Yes</th>
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<tbody>
<tr>
<td>Consistency of results with other studies?</td>
<td>Consistent</td>
</tr>
<tr>
<td>Directly applicable to guideline population?</td>
<td>Directly relevant to guideline population</td>
</tr>
<tr>
<td>Internal Validity</td>
<td>Adequately addressed</td>
</tr>
</tbody>
</table>
Gender differences on the risk evaluation of acute coronary syndromes: The CARDIO2000 study

Ref ID 3520  Preventive Cardiology  Pages 71 to 77  2003

Study Type  Cohort  Funding  Not reported

Number of participants  848 patients (701 men, 147 women) and 1078 in the control group (862 men, 216 women)

Inclusion/Exclusion Criteria  Inclusion: first event of acute MI as diagnosed by 2 or more of following; ECG, compatible clinical symptoms, enzyme elevations, or first diagnosis of unstable angina as described by class III of the Braunwald classification

Patient Characteristics  Seven hundred and one (82%) of the cardiac patients were men with a mean age 59 SD 10 years, and 147 (18%) of cardiac patients were women with a mean age of 65.3 SD 8 years. For controls 80% were men and 20% were women with mean ages of 58.8 SD 10 years and 64.8 SD 10 years, respectively

Recruitment  Random selection of patients admitted between January 2000 and August 2001 who met the inclusion criteria. The control group were selected from patients who attended the hospital for routine outpatient appointments who were cardiovascular disease free.

Setting  Secondary Care, Greece

Interventions/ Tests/ Factor being investigated  Risk factors for diagnosis ACS

Comparisons  Smoking, hypertension, hypercholesterolemia, diabetes, family history of premature CAD, BMI, physical activity, diet, alcohol consumption

Length of Study/ Follow-up  Not applicable

Outcome measures studied  Risk factors for diagnosis ACS

Results  Women experiencing their first cardiac event were significantly older than men (P < 0.01). Univariant analysis found that women were significantly more likely to have hypertension, hypercholesterolemia and diabetes, whereas men were significantly more likely to smoke, do physical activity and have higher alcohol consumption. This difference was found in both the cardiac patient group and the control group.

When adjusting for age, multivariate analysis found that for women hypertension was associated with a higher risk of coronary artery disease compared with men (odds ratio 4.86 versus 1.66 P < 0.01, respectively). Family history of coronary artery disease and hypercholesterolemia were associated with a higher risk of coronary artery disease in men than in women with odds ratios of 5.11 versus 3.14, P < 0.05 for family history, respectively, and odds ratios of 3.77 versus 2.19 P < 0.05 for hypercholesterolemia, respectively.

Safety and adverse effects  Not applicable

Does the study answer the question?  Yes. Study found that impact of CAD is different for women versus men.. Men were more likely to have a family history of CAD and hypertension. Women were more likely to have hypertension compared with men.

Effect due to factor in study?  Yes
Consistency of results with other studies? Consistent

Directly applicable to guideline population? Not unselected chest pain population, however ACS I population is subset of this, therefore cohort is applicable as subset of the chest pain guideline population

Internal Validity Well covered

Isaksson RM; Holmgren L; Lundblad D; Brulin C; Eliasson M;

Time trends in symptoms and prehospital delay time in women vs. men with myocardial infarction over a 15-year period. The Northern Sweden MONICA Study

Ref ID 25380 EUR J CARDIOVASC NURS 152 to 158 2008

Study Type Cohort Funding Norrbotten County Council provided funding for the myocardial registry

Number of participants 6342 patients (5072 men and 1470 women).

Inclusion/Exclusion Criteria Patients with a diagnosis of MI according to standard WHO definition. Exclusion criteria were patients in the registry with incomplete data

Patient Characteristics Patients with MI according to standard WHO definition

Recruitment Not applicable

Setting Northern Swedish registry survey

Interventions/ Test/ Factor being investigated Symptom presentation and prehospital delay and risk stratification according to age and gender

Comparisons Age and gender, with respect to symptoms of MI

Length of Study/ Follow-up Records over 15 years

Outcome measures studied Signs and symptoms, hospital delay

Results The study found that men were more likely to experience typical pain based on the MONICA criteria compared with women (86.3% versus 80.8%, respectively). Symptoms were also analysed with stratification for age and gender. A greater proportion of younger men (age group 25 to 34 years) had typical pain compared with older age groups, and with increasing age a greater proportion of men experienced typical symptoms. For women, a lower proportion experienced typical symptoms compared with men in all age ranges, however in the age range 65 to 74 years the difference in proportion of men versus women with typical symptoms was less marked (79.8% versus 78.0%), hence in the oldest age group the frequency of atypical pain is similar in men and women.

The study analysed prehospital delay in seeking medical attention according to age and gender (from < 2 h to > 24 h). For the total male population compared with the female population, there was no difference in the proportions in time to hospital delay; < 2 h, 41.2% men versus 41.2% women, < 4 h, 20.2% men versus 19.8% women, < 4 to 24 h, 27.7% men versus 29.8% women, and < 24 h, 10.9% men versus 9.8% women. Analysis of prehospital delay by stratifying according to age and gender found that there was no consistent difference with gender, although for the oldest age group of 65 to 74 years the delay was greater for women compared with men, 25% of older men delayed for more than 4 h compared with 31% for women.
Yes. Study found that typical pain was more common in men than in women with MI, hence women were more likely to experience atypical symptoms. Up to age 65 years there was no gender difference in time between onset of symptoms of MI and medical presence, thereafter women sought medical attention later than men.

Effect due to factor in study?
Yes

Consistency of results with other studies?
Consistent

Directly applicable to guideline population?
Not unselected chest pain population, however MI population is subset of this, therefore cohort is applicable as subset of the chest pain guideline population

Internal Validity
Not addressed

Differences between men and women in terms of clinical features of ST-segment elevation acute myocardial infarction

Kosuge M;Kimura K;Ishikawa T;Ebina T;Hibi K;Tsukahara K;Kanna M;Iwahashi N;Okuda J;Nozawa N;Ozaki H;Yano H;Nakat T;Kusama I;Umemura S;

Ref ID 25382 Circulation Journal 222 to 226 2006

Study Type Cohort
Funding Not reported

Number of participants 457 patients (106 women and 351 men)

Inclusion/Exclusion Criteria
Inclusion patients with STEMI with symptom onset within 24 h of admission to the coronary care unit and detailed medical history. Acute MI defined as elevation of greater than 2 mmm at least 2 contiguous precordial leads or ST elevation of greater than 1 mm in at least 2 inferior leads (II, III, or a VF), and a typical increase in serum creatine kinase.

Patient Characteristics
Patients with STEMI within 24 h after symptom onset, 457 patients (106 women and 351 men)

Recruitment Consecutive recruitment from a coronary care unit

Setting Coronary care unit in Japan

Interventions/ Test/ Factor being investigated Signs and symptoms, and risk factors

Comparisons Men versus women, signs and symptoms and risk factors

Length of Study/ Follow-up Not applicable

Outcome measures studied Location of pain, nausea, shortness of breath, risk factors

Results The study found that women were older than men (72 versus 62 years, respectively, P < 0.001), had higher rates of hypertension (51% versus 38%, respectively, P = 0.017), diabetes (36% versus 26%, respectively, P = 0.047) and hyperlipidaemia (51% versus 38%, respectively, P = 0.019). Women were also likely to experience atypical symptoms compared with men. For women versus men, pain was more common in the jaw (9% versus 3%, respectively P = 0.047) throat and neck (13% versus 5%, respectively P = 0.007), left shoulder, left arm, forearm and/or hand (12% versus 5%, respectively P = 0.024) and back (24% versus 12%, respectively P = 0.047). Women were also more likely to experience milder pain compared with men (20% versus 7%, respectively P > 0.001), and nausea (49% versus 36%, respectively P = 0.047); vomiting (25% versus 15%, respectively P = 0.08), and shortness of
women, although in hospital mortality was significantly higher in women than in men (6.6% versus 1.4%, respectively P = 0.003).

<table>
<thead>
<tr>
<th>Safety and adverse effects</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the study answer the question?</td>
<td>Yes. Study found that women have atypical presentation of STEMI compared with men, and higher rates of hypertension, diabetes and hyperlipidaemia compared with men.</td>
</tr>
<tr>
<td>Effect due to factor in study?</td>
<td>Yes</td>
</tr>
<tr>
<td>Consistency of results with other studies?</td>
<td>Consistent</td>
</tr>
<tr>
<td>Directly applicable to guideline population?</td>
<td>Not unselected chest pain population, however STEMI population is subset of this, therefore cohort is applicable as subset of the chest pain guideline population</td>
</tr>
<tr>
<td>Internal Validity</td>
<td>Adequately addressed</td>
</tr>
</tbody>
</table>
Grading:  2-

Case–control or cohort studies with a high risk of confounding bias, or chance and a significant risk that the relationship is not causal

Are there gender differences in patients presenting with unstable angina?

Ref ID 1204 International journal of cardiology 281 to 286 2000

Study Type Cohort

Number of participants 313, 210 (67%) men, 103 (33%) women

Inclusion/Exclusion Criteria Patients transferred to St Georges Hospital London UK, with a view to coronary angiography and further management, during a 42 month period (January 1994-January 1997)

Patient Characteristics The mean age for men was 61.6±11 years, for women 63.5±10.5 years (P=0.14). 184 men were Caucasian, 23 were Asian (Indian subcontinent) and 3 had other ethnic origin. 83 women were Caucasian, 15 were Asian (Indian subcontinent) and 5 had other ethnic origin (P=0.4)

Recruitment Patients transferred to tertiary care unit

Setting St Georges Hospital, London, UK

Interventions/Test/Factor being investigated Gender differences in patients presenting with unstable angina

Comparisons Retrospective review of case notes of risk factors for men and women referred for coronary angiography and further care

Length of Study/Follow-up Review of case notes

Outcome measures studied Differences in risk factors for men and women with unstable angina

Results The mean age was 61.6±11 years for men and 63.5±10.5 for women (P=0.14). 184 men were Caucasian, 23 were Asian (Indian subcontinent) and 3 had other ethnic origin. 83 women were Caucasian, 15 were Asian (Indian subcontinent) and 5 had other ethnic origin (P=0.4).

51% of men and 39% of women had a history of previous MI (P=0.06).

76% of men and 79% of women had angina pectoris (P=0.73).

Time to seeking help: <1 day - 23% men, 28% women; 1-7 days - 38% men, 33% women; >1 week: 39% men, 39% women.

17% of men and 6% of women had a previous coronary artery bypass graft operation (P=0.013).

56% of men and 64% of women had hypercholesterolemia (P=0.23).

The mean total serum cholesterol concentration was 6.4±1.6 mmol/l in men and 6.7±1.5 mmol/l in women (P=0.4).

42% of men and 49% of women had a family history of ischaemic heart disease (P=0.28).

11% of men and 23% of women had diabetes mellitus (P=0.007).

32% of men and 52% of women had a history of hypertension (P=0.001).

73% of men and 46% of women were current or previous smokers (P=0.00001).

25% of men and 40% of women were current smokers (P=0.06).

The study also considered the management of patients, a similar number of men and women underwent coronary artery bypass graft operation and coronary angioplasty.

Safety and adverse effects Not applicable

15 September 2009 Page 78 of 199
The results found that more men than women with unstable angina were referred for coronary angiography reflecting the higher prevalence of ischaemic heart disease in men.

There was no significant difference between men and women in age, the ratio of Caucasian to non-Caucasian patients, past history of angina pectoris, the duration of time before seeking medical help, mean total serum cholesterol level, family history of ischaemic heart disease. The prevalence of hypercholesterolemia was higher in women but it was not significant. Women were more likely to have diabetes mellitus, a history of hypertension and to currently smoke. Men were more likely to have a history of previous MI, history of previous coronary artery bypass graft operation and a history of smoking.

The study also considered the subsequent management of patients, and showed that the subsequent management of patients was not influenced by their gender. A similar proportion of male and female patients underwent coronary artery bypass graft operation and coronary angioplasty.

Does the study answer the question?

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity

Not addressed
Question: In adults presenting with acute chest pain/discomfort of suspected cardiac origin, what is the clinical and cost effectiveness of giving oxygen compared with a placebo?
Grading: 1+ Well-conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias

Meme Wijesinghe; Kyle Perrin; Anil Ranchord; Mark Simmonds; Mark Weatherall; Richard Beasley;

The routine use of oxygen in the treatment of myocardial infarction: systematic review

Study Type Systematic Review

Funding No specific funding was sought for this study.

Number of participants Two RCTs

Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

This review set out to assess the effectiveness of routine oxygen in the treatment of myocardial infarction (MI) in humans (most of the available evidence on the benefits of routine oxygen in MI come from animal studies). The primary outcome variable was in-hospital mortality. Only two studies met the inclusion criteria and only one included mortality as an outcome. The latter study included 200 patients with suspected MI (43 patients in whom MI was not subsequently confirmed were excluded from the analysis). There were 9/80 (11.3%) deaths in the oxygen group and 3/77 (3.9%) in the air group, relative risk of death was 2.9 (95% CI 0.8 to 10.3, P=0.08).

The review concludes that there is little evidence by which to determine the efficacy and safety of high flow oxygen therapy in MI. The evidence that does exist suggests that routine oxygen may result in a greater infarct size and possibly increase the risk of mortality.

Effect due to factor in study?

Consistency of results with other studies?
Directly applicable to guideline population?

Internal Validity

Nicholson C;

A systematic review of the effectiveness of oxygen in reducing acute myocardial ischaemia

Ref ID 71 Journal of Clinical Nursing pg 996 to 1007 2004

Study Type Systematic Review Funding not reported
Number of participants 9 Controlled clinical trials (2 randomised and 7 non randomised)

Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

A systematic review (SR) on the effectiveness of oxygen in reducing acute myocardial ischaemia identified 9 studies; 2 randomised controlled trials (RCT(s)) and 7 case control studies (Nicholson 2004). The intervention was oxygen of any flow rate or delivery method (excluding hyperbaric oxygen). The studies identified had a combined total of 463 patients, of which 93 were women and 37 which had no gender stated. Of the 7 studies that reported age, the ranges and the means were comparable. Seven out of 9 studies reported haemodynamic data. The data synthesis of the SR found that oxygen administration resulted in; an unchanged heart rate but a fall in stroke volume and cardiac volume, a rise in systemic vascular resistance, and either a slight rise or no change in arterial blood pressure.

Five of the 9 studies reported metabolic data. Lactate levels were measured in 2 studies; one found oxygen reduced lactate levels in the patients tested, while the second study found no change with oxygen. Two studies examined lactate extraction ratios, one showing oxygen had no effect and the other indicating that ratios were worse with oxygen administration. Another study found oxygen administration resulted in an increase in the cardiac enzyme aspartate aminotransferase.

Electrocardiogram data were reported in 3 of the 9 studies. Two examined ST-depression, one study found that oxygen did not prevent the onset of ischaemic changes, and the other found oxygen administration was not associated with any changes to the ST-segment. The third study used a 49-lead precordial electrocardiogram mapping technique and noted occurrences of ST-elevation and the sum of all ST-segment elevation. ST-elevation is usually ascribed to injury-infarction and this study may not have measured the same effect as the other studies using electrocardiogram data. This third study found oxygen administration reduced both the number of elevated ST-segments and the sum of all the elevation.
None of the studies reported any respiratory side effects, and only one study reported any side effect which was nausea as a reason for withdrawal from oxygen administration (Nicholson 2004). The author of the SR concluded that there was a lack of strong evidence for using oxygen as a treatment of acute myocardial infarction (MI), although it was recognised that all patients with systemic hypoxaemia should have this corrected by oxygen administration.

**Effect due to factor in study?**

**Consistency of results with other studies?**

**Directly applicable to guideline population?**

**Internal Validity**

Rawles JM; Kenmure AC;

Controlled trial of oxygen in uncomplicated myocardial infarction

Ref ID 2303 Br Med J 1121-1123 1976

**Study Type** Randomised Controlled Trial  **Funding** Not reported

**Number of participants** 200 patients were included; 105 were randomised to receive oxygen, 95 to receive air

**Inclusion/Exclusion Criteria**

Patients were under 65 who were admitted to the coronary care unit where the admitting medical officer suspected the patient to have had a MI in the previous 24 hours. Patients were excluded if they had clinical evidence of right or left heart failure, chronic bronchitis or emphysema or breathlessness from any other cause or if the has been transferred from other wards for treatment of arrhythmias or had undergone a cardiac arrest before admission or had suffered from cardiogenic shock.

**Patient Characteristics**

Those without confirmation of an MI:

Air group –
Number of patients 18
Number of men 17
Mean age 50.8 ± 2.4

Oxygen group –
Number of patients 25
Number of men 19
Mean age 51.3 ± 1.7

Those with a confirmed MI:

Air group –
Number of patients 77
Number of men 61
Mean age 56.4 ± 0.8

Oxygen group –
Number of patients 80
Number of men 63
Mean age 55.1 ± 0.9

**Recruitment**

Patients admitted to the coronary care unit at Aberdeen Royal Infirmary which met the inclusion criteria.

**Setting**

Hospital - Coronary Care Unit

**Interventions/ Test/ Factor being investigated**

Oxygen or compressed air as given through an MC mask at a flow rate of 6 L/min for 24 hours.
The comparison is between receiving oxygen and air. Patients were followed up for 24 hours.

In all patients: ECG, serum aspartate aminotransferase level, Pao2, stay in hospital, number of patients given diamorphine and the number of doses. Patients with confirmed MI: arrhythmias, heart rate and PEP/LVET.

Results

Those without confirmation of an MI:

<table>
<thead>
<tr>
<th></th>
<th>Air group</th>
<th>Oxygen group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>Mean Pao2 (kPa)</td>
<td>11.2 ± 0.17</td>
<td>23.7 ± 1.32</td>
</tr>
<tr>
<td>Mean stay in hospital (d)</td>
<td>9.9 ± 1.6</td>
<td>11.1 ± 1.3</td>
</tr>
<tr>
<td>No. Pts given diamorphine</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Mean no. doses of diamorphine</td>
<td>2.7 ± 0.9</td>
<td>1.4 ± 0.2</td>
</tr>
<tr>
<td>Mean serum aspartate aminotransferase level (IU/ml)</td>
<td>18.3 ± 3.0</td>
<td>15.8 ± 1.1</td>
</tr>
</tbody>
</table>

Those with a confirmed MI:

<table>
<thead>
<tr>
<th></th>
<th>Air group</th>
<th>Oxygen group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>77</td>
<td>80</td>
</tr>
<tr>
<td>Mean Pao2 (kPa)</td>
<td>8.7 ± 0.29</td>
<td>18.2 ± 1.56</td>
</tr>
<tr>
<td>Mean stay in hospital (d)</td>
<td>14.9 ± 0.6</td>
<td>16.2 ± 0.6</td>
</tr>
<tr>
<td>No. Pts given diamorphine</td>
<td>52</td>
<td>57</td>
</tr>
<tr>
<td>Mean no. doses of diamorphine</td>
<td>2.0 ± 0.2</td>
<td>2.1 ± 0.2</td>
</tr>
<tr>
<td>Mean serum aspartate aminotransferase level (IU/ml)</td>
<td>80.7 ± 6.6</td>
<td>99.9 ± 7.1</td>
</tr>
<tr>
<td>Mean heart rate/min</td>
<td>72.7 ± 1.7</td>
<td>77.0 ± 1.7</td>
</tr>
<tr>
<td>Mean PEP/LVET day 1</td>
<td>0.43 ± 0.04</td>
<td>0.35 ± 0.03</td>
</tr>
<tr>
<td></td>
<td>day 2</td>
<td>0.44 ± 0.06</td>
</tr>
</tbody>
</table>

Number of patients with arrhythmias after MI

<table>
<thead>
<tr>
<th></th>
<th>Air group</th>
<th>Oxygen group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrial ectopics</td>
<td>35</td>
<td>34</td>
</tr>
<tr>
<td>Mean frequency/min (when present)</td>
<td>0.44 ± 0.22</td>
<td>0.45 ± 0.16</td>
</tr>
<tr>
<td>Atrial tachycardia</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Atrial flutter</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Sinus tachycardia</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td>Sinus bradycardia</td>
<td>36</td>
<td>26</td>
</tr>
<tr>
<td>Junctional rhythm</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Accelerated idioventricular rhythm</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Ventricular ectopics</td>
<td>62</td>
<td>72</td>
</tr>
<tr>
<td>Mean frequency/min (when present)</td>
<td>0.57 ± 0.12</td>
<td>0.42 ± 0.08</td>
</tr>
<tr>
<td>Ventricular tachycardia</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Ventricular fibrillation</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Heart block 1o</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>2o</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>3o</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Safety and adverse effects

Those who received oxygen had an increase in sinus tachycardia, Pao2, serum aspartate aminotransferase. There were 12 deaths in total, 9 in the oxygen group and 3 in the air group. 3 of the deaths occurred during treatment 1 was receiving oxygen and 2 were receiving air.

Does the study answer the question?

The paper does start to address the key clinical question; it highlights several effects giving oxygen has to patients. The paper shows there is a significant increase in the sinus tachycardia for those who received oxygen compared to those who received air. The paper also showed that the serum aspartate aminotransferase level is significantly higher in the oxygen group than the air group. The paper shows that giving oxygen does not reduce to number arrhythmias, nor does it affect the number of mortalities or give rise to an improvement in left ventricular function.

The paper suggests that giving oxygen may be harmful and does not appear to give a beneficial effect. It suggests that oxygen should not be given routinely but instead should be given to those with obvious hypoxia.
Internal Validity

Patients changed to oxygen were included in result

Effect due to factor in study?

Patients were also able to receive diamorphine, which could have affect results, however it is likely that the intervention of oxygen was most likely to have caused the results of the study.

Consistency of results with other studies?

No other comparable studies

Directly applicable to guideline population?

Correct intervention and population

Internal Validity

Patients changed to oxygen were included in result

Wilson AT; Channer KS;

Hypoxaemia and supplemental oxygen therapy in the first 24 hours after myocardial infarction: the role of pulse oximetry

Ref ID: 1796 J R Coll Physicians Lond 657 to 661 1997

Study Type

Randomised Controlled Trial

Funding

Unknown

Number of participants

22 in group 1 receiving continuous oxygen post MI at 4 litres per minute by face mask; 20 in group 2 receiving no supplemental oxygen except for central cyanosis or respiratory distress.

Inclusion/Exclusion Criteria

50 consecutive patients with acute MI admitted to the coronary care unit at the Royal Hallamshire Hospital participate within six hours of the onset of thrombolytic therapy. Patients with central cyanosis, pulmonary disease requiring oxygen independent of the cardiac status or those in whom blood gas estimation showed a pCO-2 > 5.5 kPa and patients with left ventricular failure requiring inotrope support were excluded.

Patient Characteristics

There were 25 men and 17 women in the study. The two groups were comparable for the number of smokers (5 and 7 respectively), diabetics (2 and 2) and mean ages (64 and 65 years).

Recruitment

The subjects were consecutive patients with acute MI admitted to the coronary care unit at the Royal Hallamshire Hospital.

Setting

Royal Hallamshire Hospital, England

Interventions/ Test/ Factor being investigated

The incidence and degree of hypoxaemia in patients with acute MI was studied to assess the use of pulse oximetry and supplemental oxygen therapy in the first 24 hours after MI

Comparisons

A comparison is made between the use of continuous oxygen at 4 litres per minute and no oxygen therapy. All subjects were monitored with pulse oximetry through the first 24 hours post MI.

Length of Study/ Follow-up

24 hours

Outcome measures studied

Oxygen saturation (SpO-2) and arrhythmias and ST segment changes were measured.

Results

Twenty of the 42 (48%) patients had periods of at least moderate hypoxaemia (SpO-2 <90%) and 8 (19%) patients had severe hypoxaemia (SpO-2 <80%). Seven of the 8 severely hypoxaemic patients were in group 2 (p<0.05) which received no supplemental oxygen and were clinically undetected in all but one case (pO-2 71%). There were no significant differences in the prescription of opiates between groups.

The postal survey revealed the following: 105 units (51%) did not use routine oxygen yet 81 (77%) of these had a pulse oximeter. Only 3% said they measured oxygen saturation in all patients although 14% said they measured if blood gases were poor. In 93 units (45%) oxygen therapy was routinely given and pulse oximetry was available in 76 (80%) of these. However, oxygen saturation was routinely measured in only 6% and measured in 8% when indicated by
poor arterial blood gases.

<table>
<thead>
<tr>
<th>Safety and adverse effects</th>
<th>None reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the study answer the question?</td>
<td>This study demonstrates that hypoxaemia in the first 24 hours after an acute MI is a frequent and predictable occurrence and that this remains undetected by the medical and nursing staff unless a pulse oximeter is used.</td>
</tr>
<tr>
<td>Effect due to factor in study?</td>
<td>This study demonstrated no statistical correlation between hypoxaemic events and adverse cardiac events but the study was too small to assess this outcome effectively. Otherwise, the results of pulse oximetry appear to be accurate.</td>
</tr>
<tr>
<td>Consistency of results with other studies?</td>
<td>With regard to adverse cardiac events there is a lack of consistency.</td>
</tr>
<tr>
<td>Directly applicable to guideline population?</td>
<td>Yes</td>
</tr>
<tr>
<td>Internal Validity</td>
<td>No control arm and no allocation concealment</td>
</tr>
</tbody>
</table>
Question: In adults presenting with chest pain, what is the clinical and cost effectiveness of pain management (e.g. sublingual and buccal nitrates, diamorphine, morphine with anti-emetic) compared with active comparators?
### Study Type
Randomised Controlled Trial

### Funding
Not reported

### Number of participants
study 1: 10 patients, study 2: 43 patients, study 3: 118 patients

### Inclusion/Exclusion Criteria
- **Inclusion**: Patients with chest pain due to suspected MI who required analgesia

### Patient Characteristics

#### study 3:
- **Buprenorphine group** - male:female ratio = 5.6:1, mean age 55 ± 10 years, mean duration of chest pain 5.5 ± 7.3 hours, previous analgesia (morphine, diamorphine or pethidine) 54%, admission heart rate 78 ± 19 beats per min, systolic blood pressure 129 ± 28 mm Hg, diastolic blood pressure 82 ± 22 mm Hg, mean AST 136 ± 154 IU/l, mean SHBD 567 ± 352 IU/l, ECG changes - anterior infarction 44%, other sites of infarction 36%, no changes of infarction 20%

- **Diamorphine group** - male:female ratio = 3.5:1, mean age 56 ± 10 years, mean duration of chest pain 7.9 ± 11.6 hours, previous analgesia (morphine, diamorphine or pethidine) 54%, admission heart rate 80 ± 23 beats per min, systolic blood pressure 127 ± 31 mm Hg, diastolic blood pressure 79 ± 24 mm Hg, mean AST 97 ± 68 IU/l, mean SHBD 544 ± 375 IU/l, ECG changes - anterior infarction 41%, other sites of infarction 34%, no changes of infarction 25%

### Recruitment
Patients admitted to the CCU with chest pain due to suspected MI

### Setting
Secondary care, England

### Interventions/ Test/ Factor being investigated
- Intravenous buprenorphine, sublingual buprenorphine, diamorphine

### Comparisons
- Intravenous buprenorphine, sublingual buprenorphine, diamorphine

### Length of Study/ Follow-up
48 hours

### Outcome measures studied
- Pain relief, need for further analgesia, systolic blood pressure, heart rate

### Results

#### Study 1
Haemodynamic studies were performed on an initial 10 patients with MI proved on ECG. All had received diamorphine previously but then required further analgesia for recurrent pain. The pulmonary artery pressure was recorded continuously before and after an intravenous injection of 0.3 mg buprenorphine, by means of a 3 F gauge polyethylene catheter inserted percutaneously via an antecubital vein. Cuff measurements of the systemic blood pressure were made at defined intervals. The ECG was monitored continuously and measurements of heart rate obtained from the ECG.

This study showed that intravenous buprenorphine had no significant effect on heart rate or systemic diastolic blood pressure. There was a sustained fall in systemic arterial systolic pressure of about 10 mmHg but this was not statistically significant.

#### Study 2

**Grading:** 1+ Well-conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias
43 patients who required analgesia in the coronary care unit were given either injections of intravenous buprenorphine or sublingual tablets. 18 received a total of 20 tablets of sublingual buprenorphine 0.4 mg, and 25 received a total of 40 injections of intravenous buprenorphine 0.3 mg as and when they needed analgesia for chest pain. In this group only systemic blood pressure and heart rate were measured and the ECGs were continuously monitored. The degree of pain relief and more particularly the time of onset of pain relief were assessed subjectively by the medical and nursing staff.

In the intravenous buprenorphine group 9 patients had complete relief after 5 minutes, a further 21 patients had complete relief after 15 minutes, a further 3 patients had complete relief after 30 minutes and 6 further patients had complete relief after 45 minutes. 1 patient reported inadequate pain relief. In the sublingual buprenorphine group 2 patients had complete relief after 5 minutes, a further 2 patients had complete relief after 15 minutes, a further 12 patients had complete relief after 30 minutes and 3 further patients had complete relief after 45 minutes. 1 patient reported inadequate pain relief.

The study showed that sublingual buprenorphine had no significant effect on systolic blood pressure and heart rate and provided good pain relief to most patients. Intravenous buprenorphine gave faster pain relief.

Study 3
120 patients who were admitted to the CCU with chest pain due to suspected myocardial infarction and who required analgesia were randomly allocated in a double-blind fashion to receive either buprenorphine 0.3 mg intravenously or diamorphine 5 mg intravenously. There were no medical contraindications for inclusion in this trial. Patients were randomised in blocks of six, the trial ampoules being prepared and issued by the General Hospital pharmacy daily because of the instability of diamorphine when in solution. After entry into the trial records were kept of the time, dose, and frequency of subsequent analgesic administration. The time, degree, and duration of pain relief were monitored using an unmarked visual analogue scale, 3 which was scored by the patient. The scale was subsequently measured and pain relief expressed as a percentage of the original score. If the patients were asleep they were left undisturbed and considered to have complete pain relief. The incidence of nausea, vomiting, and other adverse reactions was also recorded.

In the buprenorphine group 27 (49%) patients did not require further analgesia after initial dose, 12 (22%) required analgesia within 6 hours after initial dose and 16 (29%) required analgesia in 6-48 hours after initial dose.
In the diamorphine group 23 (42%) patients did not require further analgesia after initial dose, 16 (29%) required analgesia within 6 hours after initial dose and 16 (29%) required analgesia in 6-48 hours after initial dose.

Safety and adverse effects
None reported

Does the study answer the question?
This study showed that sublingual buprenorphine had no significant effect on systolic blood pressure and heart rate and provided good pain relief to most patients. However the concluded that intravenous buprenorphine gave faster pain relief. The difference in the visual pain relief during the 6 hour trial was not statistically significant between the buprenorphine and diamorphine groups. The analgesic requirements for the two groups were not significantly different either. At five minutes the percentage pain relief in the buprenorphine group was significantly less than in the diamorphine group (p<0.01), but this difference progressively diminished so that both groups were similar at 15 minutes, there was no difference in the two groups at 6 hours.

Consistency of results with other studies?
Consistent

Effect due to factor in study?
Yes

15 September 2009 Page 89 of 199
**Directly applicable to guideline population?**
Patients had chest pain due to suspected MI and required analgesia.

**Internal Validity**
No report of concealment methods.

Hew E; Haq A; Strauss H;
A randomized controlled trial of nalbuphine vs morphine in the treatment of ischemic chest pain

<table>
<thead>
<tr>
<th>Ref ID</th>
<th>Current Therapeutic Research - Clinical and Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>3362</td>
<td>394 to 402 1987</td>
</tr>
</tbody>
</table>

**Study Type**
Randomised Controlled Trial

**Funding**
Not reported

**Number of participants**
24 patients received nalbuphine, 29 received morphine

**Inclusion/Exclusion Criteria**
inclusion: moderately severe to severe pain unresponsive to sublingual nitroglycerin and a suspected diagnosis of MI or unstable angina. Exclusion: heart rate less than 50 beats per minute, systolic blood pressure less than 90 mmHg, cardiac shock, acute or chronic renal failure, valvular heart disease, signs of right or left ventricular failure, pulmonary oedema, patient is a or suspected of being a drug user.

**Patient Characteristics**
In the nalbuphine group 3 were female, mean age was 60 years old. The mean pain was 5.5 ± 0.5, the mean systolic blood pressure was 134.5 ± 4.4 mmHg, diastolic blood pressure was 82.2 ± 2.8, the mean respiratory rate was 19.7 ± 0.6 breaths/min, the mean heart rate was 71.3 ± 3.9 beats/min, the concomitant of treatments were 7 patients had nitroglycerin infusion, 1 patient had antiarrhythmic, 1 patient had beta-blocker, 2 patients had calcium-channel blocker.
In the morphine group 9 were women, mean age 62.2 years old. The mean pain was 6.3 ± 0.4, the mean systolic blood pressure was 142.6 ± 5.3 mmHg, diastolic blood pressure was 80.1 ± 2.6, the mean respiratory rate was 20.7 ± 0.7 breaths/min, the mean heart rate was 74.1 ± 3.2 beats/min, the concomitant of treatments were 7 patients had nitroglycerin infusion, 2 patients had antiarrhythmic, 0 patients had beta-blocker, 0 patients had calcium-channel blocker.

**Recruitment**
Patients with ischemic chest pain admitted to 2 hospitals in Canada.

**Setting**
Secondary care (2 hospitals), Canada

**Interventions/ Test/ Factor being investigated**
10 mg morphine or 20mg nalbuphine

**Comparisons**
10 mg morphine or 20mg nalbuphine

**Length of Study/ Follow-up**
2 hours

**Outcome measures studied**
pain relief

**Results**
Complete pain relief:
- At 5 minutes – 21% on morphine, 42% on nalbuphine
- At 15 minutes – 31% on morphine, 54% on nalbuphine
- At 30 minutes – 34% on morphine, 54% on nalbuphine
- At 60 minutes – 48% on morphine, 58% on nalbuphine
- At 120 minutes – 55% on morphine, 67% on nalbuphine

The mean pain scores for nalbuphine group were consistently lower than for the morphine group. The difference in scores was greatest after 5 minutes (nalbuphine = 1.88, morphine = 3.48), however the difference was not significant (F = 3.07, P = 0.08). The mean pain relief scores and the sum of the pain relief scores consistently favoured nalbuphine with the greatest difference at 5 minutes but were not significantly different (F = 2.83, P = 0.10). Neither group had a significant change in either systolic or diastolic blood pressure (F = 1.45, P >0.21). The mean heart rate did not change significantly for either group (F = 1.82, P = 0.11).
Safety and adverse effects

There were 81 unpleasant or unusual side effects reported. In the morphine group 62% reported at least 1 side effect, compared to 75% in the nalbuphine group. The mean number of complaints in the morphine group was 1.5 and in the nalbuphine group was 1.6. There was no statistically significant difference in the incidence of any complaint, including drowsiness and dry mouth which was observed.

Adverse events: (number of patients)
- Drowsiness – 4 on morphine, 9 on nalbuphine
- Dizziness – 8 on morphine, 4 on nalbuphine
- Nausea – 5 on morphine, 6 on nalbuphine
- Dry mouth – 6 on morphine, 1 on nalbuphine
- Headache – 6 on morphine, 1 on nalbuphine
- Diaphoresis – 2 on morphine, 2 on nalbuphine
- Nervousness – 2 on morphine, 1 on nalbuphine
- Hypotension – 1 on morphine, 2 on nalbuphine
- Burning at injection site – 2 on morphine, 1 on nalbuphine
- Vomiting – 1 on morphine, 1 on nalbuphine
- Euphoria – 0 on morphine, 2 on nalbuphine
- Depressed – 1 on morphine, 1 on nalbuphine
- Urticaria – 1 on morphine, 1 on nalbuphine
- Bradycardia – 0 on morphine, 2 on nalbuphine
- Other – 4 on morphine, 4 on nalbuphine

Does the study answer the question?

None of the differences were statistically significant, the trend favoured nalbuphine. The greatest difference was seen at 5 minutes. The author states that the ideal analgesic should provide prompt relief from pain and anxiety without adversely affecting hemodynamic or respiratory function, this study suggests that nalbuphine fulfils this and should be considered as an alternative to morphine.

Effect due to factor in study?

Yes

Consistency of results with other studies?

Consistent

Directly applicable to guideline population?

Patients had moderately severe to severe pain due to suspected MI or unstable angina and unresponsive to sublingual nitroglycerin

Internal Validity

Jamidar HA CSAA;

Nalbuphine versus diamorphine early in the course of suspected myocardial infarction

Ref ID 4222 Eur Heart J 597 to 602 1987

Study Type Randomised Controlled Trial

Funding Dr J Beets and Dupont supplied the Nalbuphine

Number of participants 176 in total; 87 received Nalbuphine, 89 received Diamorphine

Inclusion/Exclusion Criteria

Inclusion: patients with moderate or severe pain of suspected AMI who have not received previous analgesia

Patient Characteristics

In the Nalbuphine group:
The mean age was 60.5 years, 41% were women, 43% smoked, 30% were ex-smokers. 2% had diabetes, 21% had previous hypertension. 13% had previous severe angina, 29% had previous moderate angina, 20% had previous mild angina. 8% had more than 2 previous Mls, 14% had 2 previous Mls, 29% had 1 previous MI, 49% had had no previous MI.

In the Diamorphine group:
The mean age was 62.2 years, 34% were women, 35% smoked, 25% were ex-smokers. 9% had diabetes, 25% had previous hypertension. 18% had previous severe angina, 10% had previous moderate angina, 29% had previous mild angina. 8% had more than 2 previous Mls, 6% had 2 previous Mls, 26% had 1 previous MI, 60% had had no previous MI. NOTE one person died before a full history could be taken (smoking and previous MI data missing)
<table>
<thead>
<tr>
<th>Recruitment</th>
<th>Patients admitted with moderate or severe chest pain of a suspected acute MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting</td>
<td>Royal Victoria Hospital, Belfast, Northern Ireland</td>
</tr>
<tr>
<td>Interventions/ Test/ Factor being investigated</td>
<td>≤ 20 mg nalbuphine or ≤ 5 mg diamorphine intravenously with 10 mg metoclopramide</td>
</tr>
<tr>
<td>Comparisons</td>
<td>between ≤ 20 mg nalbuphine or ≤ 5 mg diamorphine intravenously with 10 mg metoclopramide</td>
</tr>
<tr>
<td>Length of Study/ Follow-up</td>
<td>2 hours</td>
</tr>
<tr>
<td>Outcome measures studied</td>
<td>pain relief at set times</td>
</tr>
<tr>
<td>Results</td>
<td>The differences in baseline characteristics were not statistically significant (P=&gt;0.05). Pain was recorded at 10 minutes, 30 minutes, 60 minutes and 120 minutes. At 10 minutes 77% of the nalbuphine group and 68% of the diamorphine group had satisfactory pain relief; 44% of the nalbuphine group and 39% of the diamorphine group had complete pain relief. Satisfactory pain relief (grade 0 or 1 pain) was similar for both groups during each time assessment. So there was no significant difference between the two groups for total pain relief. The average pain score at each time interval was similar for both groups. The number of doses of each drug given over the 120 minutes were comparable (n 114 + SD 0-4, d 1-28±SD 0-5). Of those withdrawn from the trial (two doses of the test drug without satisfactory pain relief) 6 patients had received diamorphine and 11 nalbuphine. This difference was not statistically significant. Pain recurred after satisfactory pain relief in 2 patients who had received diamorphine and in 5 who had received nalbuphine. There were no significant differences for heart rate, systolic and diastolic blood pressures between the two groups throughout the 120 minute observation period. Only one patient in the nalbuphine group and 3 in the diamorphine group required atropine and only 2 in the nalbuphine group and 2 in the diamorphine group received beta-blockers intravenously during the trial period. The numbers with cardiac failure initially and at 120 minutes showed no significant differences for the two groups. There were no significant differences between the two groups for mean peak CK, AST and LDH. Seven patients received streptokinase and their enzyme levels were excluded from analysis.</td>
</tr>
<tr>
<td>Safety and adverse effects</td>
<td>Dizziness, nausea and vomiting was infrequent but occurred in both groups. In the Nalbuphine group: 16% had dizziness, 14% had nausea and vomiting, 10% had other side effects, 1% died (1 patient). In the Diamorphine group: 17% had dizziness, 16% had nausea and vomiting, 7% had other side effects, 8% died (7 patients).</td>
</tr>
<tr>
<td>Does the study answer the question?</td>
<td>Yes</td>
</tr>
<tr>
<td>Effect due to factor in study?</td>
<td>Consistent</td>
</tr>
<tr>
<td>Consistency of results with other studies?</td>
<td>Directly applicable to guideline population?</td>
</tr>
<tr>
<td>Internal Validity</td>
<td>patients were withdrawn for further pain relief</td>
</tr>
</tbody>
</table>
Morphine use and pharmacokinetics in patients with chest pain due to suspected or definite acute myocardial infarction

**Ref ID**: 2966

**European Journal of Pain**

**Funding**: Swedish Medical Research Council and Medical Faculty, University of Goteborg and Bohuslandstinget

**Study Type**: Cohort

**Number of participants**: 2988

**Inclusion/Exclusion Criteria**

Patients had chest pain or symptoms suggestive of AMI. Patients had to have a confirmed or suspected AMI or myocardial ischaemia and were hospitalised and stayed for more than 1 day.

**Patient Characteristics**

The mean age was 69.3 ± 0.23 years (range 18-101 years), 40.2% were women. 921 patients developed an MI, 357 had a possible MI, 419 had myocardial ischaemia, 1291 had possible myocardial ischaemia.

**Recruitment**

Patients with chest pain or symptoms suggestive of AMI admitted to CCU in Sweden

**Setting**

Secondary care, Sweden

**Interventions/ Test/ Factor being investigated**

10mg morphine hydrochloride intravenously over one minute

**Comparisons**

Pain relief after being given 10mg morphine hydrochloride intravenously over one minute

**Length of Study/ Follow-up**

3 days

**Outcome measures studied**

Pain, morphine requirement

**Results**

The average pain intensity was 6.6±0.6 on the Numerical Rating Scale (NRS) before the morphine injection. There was rapid pain relief (6.9±11% after 20 minutes) after the morphine injection. After 20 minutes, a nadir was obtained where NRS ranged between 0 and 3 units. 7 out of 10 patients reported being pain free at one or more measurement point during the first 3 hours following morphine injection. However 3 patients needed supplementary analgesic treatment with meperidine and 1 patient was given metoprolol. 5 patients required diuretics but no patients were given thrombolysis or nitrates.

The patient characteristics which were associated with higher morphine requirements were: gender (female) P = <0.0455, history of angina pectoris P = <0.0001, previous CHF P = <0.0001, initial degree of suspicion of AMI P = <0.0001, presence of ST elevation on entry ECG P = <0.0001, presence of ST depression on entry ECG P = <0.0004, Q wave on entry ECG P = <0.0015.

The mean systolic/diastolic blood pressure at arrival at the CCU was 143±9.9/91±4.6mm Hg. After intravenous morphine administration there was a significant reduction in the diastolic blood pressure but a similar but non-significant trend in systolic blood pressure. Heart rate was 86±5.1 beats/minute on admission and tended to be reduced during the observation period after intravenous morphine. Respiratory frequency remained unchanged in all patients.
<table>
<thead>
<tr>
<th>Safety and adverse effects</th>
<th>None reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the study answer the question?</td>
<td>The study showed that there was rapid pain relief 20 minutes after the morphine injection with 7 out of 10 patients reporting complete pain relief at 1 or more measurement points during the 3 hours observation. There were certain patient characteristics associated with higher morphine requirement: gender (female), history of angina pectoris, previous CHF, initial degree of suspicion of AMI, presence of ST elevation on entry ECG, presence of ST depression on entry ECG, Q wave on entry ECG. The authors concluded that when intravenous morphine is given it has full effect after 20 minutes. The authors also concluded that the need for morphine administration in patients with confirmed or suspected AMI differed among subgroups, in particular those with a strongly suspected AMI required higher doses of morphine.</td>
</tr>
<tr>
<td>Effect due to factor in study?</td>
<td>Yes</td>
</tr>
<tr>
<td>Consistency of results with other studies?</td>
<td>Consistent</td>
</tr>
<tr>
<td>Directly applicable to guideline population?</td>
<td>Pains had chest pain or symptoms suggestive of AMI</td>
</tr>
<tr>
<td>Internal Validity</td>
<td>Well covered</td>
</tr>
</tbody>
</table>
Safety of pre-hospital therapy with morphine sulfate

Study Type: Cohort
Number of participants: 84 patients

Inclusion/Exclusion Criteria: patients who received morphine sulphate in a prehospital setting

Patient Characteristics: the mean age was 68 years, 40 patients were male 39 were female and 5 patients did not have their sex documented

Recruitment: patients who the paramedics assessed as having ischaemic chest pain or pulmonary edema, which was agreed by a doctor at the base hospital were given intravenous morphine sulphate in 2mg increments along with other therapies according to treatment protocol

Setting: Paramedics, San Francisco, USA

Interventions/ Test/ Factor being investigated: safety of prehospital morphine sulphate use in an urban emergency medical system
Comparisons: The diagnosis by a paramedic and an emergency department doctor
Length of Study/ Follow-up: 6 months

Outcome measures studied: 1: Accuracy of paramedics diagnosis 2: Appropriate use of morphine sulphate 3: Side effects of appropriate and inappropriate use of morphine sulphate

Results: All patients who received morphine sulphate were included in the study. Patients who the paramedics assessed as having ischaemic chest pain or pulmonary oedema, paramedics phone through to the base hospital, where a mobile intensive care nurse and/or a doctor concurred the diagnosis. The paramedic then gave the patient intravenous morphine sulphate in 2mg increments along with other therapies according to treatment protocols. 3 private and 1 public paramedic provider agencies were included which took patients to 10 emergency departments. A total of 84 patients were given morphine sulphate.

The paramedics’ diagnosis was considered accurate in 77% of cases (65 out of 84) Paramedics diagnosed 40 patients with ischaemic chest pain, when patients were diagnosed in the emergency department - 30 had ischaemic chest pain, 4 had ischaemic chest pain and pulmonary oedema, 1 had a pulmonary oedema and 5 had another diagnosis. Paramedics diagnosed 31 patients with pulmonary oedema, when patients were diagnosed in the emergency department - 23 had pulmonary oedema, 4 had ischaemic chest pain and pulmonary oedema and 4 had another diagnosis. Paramedics diagnosed 13 patients with ischaemic chest pain and pulmonary oedema, when patients were diagnosed in the emergency department – 3 had ischaemic chest pain and pulmonary oedema, 9 had a pulmonary oedema and 1 had another diagnosis. (Other diagnosis included atypical chest pain, atypical chest pain and chronic heart failure, acute bronchospasm and pneumonia)

In the 9 cases where the paramedics miss diagnosed ischaemic chest pain or pulmonary oedema 5 patients were diagnosed as ischaemic chest pain but missed a
diagnosis of pulmonary oedema and 4 patients were diagnosed as pulmonary oedema but missed a diagnosis of ischaemic chest pain.

The appropriateness of morphine sulphate administration was assessed the 9 diagnosis which missed either ischaemic chest pain or pulmonary oedema were still treated correctly with morphine sulphate. The appropriateness use of morphine sulphate was 88%.

The overall side effects rate was 6%, 3 patients had respiratory depression and 2 had hypotension. 2 of the patients who had respiratory depression were correctly diagnosed with pulmonary oedema, which can lead to respiratory depression; therefore it is unclear if the morphine sulphate caused the side effect. The other patient who had respiratory depression was diagnosed wrongly by the paramedic and had an emergency department diagnosis of pneumonia, therefore it is likely the morphine sulphate caused the respiratory depression. The 2 patients who had hypotension were both correctly diagnosed by the paramedic and it is uncertain if the morphine sulphate caused the hypotension. This shows that only 1 patient suffered an adverse event due to inappropriate use of morphine sulphate, the complication rate for this was 10%.

Safety and adverse effects

3 cases of respiratory depression, 2 cases of hypotension

Does the study answer the question?

The study showed that the paramedics' diagnosis was considered accurate in 77% of cases (65 out of 84). The appropriateness use of morphine sulphate was 88, and the overall side effects rate was 6%, the complication rate for inappropriate use of morphine sulphate was 10%.

The authors concluded that paramedics functioning with a system of base hospital direction can safely given morphine sulphate, with the inappropriate administration of morphine sulphate and complication rate being low.

Effect due to factor in study?

Yes

Consistency of results with other studies?

Consistent

Directly applicable to guideline population?

This was a mixed population including some patients with pulmonary oedema

Internal Validity

Well covered

Herlitz J; Richterova A; Bondestam E; Hjalmarson A; Holmberg S; Hovgren C;

Chest pain in acute myocardial infarction: a descriptive study according to subjective assessment and morphine requirement

Ref ID 1168 Clin Cardiol 423 to 428 1986

Study Type Cohort

Funding Swedish Medical Research Council, the Swedish National Association against Heart and Chest Disease, the Goteborg Medical Society, AB Hassle subsidiary of Astra Pharmaceuticals

Number of participants 653 patients

Inclusion/Exclusion Criteria

Patients admitted to the CCU with suspected acute MI admitted between 1st May 1983 and 31st May 1984.

Patient Characteristics

The age range was 33-92 years with the median being 70 years. 38.3% were women, 47.1% were aged over 70 years, 39.2% had had a previous infarction, 59.4% had angina pectoris, 36.2% had hypertension, 21.2% had congestive heart failure, 24.5% had furosemide before admission, 38.6% had beta blockers before admission,
10.2% had Ca antagonists before admission.

Recruitment
Patients who were admitted to the CCU with suspected AMI were evaluated for inclusion.

Setting
Patients home and hospital

Interventions/ Test/ Factor being investigated
Patients pain and analgesic requirement

Comparisons
Pain at home and in hospital

Length of Study/ Follow-up
3 days

Outcome measures studied
visual pain score, narcotic analgesic requirement

Results
The study recorded patient's pain by a visual scale of 0-10 as reported by the patients (0 being no pain and 10 being worst pain imaginable). The pain scores recorded were the maximum pain at home (recorded once admitted to CCU) and every two hours for 6 hours after admission to CCU. If patients were asleep at the time of recording a score of 0 was reported. Patients were given morphine intravenously for severe pain and nitroglycerine sublingually for less severe pain interpreted as angina pectoris; where patients were given analgesics the pain score was increase by 2. MI was confirmed in 45% of patients and possible MI in 11.9%.

Mean maximum score at home
Patients with defined MI: 7.5
Patients with possible MI: 6.6
Patients with ischemia: 6.9
Patients with no ischemia: 5.9

Mean pain score during the first 6 hours (h) after arrival at CCU
Patients with defined MI: on arrival 2.3, after 2h 1.4, after 4h 1.1, after 6h 0.9
Patients with possible MI: on arrival 1.2, after 2h 0.7, after 4h 0.6, after 6h 0.4
Patients with ischemia: on arrival 1.4, after 2h 0.8, after 4h 0.6, after 6h 0.7
Patients with no ischemia: on arrival 1.6, after 2h 0.9, after 4h 0.6, after 6h 0.7

Safety and adverse effects
None reported

Does the study answer the question?
The study showed that for pain at home there were small differences in the mean pain scores between the groups of patients. For those with an MI the maximum pain score was 7.5±0.2 where as for those without an MI the maximum pain score was 6.6±0.2 (P<0.001). The study showed that for pain in the CCU the maximum mean score had reduced to 1.8 for all patients compared to 7.0 maximum mean score for all patients at home. The study also showed that 98% of patients had chest pain at home, but only 51% had pain on arrival at the CCU. Figure 1 (see narrative for question 17; figure 1: Herlitz et al, 1986) shows the course of pain after arrival at the CCU.

The authors commented that narcotic analgesics were given to 10% of patients after the end of recording pain scores and during the 3 day study 27.4% of patients were given nitroglycerine sublingually.

The authors of the study concluded that patients generally had worse pain at home than in the CCU. The mean pain score values show a trend of rapid decline in pain after arrival in the CCU, although there was variability in the intensity and duration of chest pain. The authors commented that there was a low difference in the pain scores between those having an MI and those who were not.

Effect due to factor in study?
Yes

Consistency of results with other studies?
No other studies compare at home to hospital pain management
Directly applicable to guideline population? Patients had suspected MI

Internal Validity Well covered

Scott ME; Orr R;

Effects of diamorphine, methadone, morphine, and pentazocine in patients with suspected acute myocardial infarction

Ref ID 10272 Lancet 1055 to 1067 1969

Study Type Cohort Funding Not reported

Number of participants 118 patients; 30 in diamorphine group, 31 in methadone group, 29 in morphine group and 25 in pentazocine group

Inclusion/Exclusion Criteria Included: patients initially assessed to have moderate or severe pain due to suspected acute MI. Excluded: patients who had cardiac shock, cardiac failure, severe nausea, pronounced bradycardia, who have received a potent analgesic or an anti-emetic in previous 4 hours

Patient Characteristics 25% were women, the age range was 30-79 years old, with 79% of patients aged between 50-69 years old. 36% of the patients had acute myocardial ischaemia rather than definite infarction. There was no significant difference in the sex-distribution, age, previous history of MI among the 4 treatment groups.

Recruitment Patients who were admitted to the cardiac department, Royal Victoria Hospital, Belfast, Northern Ireland, who were initially assessed to have moderate or severe pain due to suspected acute MI

Setting Secondary care, Northern Ireland

Interventions/ Test/ Factor being investigated pain relief from analgesics

Comparisons 5 mg diamorphine or 10 mg methadone, 10 mg morphine, 30 mg pentazocine

Length of Study/ Follow-up 2 hours

Outcome measures studied Pain relief at 10, 30, 60 and 120 minutes

Results For some degree of pain relief:
At 10 minutes - 90% of patients on diamorphine, 90% on methadone, 93% on morphine, 85% on pentazocine.
At 30 minutes - 87% of patients on diamorphine, 94% on methadone, 93% on morphine, 96% on pentazocine.
At 60 minutes - 87% of patients on diamorphine, 89% on methadone, 90% on morphine, 82% on pentazocine.
At 120 minutes - 90% of patients on diamorphine, 86% on methadone, 86% on morphine, 81% on pentazocine.

For complete of pain relief:
At 10 minutes - 47% of patients on diamorphine, 32% on methadone, 17% on morphine, 19% on pentazocine.
At 30 minutes - 43% of patients on diamorphine, 39% on methadone, 38% on morphine, 36% on pentazocine.
At 60 minutes - 43% of patients on diamorphine, 50% on methadone, 45% on morphine, 27% on pentazocine.
At 120 minutes - 34% of patients on diamorphine, 50% on methadone, 52% on morphine, 33% on pentazocine.

Safety and adverse effects Nausea and vomiting was similar across all groups (not statistically different). Morphine had an unexpected low number of patients with emetic sequelae
| **Does the study answer the question?** | The results show equal pain relief by all 4 drugs. Diamorphine gave complete pain relief in 10 minutes to a higher number of patients, it was significantly higher compared to morphine and pethazocine but not significantly higher compared to methadone. At 30 minutes the pain relief is similar across all 4 drugs, however at 60 minutes patients on pethazocine had lower pain relief than the other 3 groups. The authors suggest that diamorphine is the drug of choice. |
| **Effect due to factor in study?** | Yes |
| **Consistency of results with other studies?** | Consistent |
| **Directly applicable to guideline population?** | Patients had moderate or severe pain due to suspected acute MI |
| **Internal Validity** | Well covered |
Question: In adults presenting with chest pain/discomfort of acute suspected cardiac origin, what is the clinical and cost effectiveness of anti-platelet therapy (aspirin, clopidogrel alone or in combination) compared with a placebo?
### Grading: 2+
Well-conducted case–control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal

Barbash IM; Freimark D; Gottlieb S; Hod H; Hasin Y; Battler A; Crystal E; Matetzky S; Boyko V; Mandelzweig L; Behar S; Leor J;...

Outcome of myocardial infarction in patients treated with aspirin is enhanced by pre-hospital administration

<table>
<thead>
<tr>
<th>Ref ID</th>
<th>Cardiology</th>
<th>pgs.</th>
<th>141 to 147</th>
<th>2002</th>
</tr>
</thead>
</table>

### Study Type
Cohort

### Number of participants
922 patients were included in total; 338 received aspirin before admission to hospital, 584 received aspirin after admission to hospital

### Inclusion/Exclusion Criteria
INCLUDED: Patients who were admitted to hospital with acute myocardial infarction, who received aspirin treatment either before or after admission or hospital.
EXCLUDED: Those who had cardiogenic shock were excluded.

### Patient Characteristics
Aspirin before admission to hospital

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age</td>
<td>60.9 ± 13</td>
</tr>
<tr>
<td>Patients</td>
<td></td>
</tr>
<tr>
<td>&lt;59 years</td>
<td>174 (51%)</td>
</tr>
<tr>
<td>60-69 years</td>
<td>75 (22%)</td>
</tr>
<tr>
<td>&gt;70 years</td>
<td>92 (27%)</td>
</tr>
<tr>
<td>Women</td>
<td>57 (17%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>92 (27%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>136 (40%)</td>
</tr>
<tr>
<td>Hyperlipidaemia</td>
<td>159 (47%)</td>
</tr>
<tr>
<td>Current smokers</td>
<td>158 (47%)</td>
</tr>
<tr>
<td>Prior MI</td>
<td>82 (24%)</td>
</tr>
<tr>
<td>Prior angina</td>
<td>98 (29%)</td>
</tr>
<tr>
<td>Prior heart failure</td>
<td>13 (4%)</td>
</tr>
<tr>
<td>Prior PTCA</td>
<td>49 (15%)</td>
</tr>
<tr>
<td>Prior CABG</td>
<td>14 (4%)</td>
</tr>
<tr>
<td>PVD</td>
<td>24 (7%)</td>
</tr>
<tr>
<td>History of stroke</td>
<td>21 (6%)</td>
</tr>
<tr>
<td>Gastrointestinal disorder</td>
<td>31 (9%)</td>
</tr>
<tr>
<td>Typical chest pain</td>
<td>318 (94%)</td>
</tr>
<tr>
<td>MICU transport</td>
<td>230 (68%)</td>
</tr>
<tr>
<td>Anterior MI</td>
<td>159 (47%)</td>
</tr>
<tr>
<td>Spontaneous reperfusion</td>
<td>20 (5.9%)</td>
</tr>
</tbody>
</table>

Aspirin after admission to hospital

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age</td>
<td>64.5 ± 14</td>
</tr>
<tr>
<td>Patients</td>
<td></td>
</tr>
<tr>
<td>&lt;59 years</td>
<td>224 (41%)</td>
</tr>
<tr>
<td>60-69 years</td>
<td>114 (20%)</td>
</tr>
<tr>
<td>&gt;70 years</td>
<td>222 (39%)</td>
</tr>
<tr>
<td>Women</td>
<td>157 (27%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>184 (32%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>248 (43%)</td>
</tr>
<tr>
<td>Hyperlipidaemia</td>
<td>241 (42%)</td>
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<tr>
<td>Current smokers</td>
<td>222 (39%)</td>
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<tr>
<td>Prior MI</td>
<td>114 (20%)</td>
</tr>
<tr>
<td>Prior angina</td>
<td>154 (27%)</td>
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<tr>
<td>Prior heart failure</td>
<td>33 (6%)</td>
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<tr>
<td>Prior PTCA</td>
<td>51 (9%)</td>
</tr>
<tr>
<td>Prior CABG</td>
<td>11 (2%)</td>
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<tr>
<td>PVD</td>
<td>48 (8%)</td>
</tr>
<tr>
<td>History of stroke</td>
<td>51 (9%)</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td></td>
</tr>
</tbody>
</table>
disorder 74 (13%)  
Typical chest pain 469 (80%)  
MICU transport 90 (15%)  
Anterior MI 260 (45%)  
Spontaneous reperfusion 20 (3.4%)  

**Recruitment**  
Patients who were admitted to 26 coronary care units and 82 medicine wards in 26 hospitals  

**Setting**  
Hospital, ambulance & community in Israel  

**Interventions/ Test/ Factor being investigated**  
Aspirin administration - dose of >200mg chewable aspirin before or after admission to hospital  

**Comparisons**  
Aspirin being given before or after admission to hospital  

**Length of Study/ Follow-up**  
Follow up at 7 and 30 days  

**Outcome measures studied**  
Mortality, in-hospital complications, in-hospital treatments  

**Results**  
Aspirin given: before hospital after hospital P value  
All cause Mortality  
7 days 8 (2.4%) 42 (7.3%) 0.002  
30 days 16 (4.9%) 64 (11.1%) 0.001  
Re-hospitalisation  
Non-cardio 5 (13%) 23 (22%) 0.22  
Cardiovascular 59 (19%) 134 (27%) 0.02  
In-hospital complications  
Asystole 6 (2%) 39 (7%) < 0.001  
Resuscitation 12 (4%) 55 (9%) < 0.001  
Ventilation 17 (5%) 66 (11%) 0.001  

There was no significant difference in the following in-hospital complications recurrent MI, pulmonary oedema, sustained VT, primary VF, free wall rupture, ventricular septal defect, significant MR and cardiogenic shock  

In-hospital medications  
Ticlopidine / clopidogrel 84 (25%) 75 (13%) < 0.001  
IIb/IIIa antagonists 97 (29%) 120 (21%) 0.005  
Heparin 301 (90%) 466 (80%) < 0.001  
Primary reperfusion 219 (65%) 299 (51%) < 0.001  

There was no significant difference in in-hospital management in the following drug therapies: aspirin, vasopressors, β-blockers, calcium blockers, nitrates, diuretics, ACE inhibitors, angiotensin-II antagonist, lipid lowering drugs and digitalis  

In-hospital procedures  
Coronary angiography 195 (58%) 252 (44%) < 0.001  
PTCA 136 (41%) 155 (27%) < 0.001  

There was no significant difference in in-hospital management in the following procedures: CABG, intra-aortic balloon pump, pulmonary artery catheter  

<table>
<thead>
<tr>
<th>Age, years</th>
<th>Patients, n(%)</th>
<th>Primary reperfusion (n=518)</th>
<th>no primary reperfusion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early</td>
<td>Late</td>
<td>p value</td>
</tr>
<tr>
<td>0.007</td>
<td>59±12</td>
<td>60±12</td>
<td>0.1</td>
</tr>
<tr>
<td>Women</td>
<td>30(14%)</td>
<td>64(21%)</td>
<td>0.02</td>
</tr>
<tr>
<td>Prior MI</td>
<td>54(25%)</td>
<td>53(18%)</td>
<td>0.05</td>
</tr>
</tbody>
</table>

15 September 2009
### Safety and adverse effects

The paper does not state any adverse events caused by the aspirin administration in patients with a MI.

### Does the study answer the question?

This study addresses the key clinical question of the effect of aspirin administration, however this is on patients who have an acute MI not those with undifferentiated chest pain. The study suggests that giving aspirin early results in lower mortality rates at 7 and 30 days and a lower rate of re-hospitalisation. This benefit was also seen in a sub-group analysis of patients who underwent reperfusion. The study showed that those who received aspirin before admission to hospital were more likely to be treated with heparin, ticlopidine / clopidogrel, IIb/IIIa antagonists. The paper states that the theoretical basis of early aspirin administration is due to the anti-platelet properties and its ability to aid reperfusion.

### Effect due to factor in study?

Yes

### Consistency of results with other studies?

Limited studies in this area, results appear consistent

### Directly applicable to guideline population?

Population have a confirmed diagnosis of MI, intervention correct

### Internal Validity

Well covered

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>p-value</th>
<th>Group 1</th>
<th>Group 2</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior angina</td>
<td>59(27%)</td>
<td>73(24%)</td>
<td>0.53</td>
<td>39(33%)</td>
<td>81(29%)</td>
<td>0.41</td>
</tr>
<tr>
<td>Prior heart failure</td>
<td>5(2%)</td>
<td>8(3%)</td>
<td>0.77</td>
<td>8(7%)</td>
<td>25(9%)</td>
<td>0.47</td>
</tr>
<tr>
<td>Prior PTCA</td>
<td>36(16%)</td>
<td>35(12%)</td>
<td>0.13</td>
<td>13(11%)</td>
<td>16(6%)</td>
<td>0.07</td>
</tr>
<tr>
<td>Prior CABG</td>
<td>7(3%)</td>
<td>6(2%)</td>
<td>0.39</td>
<td>7(6%)</td>
<td>5(2%)</td>
<td>0.03</td>
</tr>
<tr>
<td>Hypertension</td>
<td>86(39%)</td>
<td>108(36%)</td>
<td>0.50</td>
<td>50(42%)</td>
<td>140(50%)</td>
<td>0.16</td>
</tr>
<tr>
<td>Diabetes</td>
<td>60(27%)</td>
<td>89(30%)</td>
<td>0.54</td>
<td>32(27%)</td>
<td>95(34%)</td>
<td>0.17</td>
</tr>
<tr>
<td>Hypertension</td>
<td>109(50%)</td>
<td>143(48%)</td>
<td>0.64</td>
<td>50(42%)</td>
<td>98(35%)</td>
<td>0.16</td>
</tr>
<tr>
<td>Current smokers</td>
<td>111(51%)</td>
<td>129(44%)</td>
<td>0.13</td>
<td>47(40%)</td>
<td>93(33%)</td>
<td>0.19</td>
</tr>
<tr>
<td>Anterior MI</td>
<td>106(48%)</td>
<td>138(46%)</td>
<td>0.31</td>
<td>53(46%)</td>
<td>122(44%)</td>
<td>0.70</td>
</tr>
<tr>
<td>Thrombolysis</td>
<td>178(81%)</td>
<td>251(84%)</td>
<td>0.43</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td></td>
</tr>
<tr>
<td>Primary PTCA</td>
<td>43(20%)</td>
<td>50(17%)</td>
<td>0.39</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td></td>
</tr>
<tr>
<td>30-day cardiovascular re-hospitalisation</td>
<td>39(19%)</td>
<td>71(26%)</td>
<td>0.07</td>
<td>20(20%)</td>
<td>63(27%)</td>
<td>0.15</td>
</tr>
<tr>
<td>Mortality – 7 D</td>
<td>3(1.4%)</td>
<td>17(5.8%)</td>
<td>0.01</td>
<td>5(4.4%)</td>
<td>25(8.9%)</td>
<td>0.13</td>
</tr>
<tr>
<td>Mortality 30 D</td>
<td>7(3.3%)</td>
<td>20(6.8%)</td>
<td>0.08</td>
<td>9(8.0%)</td>
<td>44(15.7%)</td>
<td>0.04</td>
</tr>
</tbody>
</table>
Question: What is the utility and cost effectiveness of cardiac biomarkers in evaluation of individuals with acute chest pain of suspected cardiac origin?
The meta-analysis evaluated the accuracy of biomarkers to diagnose acute cardiac ischemia in the emergency department. The analysis searched for papers examining the diagnostic performance of troponin I, troponin T, creatine kinase, CK-MB, myoglobin and CK-MB with myoglobin from 1966 to December 1998. The analysis considered 73 papers which considered the diagnosis of AMI. Where possible the authors only analyse papers which considered patients in emergency departments and the review took study quality into account when analysing the results. The study did not report the timing of the tests.

The analysis identified 7 studies which evaluated the diagnostic performance of single troponin I, the review reported the timing of the tests for two studies, one was at 2 hours from symptom onset and one was at 7 hours from onset of symptoms, but not for the other 5 studies. The prevalence of AMI ranged from 6%-39% in the studies with a total of 1149 patients included in the studies. The sensitivity ranged from 4% to 100% and the specificity ranged from 89% to 98% but 3 papers did not provide data for the specificity. The over all sensitivity was 39% and the specificity was 93%. For serial troponin I testing 2 studies were identified which had 6% and 9% prevalence of AMI and included 1393 patients. The review did not report the timing of the serial troponin I tests. The studies showed a sensitivity of 95% and specificity of 90% (sensitivity range 90%-100% and specificity range 83%-96%).

The analysis identified 8 studies which evaluated the diagnostic performance of single troponin T. The tests were conducted on admission to the emergency
The prevalence of AMI ranged from 6%-78% in the studies with a total of 1348 patients included in the studies. The sensitivity ranged from 15% to 53% and the specificity ranged from 89% to 98%. The overall sensitivity was 39% and the specificity was 93%. For serial troponin T testing 4 studies were identified which had 5% to 78% prevalence of AMI and included 904 patients. The review did not report the timing of the serial troponin T tests. The studies showed a sensitivity of 93% and specificity of 85% (sensitivity range 65%-100% and specificity range 86%-93%).

The analysis identified 12 studies which evaluated the diagnostic performance of single CK. The tests were conducted on admission to the emergency department. The prevalence of AMI ranged from 7%-41% in the studies with a total of 3195 patients included in the studies. The sensitivity ranged from 7% to 55% and the specificity ranged from 65% to 96%. The overall sensitivity was 37% and the specificity was 87%. For serial CK testing 2 studies were identified which had 26% and 43% prevalence of AMI and included 786 patients. The review did not report the timing of the serial CK tests. The studies showed a sensitivity of 83% and specificity of 76% (sensitivity range 69%-99% and specificity range 68%-84%).

The analysis identified 19 studies which evaluated the diagnostic performance of single CK-MB. The tests were conducted on admission to the emergency department. The prevalence of AMI ranged from 6%-42% in the studies with a total of 6425 patients included in the studies. The sensitivity ranged from 14% to 100% and the specificity ranged from 86% to 100%. The overall sensitivity was 42% and the specificity was 97%. For serial CK-MB testing 14 studies were identified which had 1% to 43% prevalence of AMI and included 11625 patients. The review did not report the timing of the serial CK-MB tests. The studies showed a sensitivity of 79% and specificity of 96% (sensitivity range 41%-100% and specificity range 92%-100%).

The analysis identified 18 studies which evaluated the diagnostic performance of single myoglobin. The tests were conducted on admission to the emergency department. The prevalence of AMI ranged from 6%-62% in the studies with a total of 4172 patients included in the studies. The sensitivity ranged from 21% to 100% and the specificity ranged from 61% to 100%. The overall sensitivity was 49% and the specificity was 91%. For serial myoglobin testing 14 studies were identified which had 11% to 37% prevalence of AMI and included 1277 patients. The review did not report the timing of the serial myoglobin tests. The studies showed a sensitivity of 89% and specificity of 87% (sensitivity range 57%-100% and specificity range 72%-100%).

The analysis identified 3 studies which evaluated the diagnostic performance of single CK-MB and myoglobin. Two of the studies included conducted the tests at presentation and one was 2 hours from presentation. The prevalence of AMI ranged from 9%-28% in the studies with a total of 2283 patients included in the studies. The sensitivity ranged from 62% to 100% and the specificity ranged from 72% to 80%. The overall sensitivity was 83% and the specificity was 82%. For serial CK-MB and myoglobin testing 2 studies were identified which had 11% and 20% prevalence of AMI and included 291 patients. The review did not report the timing of the serial CK-MB and myoglobin tests. The studies showed a sensitivity of 100% and specificity of 89% (specificity range 75%-91%).

**Effect due to factor in study?**

**Consistency of results with other studies?**

**Directly applicable to guideline population?**

**Internal Validity**

Ebell MH; Flewelling D; Flynn CA;
The systematic review evaluated troponin T and I for diagnosing AMI. The review searched for papers examining the diagnostic performance of troponin T and troponin I until December 1999. The review considered 19 papers which considered the diagnosis of AMI in patients with acute chest pain, presenting to an emergency department, that included the sensitivity or specificity for at least one biomarker at a set time.

The study identified 6 studies which evaluated the diagnostic value of troponin I in diagnosing AMI. The review did not report the prevalence of AMI in the test population but did report a meta-analysis of the sensitivity and specificity of troponin I at 1, 2, 3, 4, 5 and 6 hours from onset of pain. The highest sensitivity occurred at 6 hours from onset of pain and was 90% and had a specificity of 95%.

The review identified 14 studies which evaluated the diagnostic value of troponin T in diagnosing AMI. Again the review did not report the prevalence of AMI in the test population but did report sensitivity and specificity for troponin T > 0.1 and for troponin T > 0.2 at 1, 2, 3, 4, 6, 8 and 10 hours after onset of pain. The highest sensitivity for troponin T > 0.1 occurred at 10 hours from onset of pain and was 93% and had a specificity of 80%, but had the highest specificity at 1 and 2 hours from onset which had a specificity of 87% but sensitivity of 47% and 53% respectively. The highest sensitivity for troponin T > 0.2 occurred at 8 and 10 hours from onset of pain and was 96% and had a specificity of 81% and 80% respectively, but had the highest specificity at 1 and 2 hours from onset which had a specificity of 87% but sensitivity of 14% and 33% respectively.
Grading: 2++ High-quality systematic reviews of case–control or cohort studies High-quality case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal

The predictive value of the bedside troponin T test for patients with acute chest pain

Number of participants 502 patients. Patients were included if they had chest pain of suspected AMI, patients were admitted to the cardiac department or CCU. 89.1% had AMI (86.9% had TnT+ and 2.2% had TnT-)

Inclusion/Exclusion Criteria

Patient Characteristics Diagnosing AMI

Setting

Interventions/ Test/ Factor being investigated Troponin T at admission and 6 and 12 hours after admission

Comparisons No comparison

Length of Study/ Follow-up

Outcome measures studied

Results See results in guideline.

Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity

Kost GJ; Kirk JD; Omand K;
**Study Type**   Diagnostic

**Funding**   Equipment and reagents were provided by vendors (names not reported)

**Number of participants**   97 patients
Patients were included if they had acute chest pain which was possible AMI, presenting to the emergency department
28% had AMI

**Inclusion/Exclusion Criteria**

**Patient Characteristics**   Diagnosing AMI

**Recruitment**

**Setting**

**Interventions/ Test/ Factor being investigated**   Troponin T, troponin I, CK-MB and myoglobin at presentation and 3, 6 and 12 hours after admission

**Comparisons**   Biomarkers were compared to each other

**Length of Study/ Follow-up**

**Outcome measures studied**

**Results**   See results in guideline.

**Safety and adverse effects**

**Does the study answer the question?**

**Effect due to factor in study?**

**Consistency of results with other studies?**

**Directly applicable to guideline population?**

**Internal Validity**
Grading: 2+  
Well-conducted case–control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal

A rapid troponin-I-based protocol for assessing acute chest pain

<table>
<thead>
<tr>
<th>Study Type</th>
<th>Diagnostic</th>
<th>Funding</th>
<th>Not reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of participants</td>
<td>397 patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>患者 were included if they were aged over 18 years old, had acute chest pain of possible cardiac origin admitted to the CCU</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients were excluded if evidence of ST elevation on admission ECG, evidence of MI in previous 2 weeks, inability to provide informed consent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28% had AMI</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Inclusion/Exclusion Criteria

Patient Characteristics

Diagnosing chest pain

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Troponin I at 6 hours from onset of worst symptoms or from presentation if timing of symptoms was unclear

Comparisons

Standard management (CK, AST and ECG)

Length of Study/ Follow-up

Outcome measures studied

Results

See results in guideline.

Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity

Chiu A; Chan WK; Cheng SH; Leung CK; Choi CH;
Confirming a diagnosis of AMI

CK-MB, troponin I, myoglobin, triple test (troponin I, myoglobin and CK-MB) at a mean of 4.89 hours over 72 hours from onset of pain. Each biomarker is compared to each other and a confirmed diagnosis of AMI is based on the WHO definition.

Patient Characteristics

Confirming a diagnosis of AMI

Recruitment

Setting

Interventions/ Test/ Factor being investigated

CK-MB, troponin I, myoglobin, triple test (troponin I, myoglobin and CK-MB) at a mean of 4.89 hours over 72 hours from onset of pain.

Comparisons

Each biomarker is compared to each other and a confirmed diagnosis of AMI is based on the WHO definition.

Length of Study/ Follow-up

Outcome measures studied

Results

See table in guideline.

Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity

Eggers KM; Oldgren J; Nordenskjöld A; Lindahl B;

Diagnostic value of serial measurement of cardiac markers in patients with chest pain: limited value of adding myoglobin to troponin I for exclusion of myocardial infarction

Study Type

Diagnostic

Funding

Not reported
**Number of participants** 197 consecutive patients with chest pain and a non diagnostic ECG
Patients were included if they had had chest pain for longer than 15 minutes within the last 24 hours which was suspected to be unstable angina or AMI and admitted to the CCU
Patients were excluded if they had pathological ST-segment elevation on the admission ECG leading to immediate reperfusion

22% had AMI

**Inclusion/Exclusion Criteria**

**Patient Characteristics** Excluding an AMI diagnosis

**Recruitment**

**Setting**

**Interventions/ Test/ Factor being investigated** Myoglobin with troponin I, CK-MB at presentation at 6 and 12 hours after presentation

**Comparisons** Troponin I

**Length of Study/ Follow-up**

**Outcome measures studied**

**Results** See results in guideline.

**Safety and adverse effects**

**Does the study answer the question?**

**Effect due to factor in study?**

**Consistency of results with other studies?**

**Directly applicable to guideline population?**

**Internal Validity**

Falahati A; Sharkey SW; Christensen D; McCoy M; Miller EA; Murakami MA;

Implementation of serum cardiac troponin I as marker for detection of acute myocardial infarction

Ref ID 1983 Am Heart J 332 to 337 1999

**Study Type** Diagnostic

**Funding** Dade International Inc.

**Number of participants** 327 consecutive patients over a 3 month period were evaluated for AMI. Patients were excluded if less than 2 blood samples were taken. The study was conducted at the Hennepin county Medical centre, Minneapolis, USA

19% had a final diagnosis of AMI (of which 79% had a diagnostic ECG and 21% had a non diagnostic ECG)
The diagnosis of AMI

All patients had CK, CK-MB and CTnI tested every 6-8 hours from admission for 24-48 hours. The tests were compared to each other and the AMI diagnosis was based on the WHO diminution.

Internal Validity

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

See results in guideline.

Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity

Fesmire FM; Christenson RH; Fody EP; Feintuch TA;

Delta creatine kinase-MB outperforms myoglobin at two hours during the emergency department identification and exclusion of troponin positive non-ST-segment elevation acute coronary syndromes

Study Type Diagnostic

Funding Phillips Medical Systems, Millennium Pharmaceuticals Inc, Bristol-Myers Squibb Medical Imaging and EmCare Inc.

Number of participants 975 patients

Patients were included if they had a baseline troponin level of 1.0 ng/ml or less and an initial non-diagnostic ECG, presenting to a University hospital, USA

4.5% had AMI

Inclusion/Exclusion Criteria

Patient Characteristics Diagnosing AMI

15 September 2009 Page 114 of 199
Recruitment

Setting

Interventions/ Test/ Factor being investigated CK-MB, myoglobin at 2 hours from presentation

Comparisons no comparison

Length of Study/ Follow-up

Outcome measures studied

Results See results in guideline.

Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity

Gust R; Gust A; Böttiger BW; Bührer H; Martin E;

Bedside troponin T testing is not useful for early out-of-hospital diagnosis of myocardial infarction


Study Type Diagnostic

Funding Not reported

Number of participants 68 patients

Patients were included if they had chest pain strongly suspected of AMI, (pain radiated to neck or one or both shoulders which was not relieved by rest or sublingual glyceryl trinitrate), presenting to the emergency department

24% had AMI

Inclusion/Exclusion Criteria

Patient Characteristics Diagnosing AMI

Recruitment

Setting

Interventions/ Test/ Factor being investigated Troponin T

Comparisons no comparison

15 September 2009 Page 115 of 199
Planer D; Leibowitz D; Paltiel O; Boukhobza R; Lotan C; Weiss TA;

The diagnostic value of troponin T testing in the community setting

<table>
<thead>
<tr>
<th>Ref ID</th>
<th>Int J Cardiol</th>
<th>Pages</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>513</td>
<td>369 to 375</td>
<td>2006</td>
<td></td>
</tr>
</tbody>
</table>

## Study Type
Diagnostic

## Number of participants
349 patients

Patients were included if they were aged over 30 years, with at least 20 consecutive minutes of chest pain beginning at least 8 hours before presentation and occurring within the last 6 days.

Patients were excluded if they had renal failure, ST elevation on ECG, had a diagnosis of ACS or had undergone revascularization.

Patients were recruited from 44 community clinics in Jerusalem, Israel.

1.7% had AMI.

## Inclusion/Exclusion Criteria

## Patient Characteristics
Diagnosing AMI

## Recruitment

## Setting

## Interventions/ Test/ Factor being investigated
Troponin T

## Comparisons
No comparison

## Length of Study/ Follow-up

## Outcome measures studied

## Results
See results in guideline.
Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity

Zarich SW;Qamar AU;Werdmann MJ;Lizak LS;McPherson CA;Bernstein LH;

Value of a single troponin T at the time of presentation as compared to serial CK-MB determinations in patients with suspected myocardial ischemia

Ref ID 731 Clin Chim Acta

Study Type Diagnostic

Funding Not reported

Number of participants 267 patients

Patients were included if they had a complete evaluation including biomarkers, presenting to the emergency department

Patients were excluded if they had a history of chest trauma or renal failure

32% had AMI or unstable angina

Inclusion/Exclusion Criteria

Patient Characteristics Diagnosing AMI

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Single troponin T, CK-MB at presentation and serial CK-MB at presentation, 4, 8 and 16 hours after presentation

Comparisons

Compared to each other

Length of Study/ Follow-up

Outcome measures studied

Results

See results in guideline.

Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

15 September 2009
Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity
| Grading: 2- | Case–control or cohort studies with a high risk of confounding bias, or chance and a significant risk that the relationship is not causal* |

al Harbi K; Suresh CG; Zubaid M; Akanji AO;

Establishing a gradient of risk in patients with acute coronary syndromes using troponin I measurements

Ref ID: 748  
Medical Principles and Practice  
Pages: 18 to 22  
2002

<table>
<thead>
<tr>
<th>Study Type</th>
<th>Diagnostic</th>
<th>Funding</th>
<th>Not reported</th>
</tr>
</thead>
</table>

| Number of participants | 124 patients (group 1 = 86 patients, group 2 = 38 patients)  
Patients were included in group 1 if they had a diagnosis of ACS, group 2 were 38 healthy age-matched patients with no history of cardiovascular disease or any other chronic disease  
Group 1 patients were admitted to the CCU  
59% had AMI, 41% had unstable angina |

<table>
<thead>
<tr>
<th>Inclusion/Exclusion Criteria</th>
</tr>
</thead>
</table>

| Patient Characteristics | Diagnosing AMI and unstable angina |

<table>
<thead>
<tr>
<th>Recruitment</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Setting</th>
</tr>
</thead>
</table>

| Interventions/Test/Factor being investigated | Troponin I at presentation and 8 and 16 hours from presentation |

| Comparisons | no comparison |

<table>
<thead>
<tr>
<th>Length of Study/ Follow-up</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Outcome measures studied</th>
</tr>
</thead>
</table>

| Results | See results in guideline. |

<table>
<thead>
<tr>
<th>Safety and adverse effects</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Does the study answer the question?</th>
</tr>
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<table>
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<tr>
<th>Effect due to factor in study?</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Consistency of results with other studies?</th>
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<tr>
<th>Directly applicable to guideline population?</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Internal Validity</th>
</tr>
</thead>
</table>

Vatansever S; Akkaya V; Erk O; Oztürk S; Karan MA; Salmayenli N; Taşıoğlu C; Gölşer K;

The diagnostic value of troponin T and myoglobin levels in acute myocardial infarction: a study in Turkish patients

15 September 2009  
Page 119 of 199
Diagnosing AMI

TroponinT and myoglobin at 2 hours from presentation

Funding: Not reported

Internal Validity

Patient Characteristics

Diagnosing AMI

Recruitment

Setting

Interventions/ Test/
Factor being
investigated

TroponinT and myoglobin at 2 hours from presentation

Comparisons

CK

Length of Study/
Follow-up

Study Type

Diagnostic

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Safety and adverse effects

Does the study answer the question?

Zimmerman J;Fromm R;Meyer D;Boudreaux A;Wun CC;Smalling R;Davis B;Habib G;Roberts R;

Diagnostic marker cooperative study for the diagnosis of myocardial infarction

Study Type

Diagnostic

Funding

Boehringer Mannheim Corporation, Dade International, Helena Laboratories, Spectral Diagnostics, Inc, and NHLBI
Diagnosing AMI

CK-MB, troponin I, troponin T, myoglobin at 2, 4, 6, 8, 10, 18 and 22 hours after presentation
Biomarkers were compared with each other

(Grant P50-HL-54313-01)

<table>
<thead>
<tr>
<th>Number of participants</th>
<th>955 patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Characteristics</td>
<td>Diagnosing AMI</td>
</tr>
<tr>
<td>Recruitment</td>
<td></td>
</tr>
<tr>
<td>Setting</td>
<td></td>
</tr>
<tr>
<td>Interventions/ Test/ Factor being investigated</td>
<td>CK-MB, troponin I, troponin T, myoglobin at 2, 4, 6, 8, 10, 18 and 22 hours after presentation</td>
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<tr>
<td>Comparisons</td>
<td>Biomarkers were compared with each other</td>
</tr>
<tr>
<td>Length of Study/ Follow-up</td>
<td></td>
</tr>
<tr>
<td>Outcome measures studied</td>
<td></td>
</tr>
</tbody>
</table>

Results
See results in guideline.

Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity
Question: What is the incremental benefit and cost effectiveness of a clinical history, risk factors and physical examination in evaluation of individuals with stable chest pain of suspected cardiac origin?
Bedside diagnosis of coronary artery disease: a systematic review

Ref ID 10275  The American journal of medicine 334 to 343 2004

**Grading:** 1++ High-quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias

**Study Type**  Systematic Review  **Funding**  Not reported

**Number of participants**  64 studies

**Inclusion/Exclusion Criteria**

**Patient Characteristics**

**Recruitment**

**Setting**

**Interventions/ Test/ Factor being investigated**

**Comparisons**

**Length of Study/ Follow-up**

**Outcome measures studied**

**Results**

**Safety and adverse effects**

**Does the study answer the question?**

Most of the papers reviewed were of patients presenting with stable intermittent chest pain who were then referred for coronary angiography. Most of the studies had excluded patients with valvular heart disease or nonischemic cardiomyopathy. The studies used either >50% stenosis or 70-75% stenosis off any epicardial vessel as the diagnostic standard.

The study showed that for diagnosing CAD over all the physical examination gave little additional diagnostic information. The presence of an ear lobe crease gave a small increase to the probability of CAD (likelihood ratio (LR)=2.3). Arcus senilis and an ankle-brachial index <0.9 had no statistical significance, and the presence of chest wall tenderness was also diagnostically unhelpful.

The review calculated the LR by pooling the data from the included studies which used 2 diagnostic criteria for CAD (>50% stenosis and >70% to 75% stenosis). The study also analysed the data separately (>50% stenosis and >70-75% stenosis) which showed the pooled LRs remained the same. In studies which used > 50% stenosis the pooled LRs were 5.6 for typical angina, 1.1 for atypical angina, and 0.1 for nonanginal chest pain. The review calculated LRs including data from studies that combined patients with a history of MI with those without; the LRs were the same if only those studies excluding prior MI were analysed. In studies of patients without a history of MI the pooled likelihood ratios were 5.8 for typical angina, 1.3 for atypical angina and 0.1 for nonanginal chest pain.

The study showed that for the diagnosing MI, the ECG was more useful in diagnosing MI, however systolic blood pressure <100 mmHg (LR=3.6), diaphoresis...
on examination (LR=2.9), diastolic blood pressure <60 mmHg (LR=2.5), and presence of jugular venous distention (LR=2.4) were also helpful in diagnosing MI. A normal ECG was most useful in ruling out a diagnosis of MI but the patient having chest wall tenderness was also helpful for ruling out the diagnosis.

**Effect due to factor in study?** Yes

**Consistency of results with other studies?** Consistent

**Directly applicable to guideline population?** Correct population

**Internal Validity**

Chun AA; McGee SR;

Bedside diagnosis of coronary artery disease: a systematic review

Ref ID 10275 The American journal of medicine pgs. 334 to 343 2004

**Study Type** Systematic Review

**Number of participants** 64 studies

**Inclusion/Exclusion Criteria**

**Patient Characteristics**

Recruitment

Setting

Interventions/Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

Most of the papers reviewed were of patients presenting with stable intermittent chest pain who were then referred for coronary angiography. Most of the studies had excluded patients with valvular heart disease or nonischemic cardiomyopathy. The studies used either >50% stenosis or 70-75% stenosis off any epicardial vessel as the diagnostic standard.

The study showed that for diagnosing CAD over all the physical examination gave little additional diagnostic information (guideline table). The presence of an ear lobe crease gave a small increase to the probability of CAD (likelihood ratio (LR)=2.3).

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Effect due to factor in study? Yes
Consistency of results with other studies? Consistent
Directly applicable to guideline population? Correct population

Internal Validity

Chun AA; McGee SR;

Bedside diagnosis of coronary artery disease: a systematic review

Ref ID 10275 The American journal of medicine 334 to 343 2004

Study Type Systematic Review
Number of participants 64 studies
Inclusion/Exclusion Criteria
Patient Characteristics

Recruitment
Setting
Interventions/ Test/ Factor being investigated
Comparisons
Length of Study/ Follow-up
Outcome measures studied
Results

Safety and adverse effects
Most of the papers reviewed were of patients presenting with stable intermittent chest pain who were then referred for coronary angiography. Most of the studies had excluded patients with valvular heart disease or nonischemic cardiomyopathy. The studies used either >50% stenosis or 70-75% stenosis off any epicardial vessel as the diagnostic standard.

The study showed that for diagnosing CAD over all the physical examination gave little additional diagnostic information (See table in guideline). The presence of an ear lobe crease gave a small increase to the probability of CAD (likelihood ratio (LR)=2.3). Arcus senilis and an ankle-brachial index <0.9 had no statistical significance, and the presence of chest wall tenderness was also diagnostically unhelpful.

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Effect due to factor in study? Yes
Consistency of results with other studies? Consistent
Directly applicable to guideline population? Correct population

Internal Validity
Grading: 2++  
High-quality systematic reviews of case–control or cohort studies  
High-quality case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal

Diamond GA; Forrester JS;

Analysis of probability as an aid in the clinical diagnosis of coronary-artery disease

Ref ID 2196  The New England journal of medicine  
1350 to 1358 1979

<table>
<thead>
<tr>
<th>Study Type</th>
<th>Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of participants</td>
<td>4952 had coronary angiography, 23,996 autopsy (autopsy patients had died from other causes e.g. trauma and non-cardiac related diseases)</td>
</tr>
<tr>
<td>Inclusion/Exclusion Criteria</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Patient Characteristics</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Recruitment</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Setting</td>
<td>Secondary care, USA</td>
</tr>
<tr>
<td>Interventions/ Test/ Factor being investigated</td>
<td>Prevalence of CAD based on age, sex and symptoms</td>
</tr>
<tr>
<td>Comparisons</td>
<td>Coronary angiography in symptomatic patients and autopsy</td>
</tr>
<tr>
<td>Length of Study/ Follow-up</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Outcome measures studied</td>
<td>Prevalence of CAD based on age, sex and symptoms</td>
</tr>
<tr>
<td>Results</td>
<td>In 4953 patients with stable chest pain referred for angiogram; the prevalence of disease in patients with typical angina symptoms was about 90%, whereas for atypical angina patients was a 50% prevalence (P &lt; 0.001) and non-cardiac chest pain patients was 16% (P &lt; 0.001). The prevalence of CAD observed at autopsy is similar to that in asymptomatic patients confirmed by coronary angiography. Significant differences in disease prevalence occurred when patients were classified according to age and sex. For women the differences range from 0.3% for women aged 30 years to 39 years of age, to 7% for women aged 60 years to 69 years. Women in all age ranges had a lower prevalence compared with the respective age ranges in men. The pre-test likelihood of disease for any patients (according to any combination of age, sex and symptoms) was determined by conditional-probability analysis. There are a wide range of pre-test likelihoods according to sex, gender and symptoms. For example a women with atypical symptoms and aged 35% has a pre-test likelihoods of 4% compared with 92% for a man aged 55 years with typical symptoms. The authors noted that the approach used in the study was a mathematical formalisation of the intuition of the physicians reviewing the literature, or the use of past experience to assess a patients’ pre-test likelihoods. Both of these approaches...</td>
</tr>
</tbody>
</table>
The study reviewed the literature to estimate the pre-test likelihood of disease (defined by age, sex and symptoms), the results were analysed through Bayes' theorem of conditional probability. The studied described how the probability of CAD can be determined in a patient before testing from information readily obtained from clinical evaluation.

The study showed that combining data of the estimate of disease likelihood when the patient’s age and sex are known and a second estimate when the presence or absence of symptoms are known. The pre-test likelihood of disease for any patients based on any combination of age, sex and symptoms can be determined by conditional-probability analysis. The results of this analysis can be seen in the tables in the guideline which show the results of all combinations of age, sex and symptoms, which shows a wide range of pre-test likelihoods.

Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

Yes

Consistency of results with other studies?

Consistent

Directly applicable to guideline population?

Patients had chest pain

Internal Validity

Well covered

Diamond, G.A.; Staniloff, H.M.; Forrester, J.S.; Pollock, B.H.; Swan, H.J.

Computer-assisted diagnosis in the noninvasive evaluation of patients with suspected coronary

Ref ID 10281 Journal of the American College of Cardiology pgs. 444 to 455 1983

Study Type

Cohort

Funding

Not reported

Number of participants

1097, 70% men, 30% women

Inclusion/Exclusion Criteria

Inclusion: referred for non invasive testing for suspected CAD without previous MI or coronary bypass surgery

Patient Characteristics

Mean age 56±11 years

Patients were considered to have typical angina if they had substernal discomfort brought on by physical exertion and was relieved within 10 minutes through rest or nitroglycerin.

Patients were considered to have atypical angina if they had discomfort which was either not substernal or was not bought on by exertion or not relieved after 10 minutes by rest or nitroglycerin.

Patients were considered to have non-anginal discomfort if they did not have 1 or more of the above characteristics.

Recruitment

Patients who were referred for noninvasive testing for suspected CAD at the Cedars-Sinai Medical Center Cardiac Stress Laboratories, USA, between 1st January 1979 and 15th November 1980

Setting

Secondary care, USA

Interventions/ Test/ Factor being investigated

Risk factors for diagnosing CAD

Comparisons

Risk factors for diagnosing CAD
Not reported

Diagnosis of CAD

The study considered the probability of CAD and the disease prevalence. This showed that there was no significant difference between the predicted probability and the probability shown on angiography if probability was based on the age and sex of the patient, within the difference symptom classes. This, the authors states, shows the importance of clinical history as a diagnostic test.

The study stated that the probability of CAD in each symptom class was consistently slightly higher in the patients with CAD compared to those without CAD, which the authors suggest shows that the Framingham risk factors were “modest discriminators for CAD independent of symptom classification”. The data the study gained was assessed based on the age, sex, symptoms and risk factors before diagnostic testing, and based on all the data gained before catheterization and again with all the data after every test had been carried out. For each assessment the probability of disease increased in proportion to the number of diseased vessels, however there were large standard deviations.

The study showed that the mean probability for CAD increased from 30% for the patients in the normal group to 56% for the patients with 1 vessel disease, and increased to 75% for patients with 3 vessel disease. There was overlap between data sets especially for those with 2 and 3 vessel disease, which showed no significant difference. This, the study stated, led to 8% of the probability estimates for the normal patients being in excess of 90%, and for 9.7% of the probability estimates for the patients with disease shown on angiography to be 10% under. There was a 3.4% difference between predicted probability and actually probability of CAD from the estimate based on sex, age, symptoms and risk factors. The study used graphs to determine relationships between the variables and disease prevalence, and showed that the calculated probability of CAD accurately reflected the actual angiographic disease prevalence.

The study also assessed the probability of CAD and extent of disease. This showed that when the patient had a probability of below “25% when disease was present single vessel disease was slightly more prevalent than multi-vessel disease, while above a probability of 75% multi-vessel disease predominated. At a probability of 100% multi-vessel disease accounted for 89% of all angiographic disease”. The significance of these differences varied, however it shows that it does indicate that disease probability also acted as a quantitative measure of anatomic severity.
Internal Validity
Well covered

Effect due to factor in study? Yes
Consistency of results with other studies? Consistent

Directly applicable to guideline population? Patients had suspected CAD
Internal Validity Well covered

Estimating the likelihood of significant coronary artery disease

Patient Characteristics

Patient characteristics which were collected were:
- History: age, sex, chest pain history (pain type, severity, frequency, nocturnal, progressive, preinfarctional), duration of CAD, previous history of MI, congestive heart failure, history of vascular disease (Progressive chest pain - the frequency, severity or duration had increased in the 6 weeks prior to catheterisation; Preinfarctional chest pain - a very unstable pain pattern that resulted in admission to the coronary care unit for evaluation of the possible MI)
- Risk factors: smoking, hyperlipidaemia, hypertension, diabetes, family history
- Physical examination: ventricular gallop, systolic blood pressure
- ECG: ST-T wave changes, electrocardiographic premature ventricular contractions, Electrocardiographic Q waves
- Chest X-Ray: cardiomegaly

Recruitment
Patients admitted for cardiac catheterisation between November 1969 and January 1982

Setting Secondary care, USA

Interventions/Test/Factor being investigated Chest pain diagnosis

Comparisons Patient characteristics which give a probability of disease

Length of Study/Follow-up

Outcome measures studied Probability of disease

Results
The study had a training population of 3627 patients who were seen between 1969 and January 1979, from these patients a stepwise logistic regression analysis was used to develop a model for predicting the probability of significant CAD. A test population of 1811 patients seen between January 1969 and January 1982, in this population the model developed in the test population was used to predict the probability of CAD for each patient.
The authors then tested the model in other populations (from CASS study) to estimate the prevalence of disease in subgroups of the patients in the literature (external validation)
Results from training population:
Clinically Important Characteristics and the Chi-squared:
Pain type (typical, atypical or nonanginal): 1091
Previous MI: 511
Sex: 187
Age: 119
Smoking: 79
Hyperlipidaemia: 26
ST-T wave changes: 28
Diabetes: 12

Interactions
age X sex
age X smoking
age X hyperlipidaemia
sex X smoking

Poor Clinical Predictors of Significant CAD and the Chi-squared:
Chest pain severity: 0.96
Chest pain frequency: 8.57
Nocturnal chest pain: 2.22
Progressive chest pain: 2.54
Preinfarction angina: 9.70
Vascular disease: 0.40
Duration of CAD: 9.16
Congestive heart failure: 0.59
Hypertension: 5.19
Family history: 6.39
Ventricular gallop: 1.06
Cardiomegaly: 1.41
Electrocardiographic premature ventricular contractions: 0.46

The results from the training group are shown under “Clinically Important Characteristics and the Chi-squared” in the order of their importance (chi-squared added to the model by the parameter, adjusting for the characteristics that precede it). The type of chest pain (typical, atypical or nonanginal) was the most important characteristic followed by previous MI, sex, age, smoking, hyperlipidaemia, ST-T wave changes on ECG, diabetes. The results above show the 4 significant interactions which were found.
The study also showed that in men the effect of an increasing age was more important than in women, smoking was more important for women than men, and that smoking and hyperlipidaemia were more important at younger ages. The results for the other characteristics which were found to have small or nonsignificant effects on the prevalence of disease are shown under “Poor Clinical Predictors of Significant CAD and the Chi-squared”

The authors then validated the model in the test population which showed that the predicted probability of disease is nearly identical to the observed prevalence. This was with the exception of the group with predicted estimates of 0.475 to 0.525 (this group 8 out of 34 patients, with significant disease). The median prediction for patients with disease was 94% compared with a median prediction of 33% for patients without disease. A predicted probability of significant disease > 0.83 was found in 75% of patients with disease and in less than 10% of patients with disease. A probability of significant disease < 0.33 was found in nearly 50% of patients without disease and in less than 5% of patients with disease.

The authors then externally validated using the population from the CASS study. There was disagreement on patients classified as having nonanginal chest pain (where the greatest difference in predicted disease compared to observed disease was seen), but the predicted estimates from the model were nearly equal to the observed prevalence of disease. The predicted estimates from the model of the probability of significant disease were nearly identical to the observed prevalence for subgroups based on “age, sex and history of MI” or “age, sex and pain type”.

Safety and adverse effects

None
Progressive chest pain was described as being chest pain when the frequency, severity or duration had increased in the 6 weeks prior to catherisation. Preinfarctional chest pain was described as chest pain with a very unstable pain pattern that resulted in admission to the coronary care unit for evaluation of the possible MI.

The results from the training population showed the type of chest pain (typical, atypical or nonanginal) was the most important characteristic followed by previous MI, sex, age, smoking, hyperlipidaemia, ST-T wave changes on ECG, diabetes. The study also showed that in men the effect of increasing age was more important than in women, smoking was more important for women than men, and that smoking and hyperlipidaemia were more important at younger ages. The study also found some characteristics to have small or nonsignificant effects on the prevalence of disease.

The authors then validated the model in the test population which showed that the predicted probability of disease is nearly identical to the observed prevalence. When comparing the model to an external population the study showed that the predicted estimates from the model were nearly equal to the observed prevalence of disease. The predicted estimates from the model of the probability of significant disease were nearly identical to the observed prevalence for subgroups based on “age, sex and history of MI” or “age, sex and pain type”. However the greatest difference in predicted disease compared to observed disease was seen in patients with nonanginal chest pain.

Effect due to factor in study? Yes
Consistency of results with other studies? Consistent
Directly applicable to guideline population? Patients had chest pain
Internal Validity Well covered

Pryor DB; Harrell FE; Lee KL; Califf RM; Rosati RA;

Estimating the likelihood of significant coronary artery disease

Ref ID 10283 The American journal of medicine pg 771 to 780 1983

Study Type Cohort Funding Not reported
Number of participants 3627 in training population, 1811 in test population
Inclusion/Exclusion Criteria Patients with chest pain who were referred for cardiac catheterization at the Duke University Medical Center between November 1969 and January 1982
Patient Characteristics Patient characteristics which were collected were:
History: age, sex, chest pain history (pain type, severity, frequency, nocturnal, progressive, preinfarctional), duration of CAD, previous history of MI, congestive heart failure, history of vascular disease (Progressive chest pain - the frequency, severity or duration had increased in the 6 weeks prior to catherisation);
Preinfarctional chest pain - a very unstable pain pattern that resulted in admission to the coronary care unit for evaluation of the possible MI);
Risk factors: smoking, hyperlipidaemia, hypertension, diabetes, family history
Physical examination: ventricular gallop, systolic blood pressure
ECG: ST-T wave changes, electrocardiographic premature ventricular contractions, Electrocardiographic Q waves
Chest X-Ray: cardiomegaly

Recruitment Patients admitted for cardiac catheterisation between November 1969 and January 1982
Results

The study had a training population of 3627 patients who were seen between 1969 and January 1979, from these patients a stepwise logistic regression analysis was used to develop a model for predicting the probability of significant CAD. A test population of 1811 patients seen between January 1969 and January 1982, in this population the model developed in the test population was used to predict the probability of CAD for each patient. The authors then tested the model in other populations (from CASS study) to estimate the prevalence of disease in subgroups of the patients in the literature (external validation).

Clinically Important Characteristics and the Chi-squared:
- Pain type (typical, atypical or nonanginal): 1091
- Previous MI: 511
- Sex: 187
- Age: 119
- Smoking: 79
- Hyperlipidaemia: 26
- ST-T wave changes: 28
- Diabetes: 12

Interactions
- age X sex
- age X smoking
- age X hyperlipidaemia
- sex X smoking

Poor Clinical Predictors of Significant CAD and the Chi-squared:
- Chest pain severity: 0.96
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- Hypertension: 5.19
- Family history: 6.39
- Ventricular gallop: 1.06
- Cardiomegaly: 1.41
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The results from the training group are shown under “Clinically Important Characteristics and the Chi-squared” in the order of their importance (chi-squared added to the model by the parameter, adjusting for the characteristics that precede it). The type of chest pain (typical, atypical or nonanginal) was the most important characteristic followed by previous MI, sex, age, smoking, hyperlipidaemia, ST-T wave changes on ECG, diabetes. The results above show the 4 significant interactions which were found.

The study also showed that in men the effect of an increasing age was more important than in women, smoking was more important for women than men, and that smoking and hyperlipidaemia were more important at younger ages. The results for the other characteristics which were found to have small or nonsignificant effects on the prevalence of disease are shown under “Poor Clinical Predictors of Significant CAD and the Chi-squared”.
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Safety and adverse effects

Does the study answer the question?

Progressive chest pain was described as being chest pain when the frequency, severity or duration had increased in the 6 weeks prior to catheterisation. There was disagreement on patients classified as having nonanginal chest pain (where the greatest difference in predicted disease compared to observed disease was seen), but the predicted estimates from the model were nearly equal to the observed prevalence of disease. The predicted estimates from the model of the probability of significant disease were nearly identical to the observed prevalence for subgroups based on “age, sex and history of MI” or “age, sex and pain type”.

None

Effect due to factor in study?

Yes

Consistency of results with other studies?

Consistent

Directly applicable to guideline population?

Patients had chest pain

Internal Validity

Well covered

Pryor DB; Harrell FE; Lee KL; Califf RM; Rosati RA;

Estimating the likelihood of significant coronary artery disease

Ref ID 10283 The American journal of medicine 771 to 780 1983

Study Type Cohort

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Patient Characteristics
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Risk factors: smoking, hyperlipidaemia, hypertension, diabetes, family history

Physical examination: ventricular gallop, systolic blood pressure

ECG: ST-T wave changes, electrocardiographic premature ventricular contractions, Electrocardiographic Q waves

Chest X-Ray: cardiomegaly

Recruitment
Patients admitted for cardiac catheterisation between 1969 and 1982

Setting
Secondary care, USA

Interventions/ Test/ Factor being investigated
Chest pain diagnosis

Comparisons
Patient characteristics which give a probability of disease

Length of Study/ Follow-up

Outcome measures studied
Probability of disease

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The study also showed that in men the effect of an increasing age was more important than in women, smoking was more important for women than men, and that smoking and hyperlipidaemia were more important at younger ages. The results for the other characteristics which were found to have small or nonsignificant effects on the prevalence of disease are shown under “Poor Clinical Predictors of Significant CAD and the Chi-squared”

The authors then validated the model in the test population which showed that the predicted probability of disease is nearly identical to the observed prevalence. This was with the exception of the group with predicted estimates of 0.475 to 0.525 (this group 8 out of 34 patients, with significant disease). The median prediction for patients with disease was 94% compared with a median prediction of 33% for patients without disease. A predicted probability of significant disease > 0.83 was found in 75% of patients with disease and in less than 10% of patients with disease. A probability of significant disease < 0.33 was found in nearly 50% of patients without disease and in less than 5% of patients with disease.

The authors then externally validated using the population from the CASS study. There was disagreement on patients classified as having nonanginal chest pain (where the greatest difference in predicted disease compared to observed disease was seen), but the predicted estimates from the model were nearly equal to the observed prevalence of disease. The predicted estimates from the model of the probability of significant disease were nearly identical to the observed prevalence for subgroups based on “age, sex and history of MI” or “age, sex and pain type”.

Safety and adverse effects

None

Does the study answer the question?

Yes

Effect due to factor in study?

Consistent

Consistency of results with other studies?

Consistent
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directly applicable to guideline population?</td>
<td>Patients had chest pain</td>
</tr>
<tr>
<td>Internal Validity</td>
<td>Well covered</td>
</tr>
</tbody>
</table>
Grading: 2+  Well-conducted case–control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal.

<table>
<thead>
<tr>
<th>Ref ID</th>
<th>Annals of internal medicine</th>
<th>Pages</th>
<th>Year</th>
</tr>
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<tbody>
<tr>
<td>1751</td>
<td></td>
<td>81 to 90</td>
<td>1993</td>
</tr>
</tbody>
</table>

Value of the history and physical in identifying patients at increased risk for coronary artery disease

Study Type  Cohort  Funding  Agency for Health Care Policy and Research, National Heart, Lung and Blood institute, National Library of Medicine

<table>
<thead>
<tr>
<th>Number of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1030 patients, 168 had cardiac catheterization</td>
</tr>
</tbody>
</table>

Inclusion/Exclusion Criteria

Inclusion: Symptomatic patients, referred for non-invasive testing for suspected coronary artery disease
Exclusion: previous cardiac catheterization

Patient Characteristics

The mean age was 55, 37% were female, the mean pain frequency was 2 episodes a week, the mean durations of CAD symptoms was 12 months, 28% had typical angina symptoms, 52% atypical angina symptoms, 20% nonanginal pain, 18% progressive angina, 22% nocturnal angina, 44% smoked, 41% had a history of hypertension, 10% had diabetes, 11% had hyperlipidemia, 35% had ST-T wave changes on ECG, 18% had a history of MI, 8% had Q waves on ECG, 14% had a history of congestive heart failure, 0% had class IV congestive heart failure, 1% had ventricular gallop, 3% had peripheral vascular disease, 3% had cerebral vascular disease.
Of the patients who went on to have a cardiac catheterization the mean age was 56, 31% were female, the mean pain frequency was 2 episodes a week, the mean durations of CAD symptoms was 7 months, 49% had typical angina symptoms, 47% atypical angina symptoms, 4% nonanginal pain, 24% progressive angina, 24% nocturnal angina, 53% smoked, 42% had a history of hypertension, 10% had diabetes, 13% had hyperlipidemia, 42% had ST-T wave changes on ECG, 33% had a history of MI, 11% had Q waves on ECG, 11% had a history of congestive heart failure, 0% had class IV congestive heart failure, 1% had ventricular gallop, 4% had peripheral vascular disease, 2% had cerebral vascular disease.
It can therefore be seen that those having a cardiac catheterization were more likely to be male, smoke, have a history of MI, have ST-T wave changes on ECG and to be suffering typical or progressive angina.

Recruitment

Patients were referred for non-invasive testing for suspected coronary artery disease

Setting

Duke University Medical Centre USA

Interventions/ Test/ Factor being investigated

Physicians initial evaluation of patients with suspected CAD predicts coronary anatomy

Comparisons

The presence of significant coronary disease defined as any disease, severe disease, left main disease

Length of Study/ Follow-up

90 days

Outcome measures studied

Effectiveness of chest pain score to predict coronary artery disease

Results

The three diagnostic outcomes were; the presence of significant coronary artery disease defined as ‘any disease’ (≥ 75% luminal diameter narrowing of at least one major coronary artery), presence of severe coronary artery disease defined as ‘severe disease’ (significant obstruction of all 3 main coronary arteries or the left main coronary artery) and the presence of significant left main artery obstruction defined as ‘left main disease’ (168 patients referred for cardiac catheterization). The prognostic
outcome was survival at 3 years. In the multivariable regression model used, the following variables were significant predictors for any disease; age, gender, chest pain (type), diabetes, smoking, hyperlipidaemia, previous history of myocardial infarction, and significant Q waves and ST-T wave changes. For severe disease, the following variables were significant predictors; age, gender, chest pain (type, frequency, course, nocturnal, length of time present), diabetes, smoking, hyperlipidaemia, hypertension, peripheral or cerebral artery disease, carotid bruit, previous history of myocardial infarction, and significant Q waves and ST-T wave changes. For left main disease, the following variables were significant predictors; age, gender, chest pain (type), diabetes, peripheral or cerebral artery disease and carotid bruit. For survival at 3 years the following variables were significant predictors; age, gender, chest pain (frequency, course, nocturnal), peripheral or cerebral artery disease, carotid bruit, ventricular gallop, previous history of myocardial infarction, significant Q waves and ST-T wave changes, conduction abnormalities, premature ventricular contractions and cardiomegaly. The likelihood of any disease, severe coronary disease, left main disease and survival was predicted from the initial history, physical examination, electrocardiogram and chest X ray (these tests were defined as the 'initial evaluation').

Predicted coronary artery endpoints and survival based on the initial evaluation closely corresponded to actual findings. Predictions using the initial evaluation were then compared with predictions based on the treadmill exercise test. The initial evaluation was slightly better at distinguishing patients with and without coronary artery disease compared with the treadmill exercise test. The initial evaluation and the treadmill exercise test had similar discriminatory performances for patients with and without severe disease and risk of death at 3 years, while for left main disease, the treadmill exercise test was slightly better for identify patients with left main disease.

Safety and adverse effects

None reported

Does the study answer the question?

Yes

Consistency of results with other studies?

Consistent

Effect due to factor in study?

Yes

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During the study a chest X-ray was also performed, the results did not help in predicting coronary disease, however they could be used to predict survival.
The mean age was 55, 37% were female, the mean pain frequency was 2 episodes a week, the mean durations of CAD symptoms was 12 months, 28% had typical angina symptoms, 52% atypical angina symptoms, 20% nonanginal pain, 18% progressive angina, 22% nocturnal angina, 44% smoked, 41% had a history of hypertension, 10% had diabetes, 11% had hyperlipidemia, 35% had ST-T wave changes on ECG, 18% had a history of MI, 8% had Q waves on ECG, 14% had a history of congestive heart failure, 0% had class IV congestive heart failure, 1% had ventricular gallop, 3% had peripheral vascular disease, 3% had cerebral vascular disease.

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Recruitment
Patients were referred for non-invasive testing for suspected coronary artery disease

Setting
Duke University Medical Centre USA

Interventions/ Test/ Factor being investigated
Physicians initial evaluation of patients with suspected CAD predicts coronary anatomy

Comparisons
The presence of significant coronary disease defined as any disease, severe disease, left main disease

Length of Study/ Follow-up
90 days

Outcome measures studied
Effectiveness of chest pain score to predict coronary artery disease

Results
The three diagnostic outcomes were; the presence of significant coronary artery disease defined as ‘any disease’ (≥ 75% luminal diameter narrowing of at least one major coronary artery), presence of severe coronary artery disease defined as ‘severe disease’ (significant obstruction of all 3 main coronary arteries or the left main coronary artery) and the presence of significant left main artery obstruction defined as ‘left main disease’ (168 patients referred for cardiac catheterization). The prognostic outcome was survival at 3 years.
In the multivariable regression model used, the following variables were significant predictors for any disease; age, gender, chest pain (type), diabetes, smoking, hyperlipidaemia, previous history of myocardial infarction, and significant Q waves and ST-T wave changes. For severe disease, the following variables were significant predictors; age, gender, chest pain (type, frequency, course, nocturnal, length of time present), diabetes, smoking, hyperlipidaemia, hypertension, peripheral or cerebral artery disease, carotid bruit, previous history of myocardial infarction, and significant Q waves and ST-T wave changes. For left main disease, the following variables were significant predictors; age, gender, chest pain (type), diabetes, peripheral or cerebral artery disease and carotid bruit. For survival at 3 years the following variables were significant predictors; age, gender, chest pain (frequency, course, nocturnal), peripheral or cerebral artery disease, carotid bruit, ventricular gallop, previous history of myocardial infarction, significant Q waves and ST-T wave changes, conduction abnormalities, premature ventricular contractions and cardiomegaly. The likelihood of any disease, severe coronary disease, left main disease and survival was predicted from the initial history, physical examination, electrocardiogram and chest X ray (these tests were defined as the ‘initial evaluation’). The models which were used were based on mathematical models in a previous study (Pryor, 1983 – see extraction).

Predicted coronary artery endpoints and survival based on the initial evaluation closely corresponded to actual findings. Predictions using the initial evaluation were then compared with predictions based on the treadmill exercise test. The initial evaluation was slightly better at distinguishing patients with and without coronary artery disease compared with the treadmill exercise test. The initial evaluation and the treadmill exercise test had similar discriminatory performances for patients with and without severe disease and risk of death at 3 years, while for left main disease, the treadmill exercise test was slightly better for identify patients with left main disease.

Safety and adverse effects

None reported

Does the study answer the question?

Yes

Consistency of results with other studies?

Consistent

Effect due to factor in study?

Yes

During the study a chest X-ray was also performed, the results did not help in predicting coronary disease, however they could be used to predict survival.
Sox HC; Hickam DH; Marton K; Moses L; Skeff KM; Sox CH; Neal EA;

Using the patient's history to estimate the probability of coronary artery disease: a comparison of primary care and referral practices

Ref ID 1895 The American journal of medicine 7 to 14 1990

Study Type Cohort Funding Veterans Administration Health Services Research and Development Service, Henry J. Kaiser Family Foundation and Henry J. Kaiser Family Foundation General Internal Medicine Fellowship Program

Number of participants 1074 patients

Inclusion/Exclusion Criteria Inclusion: had at least 2 episodes of chest pain that led to the index visit. Exclusion: patients whose index visit led to a diagnosis of acute MI were excluded.

Patient Characteristics

Recruitment Patients admitted to Stanford University Medical Centre, or seen at Palo Alto VA Medical Center and Kaiser-Permanente Medical Center, Santa Medical Centre, USA

Setting Primary and Secondary care USA

Interventions/ Test/ Factor being investigated Diagnosing coronary artery disease

Comparisons Age, men, pain brought on by exertion, having to stop all activities when pain occurs, history of MI, pain relieved within 3 minutes of taking nitroglycerin, and ≥ 20 pack years of smoking.

Length of Study/ Follow-up Median follow up 11 months

Outcome measures studied Effectiveness of chest pain score to predict coronary artery disease

Results

Seven clinical characteristics were identified as independent predictors of significant coronary stenosis; age > 60 years, pain brought on by exertion, patient having to stop all activities when pain occurs, history of myocardial infarction, pain relieved within 3 minutes of taking nitroglycerin, at least 20 pack years of smoking, and male gender. The following were not independent predictors of disease status; location and radiation of pain, character of pain, history of hypertension, history of hypercholesterolaemia, history of angina pectoris, pain worsened by cough, deep breathing, movement of torso, or movement of arm. The chest pain score was used to test the probability of coronary artery disease (CAD) in patients from two primary care practices (997 patients) and one angiography referral practice (166 patients).

1980 Arteriography Training Set:
Score 0-4: 1 had significant CAD, 9 had insignificant CAD and the prevalence of CAD was 0.10
Score 5-9: 13 had significant CAD, 20 had insignificant CAD and the prevalence of CAD was 0.39
Score 10-14: 33 had significant CAD, 16 had insignificant CAD and the prevalence of CAD was 0.67
Score 15-19: 77 had significant CAD, 8 had insignificant CAD and the prevalence of...
The chest pain score was used to test the probability of coronary artery disease in patients from two primary care settings. The prevalence of coronary artery disease was higher in patients with a chest pain score of 20-25 compared to patients with a score of 0-25.

1982 Angiography Test Set:
Score 0-4: 1 had significant CAD, 6 had insignificant CAD and the prevalence of CAD was 0.14
Score 5-9: 4 had significant CAD, 13 had insignificant CAD and the prevalence of CAD was 0.24
Score 10-14: 11 had significant CAD, 13 had insignificant CAD and the prevalence of CAD was 0.70
Score 15-19: 19 had significant CAD, 10 had insignificant CAD and the prevalence of CAD was 0.83
Score 20-25: 12 had significant CAD, 6 had insignificant CAD and the prevalence of CAD was 0.86
The total number of patients was: 122 with significant CAD, 48 had insignificant CAD and the prevalence of CAD was 0.72

VA Test Set:
Score 0-4: 0 had significant CAD, 4 had insignificant CAD and the prevalence of CAD was 0.00
Score 5-9: 9 had significant CAD, 139 had insignificant CAD and the prevalence of CAD was 0.06
Score 10-14: 27 had significant CAD, 99 had insignificant CAD and the prevalence of CAD was 0.21
Score 15-19: 64 had significant CAD, 26 had insignificant CAD and the prevalence of CAD was 0.71
Score 20-25: 33 had significant CAD, 3 had insignificant CAD and the prevalence of CAD was 0.92
The total number of patients was: 133 with significant CAD, 271 had insignificant CAD and the prevalence of CAD was 0.33

Kaiser Test Set:
Score 0-4: 0 had significant CAD, 98 had insignificant CAD and the prevalence of CAD was 0.00
Score 5-9: 7 had significant CAD, 118 had insignificant CAD and the prevalence of CAD was 0.06
Score 10-14: 4 had significant CAD, 35 had insignificant CAD and the prevalence of CAD was 0.10
Score 15-19: 6 had significant CAD, 14 had insignificant CAD and the prevalence of CAD was 0.30
Score 20-25: 6 had significant CAD, 1 had insignificant CAD and the prevalence of CAD was 0.86
The total number of patients was: 23 with significant CAD, 266 had insignificant CAD and the prevalence of CAD was 0.08

The prevalence of a coronary artery disease diagnosis in primary care patients is lower than in angiography patients with similar chest pain histories. With the exception of the highest chest pain score subgroup, analysis on the two primary care population’s show there is not perfect agreement.

Although the patients in the primary and secondary settings had similar chest pain scores derived from the clinical history, the prevalence of coronary artery disease in the primary care patients was lower than the angiography patients across the first four scores bands compared with the angiography patients, while the prevalence at the highest score band was similar in both the primary and secondary settings.

The authors concluded that health care professionals should take in to account the clinical setting when using the patient’s history to estimate the probability of disease.

None reported

Safety and adverse effects
Does the study answer the question?

15 September 2009
patients across the first four scores bands compared with the angiography patients, while the prevalence at the highest score band was similar in both the primary and secondary settings. The authors concluded that health care professionals should take into account the clinical setting when using the patient’s history to estimate the probability of disease.

Effect due to factor in study? 
Yes

Consistency of results with other studies? 
Consistent

Directly applicable to guideline population? 
Correct population

Internal Validity 
Well covered

Using the patient’s history to estimate the probability of coronary artery disease: a comparison of primary care and referral practices

Ref ID 1895 The American journal of medicine 7 to 14 1990

Study Type Cohort

Funding Veterans Administration Health Services Research and Development Service, Henry J. Kaiser Family Foundation and Henry J. Kaiser Family Foundation General Internal Medicine Fellowship Program

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breathing, movement of torso, or movement of arm. The chest pain score was used to test the probability of coronary artery disease (CAD) in patients from two primary care practices (997 patients) and one angiography referral practice (166 patients).

For distribution of patients among Chest Pain Score Subgroups see results in guideline.

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Score 5-9: 13 had significant CAD, 20 had insignificant CAD and the prevalence of CAD was 0.39
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Score 15-19: 77 had significant CAD, 8 had insignificant CAD and the prevalence of CAD was 0.91
Score 20-25: 34 had significant CAD, 0 had insignificant CAD and the prevalence of CAD was 1.00
The total number of patients was: 158 with significant CAD, 53 had insignificant CAD and the prevalence of CAD was 0.76

1982 Arteriography Test Set:
Score 0-4: 1 had significant CAD, 6 had insignificant CAD and the prevalence of CAD was 0.14
Score 5-9: 4 had significant CAD, 13 had insignificant CAD and the prevalence of CAD was 0.24
Score 10-14: 31 had significant CAD, 13 had insignificant CAD and the prevalence of CAD was 0.70
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The total number of patients was: 122 with significant CAD, 48 had insignificant CAD and the prevalence of CAD was 0.72

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Safety and adverse effects

Does the study answer the question?

The chest pain score was used to test the probability of coronary artery disease in patients from two primary care practices (997 patients) and one angiography referral practice (166 patients). Although the patients in the primary and secondary settings had similar chest pain scores derived from the clinical history, the prevalence of coronary artery disease in the primary care patients was lower than the angiography patients across the first four score bands compared with the angiography patients, while the prevalence at the highest score band was similar in both the primary and secondary settings. The authors concluded that health care professionals should take into account the clinical setting when using the patient’s history to estimate the probability of disease.

Effect due to factor in study?

Yes

Consistency of results with other studies?

Consistent

Directly applicable to guideline population?

Correct population

Internal Validity

Well covered

Wu EB; Hodson F; Chambers JB;

A simple score for predicting coronary artery disease in patients with chest pain

Ref ID 394 QJM : monthly journal of the Association of Physicians pp. 803 to 811 2005

Study Type Cohort

Funding Grant from the special Trustee's of Guy's and St Thomas' NHS trust

Number of participants 404 patients recruited from 363 consecutive patients seen as out-patients, and 829 consecutive patients undergoing day-case coronary angiography. 155 of the 404 had an exercise test

Inclusion/Exclusion Criteria Inclusion: chest pain for > 1 month without a previous history of MI, coronary angiography, angioplasty or coronary artery bypass grafting

Exclusion: ECG showed pathological Q waves or regional wall motion abnormalities on echocardiogram

Patient Characteristics

The mean age was 60.6±9.5 years. 66% (268) were males, the mean age for males 60.5±9.1 years; 34% (137) were females, the mean ages for females was 60.8±10.2 years. Of all the patients 60% (244) had significant coronary artery disease; 40% (161) had normal coronary anatomy

Recruitment Patients who met criteria recruited from outpatient at Cardiothoracic Centre, Guy's and St Thomas' Hospital, London, UK

Setting Guy's and St Thomas' Hospital, London, UK

Interventions/ Test/ Factor being investigated Diagnosing chest pain

Comparisons The chest pain score was based on: description of pain, clinical history, medication, clinical examination, stigmata of risk, resting ECG

15 September 2009
Diagnosis of coronary artery disease, or exclusion of diagnosis of coronary artery disease

The chest pain score was based on the following: localisation of pain, radiation, quality of pain, duration, length of pain episode, frequency, associated features (breathlessness, digital paraesthesiae, palpation, light-headedness), precipitation (exercise, rest, any time, neck or back movement, carrying, swallowing, lying flat/stooping, emotional stress, particular situations), exacerbating / relieving factors (inspiration, GNT, genuine relief < 5 minutes) relief with (milk/antacids, belching, local massage rest). A medical history was also taken of: hypertension, hypercholesterolemia, diabetes, smoking and number of cigarettes per day, previous MI, alcohol intake per week, medication being used (aspirin, statins, beta blockers, calcium antagonists, nitrates, other), the patients weight, height, heart rhythm, systolic, diastolic, heart rate, apex position and character, intercostal space, heart murmur, heart sounds stigmata of risk (arcus, xanthelas mata, xanthomata, ear lobe crease) and a resting ECG. This chest pain score was based on a modification of the Master Questionnaire with 3 additional questions to define the exercise score, the rest and duration score.

1) if you go up a hill on 10 separate occasions how many do you experience chest pain; 2) if you have chest pain 10 times in a row how many happen when you are sitting or resting; 3) how long does the pain last for. For question 1 10/10 was described as “typical” and 1-9/10 was “atypical”; for question 2 a rest index or 0 or 1 was “typical and 2 or more was “atypical”; for question 3 pain lasting less than 5 minutes was “typical” and pain last more than 5 minutes was “atypical”

Multivariat Poisson Regression Analysis showed that gender (P < 0.001), age (P < 0.001), relief with rest (P=0.046), dizziness (P=0.030), smoking (P=0.006), hypertension (P=0.016), hypercholesterolemia (P=0.214), diabetes (P=0.016) and chest pain score (P = 0.009) were independently differentiated those patients with and without CAD. A secondary analysis was conducted to relate the chest pain score to the Framingham and Duke Scores. The Duke Score is a weighted index based on ST-segment deviation, treadmill time and exercised-induced angina (Duke Treadmill Score = Exercise time – [5xSTdeviation] – [4xtreadmill angina]). The chest pain score was found to have a sensitivity of 91.4% and a specificity of 28%, compared to the Duke score’s sensitivity of 82.4% and specificity of 31%. The study found that the combination of the chest pain score with Framingham and the Duke score had additive predictive value for risk of coronary artery disease.
A simple score for predicting coronary artery disease in patients with chest pain

Number of participants: 404 patients recruited from 363 consecutive patients seen as out-patients, and 829 consecutive patients undergoing day-case coronary angiography. 155 of the 404 had an exercise test.

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Recruitment: Patients who met criteria recruited from out patients at Cardiothoracic Centre, Guy's and St Thomas' Hospital, London, UK.

Setting: Guy's and St Thomas' Hospital, London, UK.

Interventions/Test/Factor being investigated: Diagnosing chest pain.

Comparisons: The chest pain score was based on: description of pain, clinical history, medication, clinical examination, stigmata of risk, resting ECG.

Length of Study/Follow-up: Not reported.

Outcome measures studied: Diagnosis of coronary artery disease, or exclusion of diagnosis of coronary artery disease.

Results: The chest pain score was based on the following: localisation of pain, radiation, quality of pain, duration, length of pain episode, frequency, associated features (breathlessness, digital paraesthesiae, palpation, light-headedness), precipitation (exercise, rest, any time, neck or back movement, carrying, swallowing, lying flat/stooping, emotional stress, particular situations), exacerbating / relieving factors (inspiration, GNT, genuine relief < 5 minutes) relief with (milk/antacids, belching, local massage rest). A medical history was also taken of: hypertension, hypercholesterolemia, diabetes, smoking and number of cigarettes per day, previous MI, alcohol intake per week, medication being used (aspirin, statins, beta blockers, calcium antagonists, nitrates, other), the patients weight, height, heart rhythm, systolic, diastolic, heart rate, apex position and character, intercostal space, heart murmur, heart sounds stigmata of risk (arcus, xanthelasma, xanthomata, ear lobe crease) and a resting ECG. This chest pain score was based on a modification of the Master Questionnaire with 3 additional questions to define the exercise score, the rest and duration score. 1) if you go up a hill on 10 separate occasions how many do you experience chest pain; 2) if you have chest pain 10 times in a row how many happen when you are sitting or resting; 3) how long does the pain last for. For question 1 10/10 was described as “typical” and 1-9/10 was “atypical”; for question 2 a rest index of 0 or 1 was “typical and 2 or more was “atypical”; for question 3 pain lasting less than 5 minutes was “typical” and pain last more than 5 minutes was “atypical”.

Multivariant Poisson Regression Analysis, showed that gender (P < 0.001), age (P < 0.001), relief with rest (P=0.046), dizziness (P=0.030), smoking (P=0.006), hypertension (P=0.016), hypercholesterolemia (P=0.214), diabetes (P=0.016) and chest pain score (P = 0.009) were independently differentiated those patients with and without CAD. A secondary analysis was conducted to relate the chest pain score to the Framingham and Duke Scores. The Duke Score is a weighted index based on ST-segment deviation, treadmill time and exercised-induced angina (Duke Treadmill Score = Exercise time – [5xSTdeviation] – [4xtreadmill angina]). The chest pain score...
A simple score for predicting coronary artery disease in patients with chest pain

Ref ID 394 QJM : monthly journal of the Association of Physicians, pp. 803 to 811, 2005

Grant from the special Trustee's of Guy's and St Thomas' NHS trust

Study Type Cohort

Number of participants 404 patients recruited from 363 consecutive patients seen as out-patients, and 829 consecutive patients undergoing day-case coronary angiography. 155 of the 404 had an exercise test.

Inclusion/Exclusion Criteria Inclusion: chest pain for > 1 month without a previous history of MI, coronary angiography, angioplasty or coronary artery bypass grafting. Exclusion: ECG showed pathological Q waves or regional wall motion abnormalities on echocardiogram.

Patient Characteristics The mean age was 60.6±9.5 years. 66% (268) were males, the mean age for males 60.5±9.1 years; 34% (137) were females, the mean ages for females was 60.8±10.2 years. Of all the patients 60% (244) had significant coronary artery disease; 40% (161) had normal coronary anatomy.

Recruitment Patients who met criteria recruited from out patients at Cardiothoracic Centre, Guy’s and St Thomas’ Hospital, London, UK

Setting Guy’s and St Thomas’ Hospital, London, UK

Interventions/ Test/ Factor being investigated Diagnosing chest pain

Comparisons The chest pain score was based on: description of pain, clinical history, medication, clinical examination, stigmata of risk, resting ECG.

Length of Study/ Follow-up Not reported

Safety and adverse effects

None reported

Does the study answer the question?

Multivariant Poisson regression analysis showed that gender (P < 0.001), age (P < 0.001), relief with rest (P=0.046), dizziness (P=0.030), smoking (P=0.006), hypertension (P=0.016), hypercholesterolemia (P=0.214), diabetes (P=0.016) and chest pain score were (P = 0.009) independently differentiated those patients with and without coronary artery disease. A secondary analysis was conducted to relate the chest pain score to the Framingham and Duke scores. The chest pain score was found to have a sensitivity of 91.4% and a specificity of 28%, compared to the Duke score's sensitivity of 82.4% and specificity of 31%. The study found that the combination of the chest pain score with Framingham and the Duke score had additive predictive value for risk of coronary artery disease.

Effect due to factor in study? Yes

Consistency of results with other studies? Consistent

Directly applicable to guideline population? Correct population

Internal Validity Well covered

Wu EB; Hodson F; Chambers JB;
Diagnosis of coronary artery disease, or exclusion of diagnosis of coronary artery disease

Multivariant Poisson regression analysis showed that gender (P < 0.001), age (P < 0.001), relief with rest (P = 0.046), dizziness (P = 0.030), smoking (P = 0.006), hypertension (P = 0.016), hypercholesterolemia (P = 0.214), diabetes (P = 0.016) and chest pain score (P = 0.009) were independently differentiated those patients with and without CAD. A secondary analysis was conducted to relate the chest pain score to the Framingham and Duke Scores. The Duke Score is a weighted index based on ST-segment deviation, treadmill time and exercise-induced angina (Duke Treadmill Score = Exercise time – [5xSTdeviation] – [4xtreadmill angina]). The chest pain score was found to have a sensitivity of 91.4% and a specificity of 28%, compared to the Duke score’s sensitivity of 82.4% and specificity of 31%. The study found that the combination of the chest pain score with Framingham and the Duke score had additive predictive value for risk of coronary artery disease.

Safety and adverse effects

None reported

Does the study answer the question?

Multivariant Poisson regression analysis showed that gender (P < 0.001), age (P < 0.001), relief with rest (P = 0.046), dizziness (P = 0.030), smoking (P = 0.006), hypertension (P = 0.016), hypercholesterolemia (P = 0.214), diabetes (P = 0.016) and chest pain score were (P = 0.009) independently differentiated those patients with and without coronary artery disease. A secondary analysis was conducted to relate the chest pain score to the Framingham and Duke scores. The chest pain score was found to have a sensitivity of 91.4% and a specificity of 28%, compared to the Duke score’s sensitivity of 82.4% and specificity of 31%. The study found that the combination of the chest pain score with Framingham and the Duke score had additive predictive value for risk of coronary artery disease

Effect due to factor in study?

Yes

Consistency of results with other studies?

Consistent

Directly applicable to guideline population?

Correct population

Internal Validity

Well covered
**Grading:** 2- Case–control or cohort studies with a high risk of confounding bias, or chance and a significant risk that the relationship is not causal*

**Cook DG; Shaper AG;**

Breathlessness, angina pectoris and coronary artery disease

<table>
<thead>
<tr>
<th>Ref ID</th>
<th>10282</th>
<th>The American journal of cardiology</th>
<th>921 to 924</th>
<th>1989</th>
</tr>
</thead>
</table>

**Study Type** | Cohort | **Funding** | Royal Free Hospital, London; British Heart Foundation Research Group; Medical Research Council and Department of Health, London; The Chest Heart and Stroke Association; Scottish Home and Health Department; Greater Glasgow Health Board

**Number of participants** | 7735 men |

**Inclusion/Exclusion Criteria** | Random selection of men from different GP practices, patients were excluded if they had severe mental or physical disability

**Patient Characteristics** | Not reported

**Recruitment** | Random selection of men from different GP practices, patients were excluded if they had severe mental or physical disability

**Setting** | Primary care, UK

**Interventions/ Test/ Factor being investigated** | Breathlessness affecting Angina

**Comparisons** | Breathlessness and other risk factors

**Length of Study/ Follow-up** | 5 years

**Outcome measures studied** | Prevalence of Angina after 5 years

**Results**

Age-standardised prevalence rates of CAD by breathlessness grade:
- None: 6394 men, 3.5% recall, 6.5% ECG, 7% possible MI, 4.4% angina
- Mild: 697 men, 8.7% recall, 9.1% ECG, 12.6% possible MI, 15.5% angina
- Moderate: 358 men, 17.7% recall, 14.6% ECG, 21.8% possible MI, 28.8% angina
- Severe: 273 men, 27.6% recall, 18.5% ECG, 33.3% possible MI, 40.9% angina
- All: 7722 men, 5.5% recall, 7.6% ECG, 9.1% possible MI, 7.9% angina.

Prevalence of angina by breathlessness grade:
- None: 89% none, 7% mild, 3% moderate, 1% severe
- Nonexertional pain: 79% none, 11% mild, 5% moderate, 4% severe
- Possible angina:
  - Grade 1: 51% none, 18% mild, 16% moderate, 15% severe
  - Grade 2: 31% none, 9% mild, 17% moderate, 43% severe
- Definite angina:
  - Grade 1: 45% none, 22% mild, 19% moderate, 14% severe
  - Grade 2: 30% none, 2% mild, 20% moderate, 48% severe.

Mean levels of risk factors for CAD by breathlessness grade:
None: 49.9 years old, 39% smokers, 25.4 kg/m² BMI, 144.9 mmHg systolic blood pressure, 6.30 mmol/l serum total cholesterol
Mild: 51.1 years old, 53% smokers, 26.1 kg/m² BMI, 146.4 mmHg systolic blood pressure, 6.27 mmol/l serum total cholesterol
Moderate: 52.6 years old, 53% smokers, 26.2 kg/m² BMI, 145.4 mmHg systolic blood pressure, 6.31 mmol/l serum total cholesterol
Severe: 53.5 years old, 52% smokers, 25.7 kg/m² BMI, 143.4 mmHg systolic blood pressure, 6.24 mmol/l serum total cholesterol.

Age-standardised prevalence rate of angina in % by breathlessness grade and smoking:
None: 4.5% never smoked, 4.5% ex-smoker, 4.3% current smoker
Mild: 18.5% never smoked, 18.2% ex-smoker, 12.6% current smoker
Moderate: 25.7% never smoked, 26.7% ex-smoker, 30% current smoker
Severe: 25.5% never smoked, 36.5% ex-smoker, 45.9% current smoker
All: 6.2% never smoked, 7.9% ex-smoker, 8.6% current smoker.

Age-standardised prevalence rate of angina in % 5 years after initial screening:
None: 5.8% no angina, 47.1% angina
Mild: 13% no angina, 44.9% angina
Moderate: 24.6% no angina, 58.6% angina
Severe: 28.2% no angina, 74.4% angina.

Relation of breathlessness grade at screening to outcome at 5 years in men with no evidence of CAD:
None: 5228 men, 91.9% alive with no CAD, 4% alive with angina, 1.6% nonfatal MI, 0.9% dead from MI, 1.6% dead from non CAD cause
Mild: 471 men, 82.6% alive with no CAD, 10% alive with angina, 2.3% nonfatal MI, 0.8% dead from MI, 4.3% dead from non CAD cause
Moderate: 177 men, 72.7% alive with no CAD, 20.9% alive with angina, 2.1% nonfatal MI, 0.9% dead from MI, 3.4% dead from non CAD cause
Severe: 100 men, 62.8% alive with no CAD, 25.4% alive with angina, 2.7% nonfatal MI, 2.4% dead from MI, 6.7% dead from non CAD cause.

Safety and adverse effects
Does the study answer the question?

This study is a publication from the British Regional Heart Study. The men in the study were classified into 3 groups based on the smoking status (never smoked, ex-smoker, current smoker), their BMI was also recorded. A modified version of the Medical Research Council Questionnaire on Respiratory Symptoms (1966 version) was also carried out. The patient’s lung function was also recorded based on the forced expiratory volume in 1 second measured using a Vitalograph J49-B2 spirometer, based on 2 consecutive readings 15 seconds apart (after an initial “practice”). The men were also split into two groups based on the presence or absence of CAD was also evaluated based on the World Health Organisation questionnaire on chest pain (which cover both CAD and MI), a 3-lead ECG recording and the patient reporting being given a diagnosis of angina or MI by a doctor. The patients were followed up for 5 years with 99% of the population being followed up. At the follow up there had been 166 nonfatal heart attacks, 119 fatal heart attacks or sudden cardiac deaths and 155 deaths from non-ischemic causes.

The study applied logistic models to find the age standardised prevalence and incidence rates of angina with age being the continuous variable. The study considered the relationship between breathlessness and chest pain, with the result of men with breathlessness being more likely to have angina than those with chest pain or with non-exertional chest pain. Breathlessness was also more common in those with grade 2 angina than those with grade 1 angina (however the study states that grade 1 angina only had 95 men and was too small to be used in evaluation).

The study also considered the effect of smoking, which showed that smoking was not strongly related to breathlessness in men, with the rate of angina increasing dependant upon the breathlessness grade but not with smokers. This can be seen as men who had smoked had only a 39% higher rate of angina compared to those who had never smoked. The authors concluded that smoking was not an important risk factor for angina. However breathlessness was strongly related to angina (men with grade 2 or 3 breathlessness were 5 times as likely to develop angina after 5 years as those with graded 0 or 1). There was also a strong relationship between breathlessness and the presence of signs and symptoms of CAD.
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
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<tbody>
<tr>
<td>Effect due to factor in study?</td>
<td>Yes</td>
</tr>
<tr>
<td>Consistency of results with other studies?</td>
<td>Yes</td>
</tr>
<tr>
<td>Directly applicable to guideline population?</td>
<td>Mixed population, selected from GP practices</td>
</tr>
<tr>
<td>Internal Validity</td>
<td>Well covered</td>
</tr>
</tbody>
</table>
Question: Are the symptoms and description of the symptoms different in women presenting with stable chest pain of suspected cardiac origin compared with men
Grading: 2++  High-quality systematic reviews of case–control or cohort studies High-quality case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal.

Diamond GA; Forrester JS;

Analysis of probability as an aid in the clinical diagnosis of coronary-artery disease

Ref ID: 2196  The New England journal of medicine  1350 to 1358  1979

Study Type: Cohort  Funding: Not reported.

Number of participants: Two separate cohorts assessed: 4952 patients referred for coronary angiography, 23,996 autopsies.

Inclusion/Exclusion Criteria: Not applicable.

Patient Characteristics: Suspected stable angina in 1 cohort (patients referred for angiogram).

Patients were considered to have typical angina if they had substernal discomfort brought on by physical exertion and was relieved within 10 minutes through rest or nitroglycerin.

Patients were considered to have atypical angina if they had discomfort which was either not substernal or was not bought on by exertion or not relieved after 10 minutes by rest or nitroglycerin. Patients were considered to have non-anginal discomfort if they did not have 1 or more of the above characteristics.

Autopsy: general population.

Recruitment: Patients referred for angiography.

Setting: Secondary care, USA.

Interventions/Test/Factor being investigated: Prevalence of coronary artery disease based on age, sex and symptoms.

Comparisons: Coronary angiography in 1 cohort, evidence of stenosis in 2 cohort at autopsy.

Length of Study/Follow-up: Not applicable.

Outcome measures studied: Prevalence of coronary artery disease based on age, sex and symptoms.

Results:

In 4953 patients with stable chest pain referred for angiogram; the prevalence of disease in patients with typical angina symptoms was about 90%, whereas for atypical angina patients was a 50% prevalence (P < 0.001) and non-cardiac chest pain patients was 16% (P < 0.001). The prevalence of CAD observed at autopsy is similar to that in asymptomatic patients confirmed by coronary angiography.

Significant differences in disease prevalence occurred when patients were classified according to age and sex. For women the differences range from 0.3% for women aged 30 years to 39 years of age, to 7% for women aged 60 years to 69 years. Women in all age ranges had a lower prevalence compared with the respective age ranges in men.

The pre-test likelihood of disease for any patients (according to any combination of age, sex and symptoms) was determined by conditional-probability analysis. There are a wide range of pre-test likelihoods according to sex, gender and symptoms. For example a women with atypical symptoms and aged 35% has a pre-test likelihoods of 4% compared with 92% for a man aged 55 years with typical symptoms.

The authors noted that the approach used in the study was a mathematical formalisation of the intuition of the physicians reviewing the literature, or the use of...
past experience to assess a patients’ pre-test likelihoods. Both of these approaches relied upon the use of data from specific populations, but that they do provide reliable estimates of the probability of coronary artery disease based on the patients age, symptoms and gender.

Safety and adverse effects

Does the study answer the question?

Yes. The study reviewed the literature to estimate the pre-test likelihood of disease (defined by age, sex and symptoms), and the results were analysed through Bayes' theorem of conditional probability. The studied described how the probability of CAD can be determined in a patient before testing from information readily obtained from clinical evaluation.

The study showed that combining data of the estimate of disease likelihood when the patient’s age and sex are known and a second estimate when the presence or absence of symptoms are known provides an estimate of the pre-test likelihood of disease for any patients based on any combination of age, sex and symptoms can be determined by conditional-probability analysis. For example, the likelihood of a woman having CAD at age ranges less than 59 years and with typical angina symptoms will be lower than a man with in the comparable age ranges.

Effect due to factor in study?

Yes

Consistency of results with other studies?

Consistent

Directly applicable to guideline population?

Patients in cohort used to develop theoretical pre-test likelihoods had stable chest pain, directly applicable to the guideline.

Internal Validity

Well covered

Zaman MJ;Junghans C;Sekhri N;Chen R;Feder GS;Timmis AD;Hemingway H;

Presentation of stable angina pectoris among women and South Asian people.[see comment]


Study Type Cohort

Funding In part, British Heart Foundation for primary author

Number of participants Of 11 082 patients seen at the rapid chest pain access clinic the following patients where excluded; 579 previous CAD, 246 patients diagnosed with ACS on day of visit, 448 prior visit to the unit during study period, 291 no chest pain, 501 due to missing data, 83 pain not diagnosed with angina, 40 not tracked by the Office for National Statistics, 968 excluded as other ethnic background (not Caucasian or Asian). Thus of the final number of people identified (7794), 2676 were Caucasian women, 2929 were Caucasian men, 980 were South Asian women, and 1209 were South Asian men

Inclusion/Exclusion Criteria Inclusion: suspected angina, recent onset chest pain

Patient Characteristics Women South Asian median age 57.6 years (49 to 67 years), Women Caucasian median age 50.6 years (42 to 58 years) (P < 0.001), Men South Asian median age 49.8 years (41 to 69 years), Men Caucasian median age 54.7 years (45 to 65 years) (P < 0.001). South Asian versus Caucasian women more likely to have diabetes and hypertension, less likely to smoke. South Asian versus Caucasian men more likely to have hypertension, less likely to smoke.

Recruitment Consecutive recent onset chest pain from 6 rapid access chest pain clinics

Setting UK rapid access chest pain clinics

15 September 2009 Page 156 of 199
Gender and race presentation atypical versus typical pain

Gender and race presentation atypical versus typical pain, outcomes of death from ACS and hospital admission due to ACS (coded according to ICD-10 classification) determined up to 3 years of clinic visit.

3 years from clinic visit

Outcomes of death from ACS and hospital admission due to ACS (coded according to ICD-10 classification)

More women than men reported atypical chest pain symptoms (56.5% versus 54.5%, respectively P = 0.054). Cardiologists were more likely to describe the symptoms of women as atypical compared with men (73.3% agreement between cardiologist summary and the symptom score, kappa statistic 0.43). With respect to symptoms and diagnosis, sex did not modify the association between exercise echocardiography results and receiving a diagnosis of angina, and after excluding patients with a positive exercise test result, cardiologist and typical symptom scores both remained predictive of a diagnosis of angina. With respect to symptoms and diagnosis, using cardiologist summaries typical symptoms in women were more strongly associated with coronary death or ACS (hazard ratio 3.74, 95% CI 2.80 to 5.01) than among men (hazard ratio 1.51, 95% CI 1.16 to 1.97, P < 0.001). This finding was also true for symptom scores (women; hazard ratio 2.30, 95% CI 1.70 to 3.11, men; hazard ratio 1.23, 95% CI 0.96 to 1.57, P < 0.002). According to cardiologist summaries and symptom scores, women with typical symptoms were more likely than men to have coronary outcomes (cardiologist summaries for women hazard ratio 1.49, 95% CI 1.09 to 2.04, and symptom score for women hazard ratio 1.39, 95% CI 1.06 to 1.84).

Women with atypical symptoms were less likely than men with atypical symptoms to experience a coronary outcome (unadjusted log rank test P = 0.001), although adjusted Cox regression ratios showed that atypical pain had similar prognostic value for coronary outcomes for women and men. The authors stated that compared to those with atypical chest pain, women with typical symptoms had worse clinical outcomes.

More South Asians compared with Caucasians reported atypical chest pain symptoms (59.9% versus 52.5%, respectively P < 0.001), and the cardiologist described more South Asians as having atypical presentation compared with Caucasians. South Asians were also more likely to report pain that was not associated with exercise. With respect to symptoms and diagnosis, ethnicity did not modify the association between exercise echocardiography results and receiving a diagnosis of angina, and after excluding patients with a positive exercise test result, cardiologist and typical symptom scores both remained predictive of a diagnosis of angina. According to cardiologist summaries and symptom scores, South Asians with typical symptoms were as likely as Caucasians with typical symptoms to have a coronary outcome for cardiologist summaries (hazard ratio 1.27, 95% CI 0.89 to 1.81), and more likely with symptom scores (hazard ratio 1.41, 95% CI 1.04 to 1.91). Among South Asians with atypical symptoms, the symptom score was associated with coronary outcomes (unadjusted log rank test P = 0.30), although adjusted Cox regression ratios showed that atypical pain had similar prognostic value for coronary outcomes across ethnic background.

The authors stated that compared to those with atypical chest pain, women with typical symptoms had worse clinical outcomes, with atypical chest pain, South Asians with typical symptoms had worse clinical outcomes.

Chest pain patients with suspected angina, directly relevant to guideline
Internal Validity

Well covered
Question: Are the symptoms and description of the symptoms different in Black and Ethnic Minorities presenting with stable chest pain of suspected cardiac origin compared with Caucasians?

Grading: 2++ High-quality systematic reviews of case–control or cohort studies High-quality case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal.

Zaman MJ; Junghans C; Sekhri N; Chen R; Feder GS; Timmis AD; Hemingway H;

Presentation of stable angina pectoris among women and South Asian people. [see comment]

Ref ID: 25388

Study Type: Cohort

Number of participants

Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity

Zaman MJ; Junghans C; Sekhri N; Chen R; Feder GS; Timmis AD; Hemingway H; Classic 2008, pgs 659 to 667, pgs 669 to 667, pgs 679 to 677.
Question: What is the utility (incremental value) and cost effectiveness of the resting ECG in evaluation of individuals with stable chest pain of suspected cardiac origin?
Bedside diagnosis of coronary artery disease: a systematic review

Ref ID 10275 The American journal of medicine 334 to 343 2004

Study Type Systematic Review

Funding Not reported

Number of participants 64 studies

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

The paper reviewed both studies of acute patients and stable patients.

Acute patients
The review considered patients with acute chest pain of suspected cardiac origin, ECG changes were found to the most discriminating criteria for the diagnosis of acute MI compared with signs and symptoms and risk factors. For a normal ECG the sensitivity was 1 to 13%, specificity was 48 to 77%, LR+ 0.20 (95%CI 0.1 to 0.3) and LR- 1.4 (95% CI 1.4 to 1.6). For ST-T wave abnormalities the sensitivity was 5 to 7%, specificity was 47 to 77%, LR+ 0.20 (95%CI 0.1 to 0.6) and LR- 1.5 (95% CI 0.9 to 2.6). For ST elevation the sensitivity was 31 to 49%, specificity was 97 to 100%, LR+ 22 (95%CI 16 to 30) and LR- 0.6 (95% CI 0.6 to 0.6). For ST depression the sensitivity was 20 to 62%, specificity was 88 to 96%, LR+ 4.5 (95%CI 3.6 to 5.6) and LR- 0.8 (95% CI 0.7 to 0.9). Q wave had a sensitivity of 10 to 34% and a specificity of 96 to 100%, LR+ 22 (95% CI 7.6 to 62) and LR- 0.8 (95% CI 0.8 to 0.9). T wave inversion had a sensitivity of 9 to 39%, and a specificity of 84 to 94%, LR+ 2.2 (95%CI 1.8 to 2.6) and LR- 0.9 (95% CI 0.8 to 1.0).

The review found that for diagnosing coronary artery disease in patients with stable chest pain the ECG gave little additional diagnostic information to the history and risk factor findings.

Stable patients:
Most studies, in patients presenting with stable intermittent chest pain were then referred for coronary angiography. The majority of these studies excluded patients...
with valvular heart disease or non-ischaemic cardiomyopathy. The studies used either > 50% stenosis or 70-75% stenosis off any epicardial vessel as the diagnostic standard. Patients presenting with acute MI were hospitalised for further monitoring and testing.

The review found that for diagnosing coronary artery disease the ECG gave little additional diagnostic information. A normal ECG gave a sensitivity of 23 to 33%, a specificity of 50-69%, LR+ 0.7 (95% CI 0.3 to 1.6) and a LR- 1.2 (95% CI 0.8 to 1.9). For ST-T wave abnormalities the sensitivity was 14 to 44%, specificity was 73 to 93%, LR+ 1.4 (95% CI 1.0 to 1.9) and LR- 0.9 (95% CI 0.9 to 1.0).

| Effect due to factor in study? | Yes |
| Consistency of results with other studies? | Consistent |
| Directly applicable to guideline population? | Correct population |

**Internal Validity**
Grading: 2++

High-quality systematic reviews of case–control or cohort studies
High-quality case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal

Pryor DB; Shaw L; McCants CB; Lee KL; Mark DB; Harrell FE; Muhlbaijer LH; Califf RM;

Value of the history and physical in identifying patients at increased risk for coronary artery disease

Ref ID 1751 Annals of internal medicine 1993

Study Type Cohort Funding Agency for Health Care Policy and Research, National Heart, Lung and Blood Institute, National Library of Medicine

Number of participants 1030 patients, 168 had cardiac catheterization

Inclusion/Exclusion Criteria
Inclusion: Symptomatic patients, referred for non-invasive testing for suspected coronary artery disease
Exclusion: previous cardiac catheterization

Patient Characteristics
The mean age was 55, 37% were female, the mean pain frequency was 2 episodes a week, the mean durations of CAD symptoms was 12 months, 28% had typical angina symptoms, 52% atypical angina symptoms, 20% nonanginal pain, 18% progressive angina, 22% nocturnal angina, 44% smoked, 41% had a history of hypertension, 10% had diabetes, 11% had hyperlipidemia, 35% had ST-T wave changes on ECG, 18% had a history of MI, 8% had Q waves on ECG, 14% had a history of congestive heart failure, 0% had class IV congestive heart failure, 1% had ventricular gallop, 3% had peripheral vascular disease, 3% had cerebral vascular disease.

Of the patients who went on to have a cardiac catheterization the mean age was 56, 31% were female, the mean pain frequency was 2 episodes a week, the mean durations of CAD symptoms was 7 months, 49% had typical angina symptoms, 47% atypical angina symptoms, 4% nonanginal pain, 24% progressive angina, 24% nocturnal angina, 53% smoked, 42% had a history of hypertension, 10% had diabetes, 13% had hyperlipidemia, 42% had ST-T wave changes on ECG, 33% had a history of MI, 11% had Q waves on ECG, 11% had a history of congestive heart failure, 0% had class IV congestive heart failure, 1% had ventricular gallop, 4% had peripheral vascular disease, 2% had cerebral vascular disease.

It can therefore be seen that those having a cardiac catheterization were more likely to be male, smoke, have a history of MI, have ST-T wave changes on ECG and to be suffering typical or progressive angina.

Recruitment
Patients were referred for non-invasive testing for suspected coronary artery disease

Setting Duke University Medical Center USA

Interventions/ Test/ Factor being investigated
Physicians initial evaluation of patients with suspected CAD predicts coronary anatomy

Comparisons
The presence of significant coronary disease defined as any disease, severe disease, left main disease

Length of Study/ Follow-up
90 days

Outcome measures studied
Effectiveness of chest pain score to predict coronary artery disease

Results
The three diagnostic outcomes were; the presence of significant coronary artery disease defined as ‘any disease’ (≥ 75% luminal diameter narrowing of at least one major coronary artery), presence of severe coronary artery disease defined as ‘severe disease’ (significant obstruction of all 3 main coronary arteries or the left main coronary artery) and the presence of significant left main artery obstruction defined as ‘left main disease’ (168 patients referred for cardiac catheterization). The prognostic
In the multivariable regression model used, the following variables were significant predictors for any disease; significant Q waves and ST-T wave changes (as well as age, gender, chest pain (type), diabetes, smoking, hyperlipidaemia and previous history of myocardial infarction). For severe disease, the following variables were significant predictors; significant Q waves and ST-T wave changes (as well as age, gender, chest pain (type, frequency, course, nocturnal, length of time present), diabetes, smoking, hyperlipidaemia, hypertension, peripheral or cerebral artery disease, carotid bruit and previous history of myocardial infarction). For left main disease ECG changes were not significant predictors. For survival at 3 years the following variables were significant predictors; significant Q waves and ST-T wave changes, conduction abnormalities, (as well as age, gender, chest pain (frequency, course, nocturnal), peripheral or cerebral artery disease, carotid bruit, ventricular gallop, previous history of myocardial infarction, premature ventricular contractions and cardiomegaly).

The likelihood of any disease, severe coronary disease, left main disease and survival was predicted from the initial history, physical examination, electrocardiogram and chest X ray (these tests were defined as the ‘initial evaluation’). The models which were used were based on mathematical models in a previous study (Pryor, 1983 – see extraction). Predicted coronary artery endpoints and survival based on the initial evaluation closely corresponded to actual findings. Predictions using the initial evaluation were then compared with predictions based on the treadmill exercise test. The initial evaluation was slightly better at distinguishing patients with and without coronary artery disease compared with the treadmill exercise test. The initial evaluation and the treadmill exercise test had similar discriminatory performances for patients with and without severe disease and risk of death at 3 years, while for left main disease, the treadmill exercise test was slightly better for identify patients with left main disease.

Safety and adverse effects

None reported

Does the study answer the question?

Yes

Effect due to factor in study?

Consistent

Consistency of results with other studies?

Correct population

Directly applicable to guideline population?

Correct population

Internal Validity

Well covered

In the multivariable regression model used, the following variables were significant predictors for any disease; significant Q waves and ST-T wave changes. For severe disease, the following variables were significant predictors; significant Q waves and ST-T wave changes. For left main disease ECG results were not significant predictors. For survival at 3 years the following variables were significant predictors; significant Q waves and ST-T wave changes. The likelihood of any disease, severe coronary disease, left main disease and survival was predicted from the initial history, physical examination, electrocardiogram and chest X ray (these tests were defined as the ‘initial evaluation’).

Predicted coronary artery endpoints and survival based on the initial evaluation closely corresponded to actual findings. Predictions using the initial evaluation were then compared with predictions based on the treadmill exercise test. The initial evaluation was slightly better at distinguishing patients with and without coronary artery disease compared with the treadmill exercise test. The initial evaluation and the treadmill exercise test had similar discriminatory performances for patients with and without severe disease and risk of death at 3 years, while for left main disease, the treadmill exercise test was slightly better for identify patients with left main disease. The models which were used were based on mathematical models in a previous study (Pryor, 1983 – see extraction).
Patient Characteristics

Physicians initial evaluation of patients with suspected CAD predicts coronary anatomy

Comparisons

The presence of significant coronary disease defined as any disease, severe disease, left main disease

Length of Study/ Follow-up

90 days

Outcome measures studied

Effectiveness of chest pain score to predict coronary artery disease

Results

The three diagnostic outcomes were; the presence of significant coronary artery disease defined as ‘any disease’ (≥ 75% luminal diameter narrowing of at least one major coronary artery), presence of severe coronary artery disease defined as ‘severe disease’ (significant obstruction of all 3 main coronary arteries or the left main coronary artery) and the presence of significant left main artery obstruction defined as ‘left main disease’ (168 patients referred for cardiac catheterization). The prognostic
In the multivariable regression model used, the following variables were significant predictors for any disease; age, gender, chest pain (type), diabetes, smoking, hyperlipidaemia, previous history of myocardial infarction, and significant Q waves and ST-T wave changes. For severe disease, the following variables were significant predictors; age, gender, chest pain (type, frequency, course, nocturnal, length of time present), diabetes, smoking, hyperlipidaemia, hypertension, peripheral or cerebral artery disease, carotid bruit, previous history of myocardial infarction, and significant Q waves and ST-T wave changes. For left main disease, the following variables were significant predictors; age, gender, chest pain (type), diabetes, peripheral or cerebral artery disease and carotid bruit. For survival at 3 years the following variables were significant predictors; age, gender, chest pain (frequency, course, nocturnal), peripheral or cerebral artery disease, carotid bruit, ventricular gallop, previous history of myocardial infarction, significant Q waves and ST-T wave changes, conduction abnormalities, premature ventricular contractions and cardiomegaly. The likelihood of any disease, severe coronary disease, left main disease and survival was predicted from the initial history, physical examination, electrocardiogram and chest X ray (these tests were defined as the ‘initial evaluation’).

Predicted coronary artery endpoints and survival based on the initial evaluation closely corresponded to actual findings. Predictions using the initial evaluation were then compared with predictions based on the treadmill exercise test. The initial evaluation was slightly better at distinguishing patients with and without coronary artery disease compared with the treadmill exercise test. The initial evaluation and the treadmill exercise test had similar discriminatory performances for patients with and without severe disease and risk of death at 3 years, while for left main disease, the treadmill exercise test was slightly better for identify patients with left main disease.

Safety and adverse effects

None reported

Consistency of results with other studies?

Consistent

Effect due to factor in study?

Yes

Does the study answer the question?

Yes
<table>
<thead>
<tr>
<th><strong>Directly applicable to guideline population?</strong></th>
<th>Correct population</th>
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<tbody>
<tr>
<td><strong>Internal Validity</strong></td>
<td>Well covered</td>
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</table>
Question: What is the diagnostic utility of calcium scoring for the evaluation of patients with stable chest pain of cardiac origin.
Grading: 2++
High-quality systematic reviews of case–control or cohort studies
High-quality case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal

Budoff MJ; Diamond GA; Raggi P; Arad Y; Guerci AD; Callister TQ; Berman D;

15 September 2009 Page 169 of 199
Continuous probabilistic prediction of angiographically significant coronary artery disease using electron beam tomography

Ref ID 9143 Circulation 1791 to 1796 2002

Study Type Diagnostic

Number of participants

Of the 1851 patients, 1466 (79%) had a total calcium score of > 0 (range from 1 to 6649). Overall sensitivity prediction of obstructive CAD was 96% and specificity was 40% for calcium scoring. For calcium scores >20, >80 and >100, sensitivity decreased from 90% to 73% to 76%, specificity increased from 58% to 72% to 75%. Of 1851 patients, 938 (53%) had luminal stenosis greater 50% in 1 or more vessels, and their mean total calcium score was 608 (range 0 to 6646). Calcium scores were lower for patients without obstructive disease (838 patients, mean calcium score 123 with range 0 to 3761, P > 0.001) compared with patients with obstructive disease. Calcium scoring considerably alters the post test probability across a wide range of patients. Patients that exhibited the greatest change from pre- to post-test probability were those patients with pre-test probabilities ranging from 20% to 70%.

Internal Validity


Correlation of coronary calcification and angiographically documented stenoses in patients with suspected coronary artery disease: results of 1,764 patients

Ref ID 10437 Journal of the American College of Cardiology 451 to 457 2001
Men had higher calcium compared with women, increasing age was associated with higher scores, and calcium scores in patients with coronary artery disease were higher than those patients without coronary artery disease. No calcium was detected in 128 (23.7%) of 540 men and in 116 (40.8%) of 284 women without significant coronary artery disease, as compared with 5 (0.7%) of 685 men and 0 of 255 women with coronary stenoses greater than or equal to 50%. Thus, exclusion of coronary calcification was associated with an extremely low probability of stenoses greater than or equal to 50% in men and women. At various score ranges. The sensitivities for calcium scores were higher than their respective specificities and this was especially marked for a score > 0 (any calcium detected) (sensitivities; 99% in men and 100% in women, specificities; 23% in men and 40% in women).

Effect due to factor in study?
Consistency of results with other studies?
Directly applicable to guideline population?

results are directly applicable.

Internal Validity
Well covered

Knez A; Becker A; Leber A; White C; Becker CR; Reiser MF; Steinbeck G; Boekstegers P;

Relation of coronary calcium scores by electron beam tomography to obstructive disease in 2,115 symptomatic patients

Ref ID 6184 Am J Cardiol 1150 to 1152 2004

Study Type Diagnostic
Funding Not reported
Number of participants
Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

The results are directly applicable.

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity

Konieczynska M; Tracz W; Pasowicz M; Przewocki T;

Use of coronary calcium score in the assessment of atherosclerotic lesions in coronary arteries

<table>
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<tr>
<th>Ref ID</th>
<th>Title</th>
<th>Year</th>
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<tr>
<td>2708</td>
<td>Use of coronary calcium score in the assessment of atherosclerotic</td>
<td>2006</td>
</tr>
<tr>
<td></td>
<td>lesions in coronary arteries</td>
<td></td>
</tr>
</tbody>
</table>

Study Type: Diagnostic

Funding: Not reported.

Number of participants

Inclusion/Exclusion Criteria

Patient Characteristics

15 September 2009
340 patients had mean calcium score 271±606 (range 0 to 7002). 92 patients had score of 0 / 248 patients > 0. 162 patients (48%) no significant angiographic lesions. Mean calcium scores increased with coronary artery disease severity, and the calcium score mean differences were significant comparing patients without coronary stenosis, and patients with vessel disease, respectively (P < 0.001). Patients with > 70% stenosis and three-vessel disease had median score of 3740 (range 2635 to 4716, 3 patients). For calcium score greater or equal to 56 sensitivity 86% and specificity 85%. PPV 86% and NPV 84%. 92 patients (27%) had calcium scores of 0: 44 women and 48 men. In 44 women coronary angiography no stenosis. In 6 men (6.5%) with calcium scores of 0, coronary angiography found stenoses; single vessel disease in 3 men, 2 vessel disease in 2 men, and 3 vessel disease in 1 man.

The results are directly applicable.

Impact of coronary calcium score on diagnostic accuracy of multislice computed tomography coronary angiography for detection of coronary artery disease

Pundziute G; Schuijf JD; Jukema JW; Lamb HJ; de RA; van der Wall EE; Bax JJ;

__**Study Type**__

Diagnostic

__**Funding**__

European Society of Cardiology and Netherlands Heart Foundation.
41 patients 16 slice-CT and 60 patients 64-slice CT. 16-slice MSCT: coronary angiography detected obstructive coronary lesions in 18 (44%) patients, and overall calcium score sensitivity and specificity values 89% and 87%. 64-slice MSCT: coronary angiography detected obstructive coronary lesions in 32 (53%) patients, and the overall sensitivity and specificity values 91% and 96%. There was little difference in the diagnostic accuracy of 16- and 64-slice MSCT between the four Agatston groups (0 to 100, 101 to 400, > 400 and > 100) Patients with > 70% stenosis and only single vessel involvement had a median score of 482 (range 23 to 2450, 12 patients).

Effect due to factor in study?
Consistency of results with other studies?
Directly applicable to guideline population?
The results are directly applicable.

Internal Validity
Grading: 2+  
Well-conducted case–control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal

Herzog C; Britten M; Balzer JO; Mack MG; Zangos S; Ackermann H; Schaechinger V; Schaller S; Flohr T; Vogl TJ;

Multidetector-row cardiac CT: diagnostic value of calcium scoring and CT coronary angiography in patients with symptomatic, but atypical, chest pain

Ref ID 6464  
Eur Radiol  
pp. 169 to 177  
2004

Study Type  
Diagnostic

Number of participants

38 consecutive patients. For calcium score > 0: sensitivity 94%, specificity 25%, PPV 52%, NPV 80%. For calcium score > 400, sensitivity 67%, specificity 25%, PPV 75%, NPV 72%. Highly significant correlation between calcium score and degree of CAD. Patients with no signs of atherosclerosis from coronary angiography (20 patients) mean total scores of 104 (range 0 to 1459). Patients with > 70% stenosis and only single vessel involvement had a median score of 482 (range 23 to 2450, 12 patients). Patients with > 70% stenosis and three-vessel disease had median score of 3740 (range 2635 to 4716, 3 patients).

Does the study answer the question?

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

The results are directly applicable.

Internal Validity

Kitamura A; Kobayashi T; Ueda K; Okada T; Awata N; Sato S; Shimamoto T;

15 September 2009  
Page 175 of 199
Evaluation of coronary artery calcification by multi-detector row computed tomography for the detection of coronary artery stenosis in Japanese patients

Ref ID 4238 J Epidemiol pgs 187 to 193 2005

Study Type Diagnostic

Funding Not reported.

Number of participants

Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/Test/Factor being investigated

Comparisons

Length of Study/Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity

The results are directly applicable.

Lau GT;Ridley LJ;Schieb MC;Brieger DB;Freedman SB;Wong LA;Lo SK;Kritharides L;

Coronary artery stenoses: detection with calcium scoring, CT angiography, and both methods combined

Ref ID 4898 Radiology pgs 415 to 422 2005

Study Type Diagnostic

Funding Departments of Cardiology and Radiology, Concord
50 consecutive patients. Coronary stenosis greater 50% present in 30 (60%) of 50 patients. 14 patients had single vessel disease 16 sixteen patients had multivessel disease. Sensitivity and specificity varied according to calcium score thresholds. Mean calcium scores were higher in patients with stenosis compared with patients without stenosis: 700±541 versus 99±140 (P < 0.001). Calcium score to discriminate between the presence or absence of stenosis greater for patients than for individual vessels and segments as demonstrated by ROC curve analysis (area under ROC curve 0.88, 0.84 and 0.74, respectively).

The results are directly applicable.

Ref ID 4496  J Am Coll Cardiol  pg 552 to 557  2005

Raff GL;Gallagher MJ;O'Neill WW;Goldstein JA;

Diagnostic accuracy of noninvasive coronary angiography using 64-slice spiral computed tomography.
70 consecutive patients. The mean calcium score in patients was 326±472. 35 patients: scores from 0 to 100 / 17 patients scores of 101 to 400, and 18 out of 70 had scores of 401 to 1804. When a calcium score was low (0 to 100), sensitivity, specificity, and positive and negative predictive values for the presence of significant stenosis (stenosis > 50%) were 94%, 95%, 94% and 95%. Diagnostic accuracy was also good for score 101 to 400, however, with extreme calcification the specificity and negative predictive values were reduced (both 67%).

The results are directly applicable.
231 low to intermediate risk CAD based on calcium score calcium score patients. Obstructive CAD (greater than 50%) in 9 patients (7%) with calcium score = 0. In patients with a low calcium score (1 to 100) obstructive CAD in 18 patients. Highly significant correlation between calcium score and degree of CAD. Patients with no signs of atherosclerosis from coronary angiography (20 patients) mean total scores of 104 (range 0 to 1459).

Effect due to factor in study?
Consistency of results with other studies?

Directly applicable to guideline population?
The results are directly applicable.

Internal Validity
Question: What is the diagnostic utility of non-invasive and invasive tests for the evaluation of patients with stable chest pain of suspected cardiac origin.
Cost-effectiveness of functional cardiac testing in the diagnosis and management of coronary artery disease: a randomised controlled trial. The CECaT trial. [Review] [207 refs]

Ref ID 527

Health Technol Assess

Funding HTA NHS R&D programme.

Study Type Diagnostic

Number of participants

Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

The aim of the study was to demonstrate equivalence in exercise time between those randomised to functional tests (SPECT, MRI, stress echo) compared with angiography. The clinical outcome measure was exercise time (Modified Bruce protocol) at 18 months. After initial testing, there were unequivocal results for 98% of angiography, 94% of SPECT (P = 0.05), 78% of MRI (P < 0.001) and 96% of stress echocardiography patients (P < 0.001). Twenty two percent of SPECT patients, 20% of MRI patients and 25% of stress echo patients were not subsequently referred for an angiogram. Positive functional tests were confirmed by positive angiography in 83% of SPECT patients, 89% of MRI patients and 84% of stress echo patients. Negative functional tests were followed by positive angiograms in 31% of SPECT patients, 52% of MRI patients and 48% of stress echo patients tested. Coronary artery bypass graft surgery was performed in 10% of the angiography group, 11% in the MRI group and 13% in both the SPECT and stress echo group. Percutaneous coronary artery intervention was performed in 25% of the angiography group, 18% in the SPECT group and 23% in both the MRI and stress echo group.

At 18 months, there was no clinical difference in total exercise time comparing SPECT and stress echo with angiography. The MRI group had significantly shorter mean total exercise time compared with the angiography group (mean 35 seconds less (P < 0.05) with an upper limit of the CI 1.14 minutes less than in the angiography group). It was concluded that between 20 to 25% patients can avoid invasive testing using functional testing as a gateway to angiography without substantial effects on
outcome. MRI had the largest number of test failures and in this study had the least practical use in screening patients with suspected CAD, although it had similar outcomes to stress echo.

Effect due to factor in study?
Consistency of results with other studies?
Directly applicable to guideline population?

Internal Validity

The results are directly applicable to the guideline.
Grading: 1+  
Well-conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias

Gianrossi R; Detrano R; Mulvihill D; Lehmann K; Dubach P; Colombo A; McArthur D; Froelicher V;

Exercise-induced ST depression in the diagnosis of coronary artery disease. A meta-analysis. [Review] [171 refs]

<table>
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<tr>
<th>Ref ID</th>
<th>Circulation</th>
<th>Pages</th>
<th>Year</th>
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<tbody>
<tr>
<td>17910</td>
<td></td>
<td>87 to 98</td>
<td>1989</td>
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</table>

Study Type  Systematic Review  
Number of participants  
Inclusion/Exclusion Criteria  
Patient Characteristics  
Recruitment  
Setting  
Interventions/ Test/ Factor being investigated  
Comparisons  
Length of Study/ Follow-up  
Outcome measures studied  
Results  
Safety and adverse effects  

Does the study answer the question?  
The SR reports that there are wide variabilities in the sensitivities and the specificities in the identified 147 diagnostic studies (mean sensitivity, 68%; range, 23-100%; SD, 16%; and mean specificity, 77%; range, 17-100%; SD, 17%). These differences cannot be explained by publication year, but lower sensitivities are reported in studies with consider additional tests in conjunction with exercise ECG.

Effect due to factor in study?  
Consistency of results with other studies?  
Directly applicable to guideline population?  
The results of the study are applicable to the guideline.

Internal Validity  

15 September 2009  
Page 183 of 199
<table>
<thead>
<tr>
<th>Grading:</th>
<th>2++</th>
<th>High-quality systematic reviews of case–control or cohort studies. High-quality case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal.</th>
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Danias PG; Roussakis A; Ioannidis JP;

Diagnostic performance of coronary magnetic resonance angiography as compared against conventional X-ray angiography: a meta-analysis. [Review] [60 refs]

Ref ID 5534 J Am Coll Cardiol pp. 1867 to 1876 2004

<table>
<thead>
<tr>
<th>Study Type</th>
<th>Diagnostic</th>
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<th>Length of Study/ Follow-up</th>
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<th>Outcome measures studied</th>
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<th>Results</th>
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<th>Safety and adverse effects</th>
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<tr>
<th>Does the study answer the question?</th>
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The SR examined magnetic resonance angiography diagnostic performance at the segment, vessel and patient level, and meta-analysis found that in evaluable segments of native coronary arteries, coronary magnetic resonance angiography has moderately high sensitivity for detecting significant proximal stenosis.

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<th>Consistency of results with other studies?</th>
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<th>Directly applicable to guideline population?</th>
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The results of the SR are directly applicable to the guideline.

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<tr>
<th>Internal Validity</th>
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| Heijenbrok-Kal MH; Fleischmann KE; Hunink MG; |

Stress echocardiography, stress single-photon-emission computed tomography and electron beam computed tomography for the assessment of coronary artery disease: a meta-analysis of diagnostic performance.
Study identifies the sensitivities and specificities of imaging technologies enabling an assessment of diagnostic performance and hence provides appropriate information for the guideline.

The results are directly applicable to the guideline.

Mowatt G; Cummins E; Waugh N; Walker S; Cook J; Jia X; Hillis GS; Fraser C;

Systematic review of the clinical effectiveness and cost-effectiveness of 64-slice or higher computed tomography angiography as an alternative to invasive coronary angiography in the investigation of coronary artery disease
# Inclusion/Exclusion Criteria

## Patient Characteristics

### Recruitment

### Setting

### Interventions/ Test/ Factor being investigated

### Comparisons

### Length of Study/ Follow-up

### Outcome measures studied

### Results

### Safety and adverse effects

### Does the study answer the question?

This SR and meta-analysis aimed to assess the diagnostic value of 64-slice CT in CAD when compared to conventional CA. Methodology was clearly described. Twenty-one diagnostic studies (n=1286 patients) were included. Levels of analysis included patient (n=18), segment (n=17), left main artery (n=5), left anterior descending (LAD) overall (n=7), LAD proximal (n=5), left circumflex overall (n=7), right coronary artery overall (n=7), stents (n=6) and CABGs (n=4). The median prevalence of CAD across the 21 studies was 58%. A separate SROC curve was derived for each level of analysis e.g. one for patient-level and another for segment level. Sensitivity, specificity, PPV and NPV for patient-based evaluation were 99%, 89%, 93%, and 100%, respectively. For segment-based analysis results were 90%, 97%, 76% and 99%, respectively. The studies were heterogeneous in terms of their participants. In some studies the participants were all suspected CAD, in others they were all known CAD or a mixture of both, or with previous CABG or had LBBB.

### Effect due to factor in study?

### Consistency of results with other studies?

### Directly applicable to guideline population?

The results of the study are broadly applicable to the guideline, although up to 75% of included studies were not on stable chest pain patients.

### Internal Validity

Mowatt G; Vale L; Brazzelli M; Hernandez R; Murray A; Scott N; Fraser- C; McKenzie L; Gemmell H; Hillis G; Metcalfe M;

Systematic review of the effectiveness and cost-effectiveness, and economic evaluation, of myocardial perfusion scintigraphy for the diagnosis and management of angina and myocardial infarction

### Ref ID

786

### Study Type

Diagnostic

### Number of participants

### Inclusion/Exclusion Criteria

### Funding

HTA NHS R&D programme.

### 15 September 2009
For diagnostic studies the interventions included were SPECT vs. stress ECG, with CA as the reference standard test. In situations where CA would be inappropriate reference standard, clinical follow-up was accepted as the reference standard. For prognostic studies, strategies involving SPECT were compared with strategies that did not. These included:

- Stress ECG-SPECT-CA vs Stress ECG-CA
- Stress ECG-SPECT vs stress ECG alone
- SPECT-CA vs CA alone
- Stress ECG vs SPECT vs CA
- SPECT vs CA
- Stress ECG vs SPECT

Sensitivity: For studies excluding patients with previous MI: SPECT (n=4) median range 0.92 (0.76-0.93); Stress ECG (n=4) median range 0.66 (0.42-0.85). For studies including patients with previous MI: SPECT (n=10) median range 0.76 (0.63-0.93); Stress ECG (n=10) median range 0.63 (0.44-0.92). Due to heterogeneity among studies no weighted averages were conducted for either SPECT or stress ECG.

Specificity: For studies excluding patients with previous MI: SPECT (n=4) median range 0.74 (0.54-0.90); Stress ECG (n=4) median range 0.77 (0.58-0.88). For studies including patients with previous MI: SPECT (n=10) median range 0.65 (0.10-0.80); Stress ECG (n=10) median range 0.77 (0.41-0.80). Due to heterogeneity among studies no weighted averages were conducted for either SPECT or stress ECG.

Positive LR: the range of positive LR was 0.95-8.99 (median 2.33) for SPECT and 1.14-5.60 (median 2.06) for stress ECG. All positive LR were <10 in both tests. LR for both tests were calculated for 12 of the 16 studies. For both tests there was significant heterogeneity among positive LR (p<0.001).

Negative LR: Negative LR ranged from 0.09 to 1.12 (median 0.29) for SPECT and from 0.18 to 0.91 (median 0.57) for stress ECG. Values varied considerably among studies. Two studies showed negative LR for SPECT <0.1 (0.09) and LR for SPECT were smaller than those for stress ECG.

High quality SR. Heterogeneity of studies was taken into consideration in analysis. Prospective and retrospective primary studies of SPECT MPS.
Internal Validity

Nandalur KR; Dwamena BA; Choudhri AF; Nandalur MR; Carlos RC;

Diagnostic performance of stress cardiac magnetic resonance imaging in the detection of coronary artery disease: a meta-analysis. [Review] [44 refs]

Ref ID 1118 J Am Coll Cardiol  1343 to 1353  2007

Study Type  Diagnostic

Funding  Not stated.

Number of participants

Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population?

Internal Validity

Nandalur KR; Dwamena BA; Choudhri AF; Nandalur MR; Carlos RC;

Pryor DB; Harrell FE; Lee KL; Califf RM; Rosati RA;

Estimating the likelihood of significant coronary artery disease

Ref ID 10283 The American journal of medicine  771 to 780  1983

The SR determines the diagnostic utility of cardiac magnetic resonance imaging in the detection of CAD. The SR found that the tests have good sensitivity and specificities, however, the disease prevalence in the identified is studies high, and the performance of the test may not be as sensitive or specific in lower prevalence populations.

The included studies were determining the performance of the test to determine CAD hence the population is directly applicable to the guideline.
Patient characteristics which were collected were:

- History: age, sex, chest pain history (pain type, severity, frequency, nocturnal, progressive, preinfarctional), duration of CAD, previous history of MI, congestive heart failure, history of vascular disease (Progressive chest pain - the frequency, severity or duration had increased in the 6 weeks prior to catheterisation; Preinfarctional chest pain - a very unstable pain pattern that resulted in admission to the coronary care unit for evaluation of the possible MI)

- Risk factors: smoking, hyperlipidaemia, hypertension, diabetes, family history

- Physical examination: ventricular gallop, systolic blood pressure

- ECG: ST-T wave changes, electrocardiographic premature ventricular contractions, Electrocardiographic Q waves

- Chest X-Ray: cardiomegaly

Inclusion/Exclusion Criteria

Patients with chest pain who were referred for cardiac catheterization at the Duke University Medical Center between November 1969 and January 1982

Recruitment

Patients admitted for cardiac catheterisation between November 1969 and January 1982

Setting

Secondary care, USA

Interventions/Test/Factor being investigated

- Chest pain diagnosis

Comparisons

Patient characteristics which give a probability of disease

Length of Study/Follow-up

3627 in training population, 1811 in test population

Outcome measures studied

Probability of disease

Results

The study had a training population of 3627 patients who were seen between 1969 and January 1979, from these patients a stepwise logistic regression analysis was used to develop a model for predicting the probability of significant CAD. A test population of 1811 patients seen between January 1969 and January 1982, in this population the model developed in the test population was used to predict the probability of CAD for each patient.

The authors then tested the model in other populations (from CASS study) to estimate the prevalence of disease in subgroups of the patients in the literature (external validation)

Results from training population:
- Poor Clinical Predictors of Significant CAD and the Chi-squared: See narrative for question 4; Table 1; Pryor et al, 1983
- Cardiomegaly: 1.41

The results from the training group show that cardiomegaly shown on chest x-ray was a poor predictor of significant coronary artery disease

The authors then validated the model in the test population which showed that the predicted probability of disease is nearly identical to the observed prevalence. The authors then externally validated using the population from the CASS study. There was disagreement on patients classified as having nonanginal chest pain (where the greatest difference in predicted disease compared to observed disease was seen), but the predicted estimates from the model were nearly equal to the observed prevalence of disease. The predicted estimates from the model of the probability of significant disease were nearly identical to the observed prevalence for subgroups based on “age, sex and history of MI” or “age, sex and pain type”.

Safety and adverse effects

None

15 September 2009
Progressive chest pain was described as being chest pain when the frequency, severity or duration had increased in the 6 weeks prior to catheterisation. Preinfarctional chest pain was described as chest pain with a very unstable pain pattern that resulted in admission to the coronary care unit for evaluation of the possible MI.

The results from the training group show that cardiomegaly shown on chest X-ray was a poor predictor of significant coronary artery disease (chi-square = 1.41).

The authors then validated the model in the test population which showed that the predicted probability of disease is nearly identical to the observed prevalence. When comparing the model to an external population the study showed that the predicted estimates from the model were nearly equal to the observed prevalence of disease. The predicted estimates from the model of the probability of significant disease were nearly identical to the observed prevalence for subgroups based on “age, sex and history of MI” or “age, sex and pain type”. However the greatest difference in predicted disease compared to observed disease was seen in patients with nonangina chest pain.

Does the study answer the question?
Yes

Effect due to factor in study?
Yes

Consistency of results with other studies?
No similar studies

Directly applicable to guideline population?
Patients had chest pain

Internal Validity
Well covered

Vanhoenacker PK; Heijenbrok-Kal MH; Van HR; Decramer I; Van-Hoe LR; Wijns W; Hunink MM;

Diagnostic performance of multidetector CT angiography for assessment of coronary artery disease: meta-analysis

Ref ID: 10274
Radiology

Number of participants
Study types not specified.

Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects
This review assessed the diagnostic performance of CT angiography using 4, 16, and 64-slice detectors. Six studies of 64-slice CT were included. The study concluded that the newer generation scanners significantly reduced the proportion of non-assessable coronary artery segments. Combined with reduction of the heart rate through the use of beta-blockers, practically all coronary artery segments are assessable.

Also, as one increases the size of the unit analysed from coronary arterial segments, to vessels, and to patients, the sensitivity increase, the specificity decreases, and the overall diagnostic performance decreases.

Prevalence of CAD was relatively high in the source populations. The results of this study may therefore not be generalizable to low-prevalence populations.

**Internal Validity**

**Does the study answer the question?**

The results are directly applicable to the guideline.

**Effect due to factor in study?**

**Consistency of results with other studies?**

**Directly applicable to guideline population?**
Grading: 2+ Well-conducted case–control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal

Abdulla J; Abildstrom SZ; Gotzsche O; Christensen E; Kober L; Torp-Pedersen C;

64-Multislice detector computed tomography coronary angiography as potential alternative to conventional coronary angiography: A systematic review and meta-analysis

Ref ID 21285 Eur Heart J

Number of participants Type of study not specified.

Funding Not reported.

Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question? This meta-analyses found that there were differences in sensitivity and specificity values in per-segment vs. per-patient analysis due to calculated higher prevalence of CAD in per-patient data. Sensitivity in per-patient data was 97.5% vs. 86 in per-segment data, in analysis of native coronary arteries. And specificity was 91% vs. 96%, in per-patient and per-segment, respectively.

In general CT demonstrated high accuracy particularly by its high negative predictive values. The accuracy was highest in assessing CABG (96.5) and lowest in stented segments (92%).

Effect due to factor in study?

Consistency of results with other studies?

Directly applicable to guideline population? The results are directly applicable.

Internal Validity
The aim of the SR was to examine the diagnostic accuracy of dobutaine stress echocardiography in women. For the detection of coronary artery disease in women, dobutamine stress echocardiography has reasonable sensitivity and good specificity. Similar sensitivities and specificities were found in studies comparing diagnostic performance in men versus women. Dobutamine stress echocardiography is at least as sensitive as SPECT for the detection of coronary artery disease in women.

### Internal Validity

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<tr>
<th>Study Type</th>
<th>Diagnostic</th>
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<td>Number of participants</td>
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<td>Does the study answer the question?</td>
<td>The study is directly applicable to the guideline.</td>
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The study is directly applicable to the guideline.
The study found that the exercise ECG for women had lower accuracy compared with men, sensitivity 61% versus 70% and specificity 70% versus 77%. There was wide variability in the sensitivities for exercise ECG in women (27% to 91%) and also specificity (46% to 86%). The variability was not associated with the exclusion of patients with baseline ECG changes. Sensitivity and specificity were highly correlated suggesting that investigators may have different threshold for the identification for interpreting a test as positive, despite using the same threshold for interpreting a test as positive. Exercise thallium scanning in women had a higher sensitivity but a lower specificity compared with exercise ECG in women, but the differences were not clinically relevant. Although data was limited in this study exercise echocardiography has higher sensitivities and specificities compared with the other 2 tests.

No information was given on heterogeneity.

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| Pryor DB;Shaw L;McCants CB;Lee KL;Mark DB;Harrell FE;Muhlbaier LH;Califf RM; |

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<th>Value of the history and physical in identifying patients at increased risk for coronary artery disease</th>
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| Agency for Health Care Policy and Research, National Heart, Lung and Blood institute, National Library of Medicine |

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<tr>
<th>Ref ID 1751</th>
<th>Annals of internal medicine</th>
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<th>Page 194 of 199</th>
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The mean age was 55, 37% were female, the mean pain frequency was 2 episodes a week, the mean durations of CAD symptoms was 12 months, 28% had typical angina symptoms, 52% atypical angina symptoms, 20% nonanginal pain, 18% progressive angina, 22% nocturnal angina, 44% smoked, 41% had a history of hypertension, 10% had diabetes, 11% had hyperlipidemia, 35% had ST-T wave changes on ECG, 18% had a history of MI, 8% had Q waves on ECG, 14% had a history of congestive heart failure, 0% had class IV congestive heart failure, 1% had ventricular gallop, 3% had peripheral vascular disease, 3% had cerebral vascular disease.
Of the patients who went on to have a cardiac catheterization the mean age was 56, 31% were female, the mean pain frequency was 2 episodes a week, the mean durations of CAD symptoms was 7 months, 49% had typical angina symptoms, 47% atypical angina symptoms, 4% nonanginal pain, 24% progressive angina, 24% nocturnal angina, 53% smoked, 42% had a history of hypertension, 10% had diabetes, 13% had hyperlipidemia, 42% had ST-T wave changes on ECG, 33% had a history of MI, 11% had Q waves on ECG, 11% had a history of congestive heart failure, 0% had class IV congestive heart failure, 1% had ventricular gallop, 4% had peripheral vascular disease, 2% had cerebral vascular disease.

Physicians initial evaluation of patients with suspected CAD
The presence of significant coronary disease defined as any disease (≥ 75% luminal diameter narrowing of at least one major coronary artery), presence of severe coronary artery disease defined as ‘severe disease’ (significant obstruction of all 3 main coronary arteries or the left main coronary artery) and the presence of significant left main artery obstruction defined as ‘left main disease’ (168 patients referred for cardiac catheterization). The prognostic outcome was survival at 3 years.
In the multivariable regression model used, chest x-ray to show cardiomegaly was not a significant predictor for any disease, severe disease or left main disease. However for cardiomegaly (shown on chest x-ray) was a significant predictor for survival at 3 years.

Patient Characteristics
- Number of participants: 1030 patients, 168 had cardiac catheterization. At 3 years data for 973 patients (94%) was obtained.

Recruitment
- Patients were referred for non-invasive testing for suspected coronary artery disease.

Setting
- Duke University Medical Centre USA

Interventions/Test/Factor being investigated
- The presence of significant coronary disease defined as any disease, severe disease, left main disease, predicting survival.

Comparisons
- Effectiveness of chest pain score to predict coronary artery disease and survival.

Length of Study/Follow-up
- 3 years

Results
The three diagnostic outcomes were: the presence of significant coronary artery disease defined as ‘any disease’ (≥ 75% luminal diameter narrowing of at least one major coronary artery), presence of severe coronary artery disease defined as ‘severe disease’ (significant obstruction of all 3 main coronary arteries or the left main coronary artery) and the presence of significant left main artery obstruction defined as ‘left main disease’ (168 patients referred for cardiac catheterization). The prognostic outcome was survival at 3 years.

Safety and adverse effects
- None reported.

Does the study answer the question?
- In the multivariable regression model used, chest x-ray which showed cardiomegaly was shown to be a significant predictor of survival. However it could not be used to predict coronary disease.
Meta-analysis of comparative diagnostic performance of magnetic resonance imaging and multislice computed tomography for noninvasive coronary angiography.[see comment]. [Review] [57 refs]

Ref ID 3788  Am Heart J  404 to 411  2006

Study Type  Diagnostic  Funding  Netherlands Heart Foundation (grant 2002B105).

Number of participants

Inclusion/Exclusion Criteria

Patient Characteristics

Recruitment

Setting

Interventions/ Test/ Factor being investigated

Comparisons

Length of Study/ Follow-up

Outcome measures studied

Results

Safety and adverse effects

Does the study answer the question?

The SR the summary odds ratio for an abnormal multislice CT was elevated 16.9 fols (95% CI 11.0 to 26.1) indicating that an abnormal segment had a 16.9 fold increased odds of significant CAD at cardiac catheterization. In contrast the summary odds ratio was increased 6.4 fold (95% CI 5.0 to 8.3) for MRI. An inverse relationship between diagnostic specificity and CAD prevalence for multislice CT was observed, which remained consistent when controlling for average age and the frequency of men enrolled in each study. No relationship was found for MRI. The authors concluded that MSCT has a significantly better diagnostic accuracy in the detection of CAD compared with MRI.

Effect due to factor in study?
The results of the SR are directly applicable to the guideline.

**Sun Z; Lin C; Davidson R; Dong C; Liao Y;**

Diagnostic value of 64-slice CT angiography in coronary artery disease: A systematic review

Ref ID 20820 Eur J Radiol 78 to 84 2008

**Study Type** Diagnostic **Funding** Not reported

**Number of participants** Type of study not specified. All studies on human subjects were included except case reports and abstracts.

**Inclusion/Exclusion Criteria**

**Patient Characteristics**

**Recruitment**

**Setting**

**Interventions/Test/Factor being investigated**

**Comparisons**

**Length of Study/Follow-up**

**Outcome measures studied**

**Results**

**Safety and adverse effects**

**Does the study answer the question?**

This review answers the question it set out to answer. That is, it provides an estimate of the diagnostic value of 64-slice CT when compared to coronary angiography (CA). It included patients with known CAD and those with suspected CAD (those presenting with chest pain) and as such is useful for our question. However, it would have been even more useful if separate results had been presented for those groups separately.

Very little information on the type of studies included was reported. E.g. number of RCTs, cohort studies etc. And no details of the number of patients included in the sensitivity/specificity calculations were reported. However, sensitivity/specificity was reported at patient, vessel and segment level.

**Effect due to factor in study?**

**Consistency of results with other studies?**
Directly applicable to guideline population?

The results of this SR are directly applicable to the guideline.

Internal Validity
A systematic review on diagnostic accuracy of CT-based detection of significant coronary artery disease. [Review] [60 refs]

Ref ID 177 Eur J Radiol

**Study Type**
Diagnostic

**Funding**
Not stated.

**Number of participants**

**Inclusion/Exclusion Criteria**

**Patient Characteristics**

**Recruitment**

**Setting**

**Interventions/ Test/ Factor being investigated**

**Comparisons**

**Length of Study/ Follow-up**

**Outcome measures studied**

**Results**

**Safety and adverse effects**

**Does the study answer the question?**

This study assessed the diagnostic accuracy of multislice CT (4-8-16- and 64-slice), although only 5 studies were 64 slice and study sizes ranged from 35 to 84 patients. The main conclusion is that with 64 slice scanners, diagnostic accuracy is high on a per segment basis. Per patient however, this accuracy may be lower in patients with multi-vessel disease, which may limit the utility of CT in populations at high risk for CAD. Apart from selection bias, this study highlights the fact that most of the studies used two independent investigators to read the scans which might differ from routine clinical practice, and which consequently could limit the applicability of the findings.

**Effect due to factor in study?**

**Consistency of results with other studies?**

**Directly applicable to guideline population?**

The results of the study may not be applicable to the guideline as it was poorly conducted. Very little information is given on the type of studies included (RCTs, cohorts). No details of the number of patients included in the meta-analysis are given.

**Internal Validity**

15 September 2009