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CLINICAL INVESTIGATIONS FROM THE RACP

Is this chest pain due to myocardial ischaemia?

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In this series, we present authoritative advice on the investigation of a common clinical problem, especially commissioned for family doctors and written by members of the Royal Australasian College of Physicians.

Key points

- Careful history taking can help identify patients with angina and stratify their risk.
- A resting ECG is essential for assessing risk and planning further investigations.
- Typical angina symptoms and an abnormal ECG are an indication for early referral for coronary angiography.
- Symptoms at rest and an abnormal ECG may be an indication to call an ambulance.
- Other investigations that may be helpful include exercise stress ECGs, stress echocardiography and myocardial perfusion scanning, and CT coronary angiography.
- A negative noninvasive test result does not exclude myocardial ischaemia, and continuing symptoms are an indication for referral.

Chest pain is an urgent symptom. The doctor, and often the patient, knows that chest pain can be due to myocardial ischaemia and can be associated with sudden death. Careful history taking, physical examination and appropriate investigations can usually either provide reassurance that the pain is not ischaemic or help diagnose the extent of coronary disease and enable treatment that will protect the patient.

HISTORY TAKING

Careful history taking is particularly important for diagnosing the cause of chest pain. It is difficult to improve on William Heberden's original (1772) description of the pain of myocardial ischaemia, which he termed angina pectoris:

'They who are afflicted with it, are seized while they are walking (more especially if it be up hill and soon after eating) with a painful and most disagreeable sensation in the breast, which seems as if it would extinguish life, if it were to increase or continue; but the moment they stand still, all this uneasiness vanishes.'

However, the sensation is not always described as pain, and it is important to ask the patient about feelings of discomfort or tightness. The symptoms described by Heberden are often termed typical angina (see the box on page 31 for a classification of chest pain[1]).

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CLASSIFICATION OF CHEST PAIN ACCORDING TO THE EUROPEAN SOCIETY OF CARDIOLOGY[1]

Typical angina – meets all three of the criteria listed below.

- Retrosternal chest discomfort of typical quality and duration (see text)
- Provoked by exertion or emotion
- Relieved rapidly by rest or glyceryl trinitrate or both

Atypical angina – meets two of the above criteria

Noncardiac chest pain – meets one or none of the above criteria

TABLE. COMMON NONCARDIAC CAUSES OF CHEST PAIN

Cause of pain	Typical features
Vascular pain	
Aortic dissection	Pain of sudden onset, radiates to back
Pleuropericardial pain	
Pericarditis	Pleuritic pain, better when sitting up
Pleurisy	Pleuritic pain
Pneumonia	Accompanied by fever, cough
Pneumothorax	Sudden onset, dyspnoea, typical body habitus
Chest wall pain	
Bony and muscular causes	Localised pain, worse with movement
Herpes zoster	Dermatomal distribution, obvious when rash appears
Gastrointestinal pain	
Gastro-oesophageal reflux	Pain often nocturnal, burning, prolonged
Oesophageal spasm	Intermittent pain, often relieved by swallowing warm liquids but also by nitrates

Characterise the pain or discomfort

Ask the patient:

- What is the feeling like? The description may be of tightness, constriction or heaviness, and often the patient does not describe it as painful. Angina is not usually described as sharp.
- Where do you feel it? Angina is typically felt behind the sternum and may radiate into the left arm, neck and right and left sides of the jaw. The term angina is Latin for 'choking', and the feeling often involves the throat.
- When do you get it? Typical angina occurs predictably with exertion and is worse after eating or in cold weather. It is rapidly relieved by rest or even by slowing down. Patients may have tried sublingual nitrate treatment. Nitrates usually relieve angina rapidly (within one minute).
- How long does it last? Angina rarely lasts more than five to 10 minutes unless the patient has an acute coronary syndrome. Repeated episodes of prolonged chest discomfort are unlikely to be due to angina.

When the chest pain is atypical, consider noncardiac causes (see the Table).

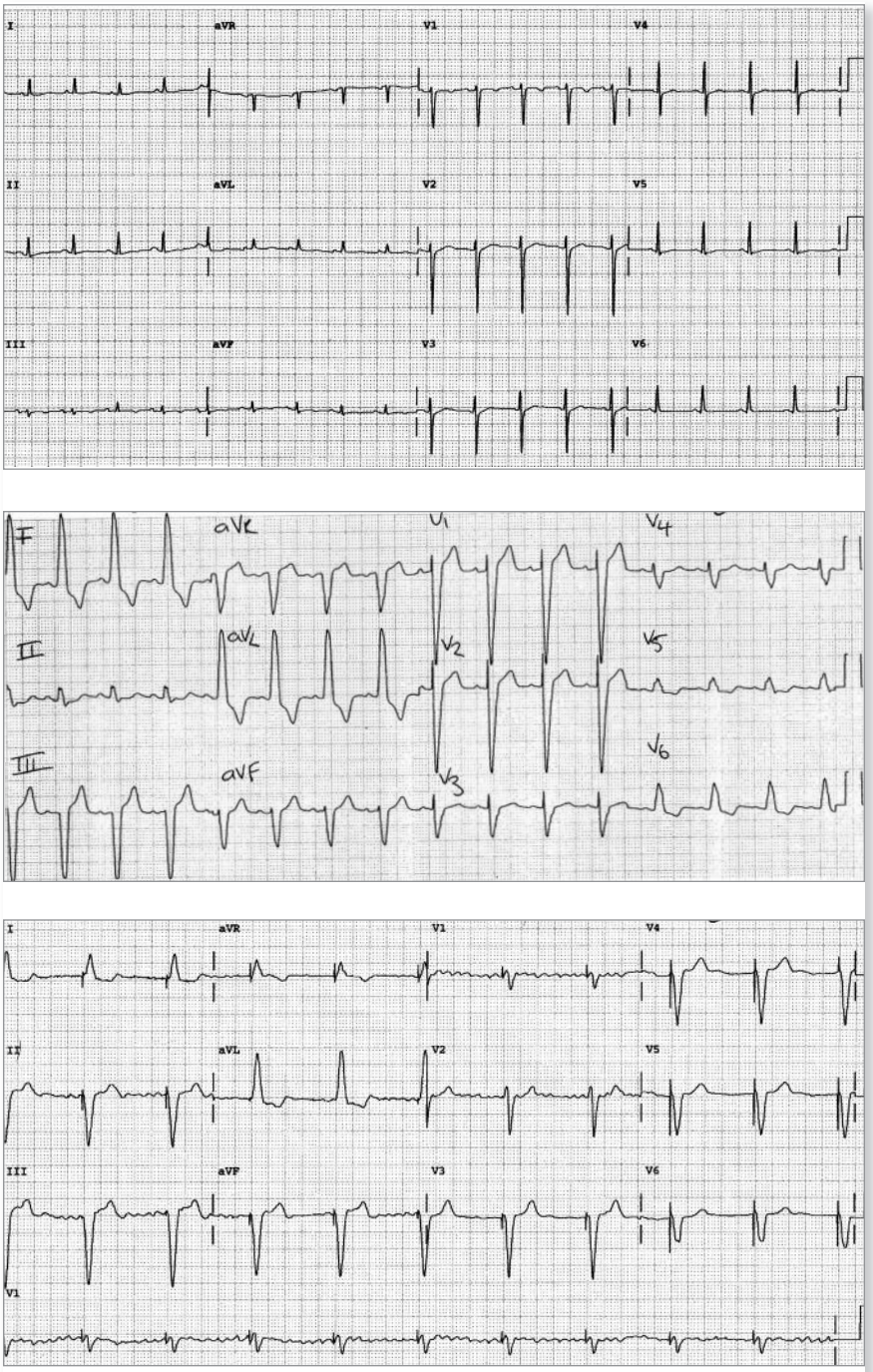
Assess risk factors for ischaemic heart disease

Take a brief history to assess the patient's risk factors and to estimate the pre-test probability of ischaemic heart disease.

- Have you had angina before? A history of coronary disease is the strongest risk factor for further disease.
- Does it feel the same as it did before? Patients with recurrent angina usually say their present symptoms are similar in quality to previous symptoms.
- Do you smoke? A smoker's risk of ischaemic heart disease falls to that of a nonsmoker 10 years after stopping smoking.
- Has your cholesterol level been elevated in the past?
- Have you had high blood pressure?
- Do you have diabetes?
- Is there a history of heart attacks or angina in your family? A relevant family history comprises premature coronary disease (before the age of 60 years) in a first-degree relative.

Assess the possibility of an acute coronary syndrome

Ask about warning symptoms of an acute coronary syndrome. Exertional angina occurs as a result of a fixed coronary lesion limiting maximum blood flow. Rupture of a plaque, which is an unpredictable event, leads to a



Figures 1a to c. ECG examples showing changes that are not specific for myocardial ischaemia and may mask its presence. a (top). Nonspecific ST and T wave changes (leads II, III, aVF and V4–V6). b (centre). Left bundle branch block. c (bottom). Ventricular paced rhythm with underlying atrial fibrillation. The baseline is irregular (fibrillation waves), and the broad QRS complexes are preceded by a racing spike.

WARNING SYMPTOMS THAT MAY INDICATE AN ACUTE CORONARY SYNDROME*

- Symptoms occur with less and less exertion
- Previous exertional symptoms occur at rest
- Additional symptoms such as sweating and nausea occur during episodes

* The term unstable angina is no longer used.

sudden, more severe reduction in blood flow and an acute coronary syndrome, which may include an ST elevation myocardial infarction. Warning symptoms that may indicate an acute coronary syndrome are shown in the box on this page. Prolonged symptoms at rest, whether or not preceded by exertional angina, also suggest an acute coronary syndrome, especially if associated with sweating and nausea.

PHYSICAL EXAMINATION

It is unusual for angina to be associated with physical signs, but a third or fourth heart sound can be present during an episode. A third heart sound is low pitched and heard just after the second heart sound. A fourth heart sound is higher pitched and occurs closer to the second heart sound. The presence of either a third or fourth heart sound creates a triple cadence, termed a gallop rhythm.

INVESTIGATIONS IN THE GP SURGERY

Electrocardiography

Electrocardiography is a simple and non-invasive test that should be performed routinely. The ECG may:

- be normal – no ST or T wave changes and no pathological Q waves
- show changes that may mask the presence of myocardial ischaemia, such as left bundle branch block, a paced rhythm, left ventricular hypertrophy with or without lateral ST changes (strain pattern) and

nonspecific T wave flattening (Figures 1a to c)
- show changes suggesting myocardial ischaemia, such as ST depression and T wave inversion (Figures 2a and b)
- show changes indicating acute myocardial infarction (or pericarditis), such as ST elevation (Figure 2c)
- show changes suggesting previous or recent myocardial infarction such as T wave inversion and Q waves.

If the ECG shows ST elevation or evidence of a recent myocardial infarction then the patient should be sent urgently to a hospital emergency department by ambulance.

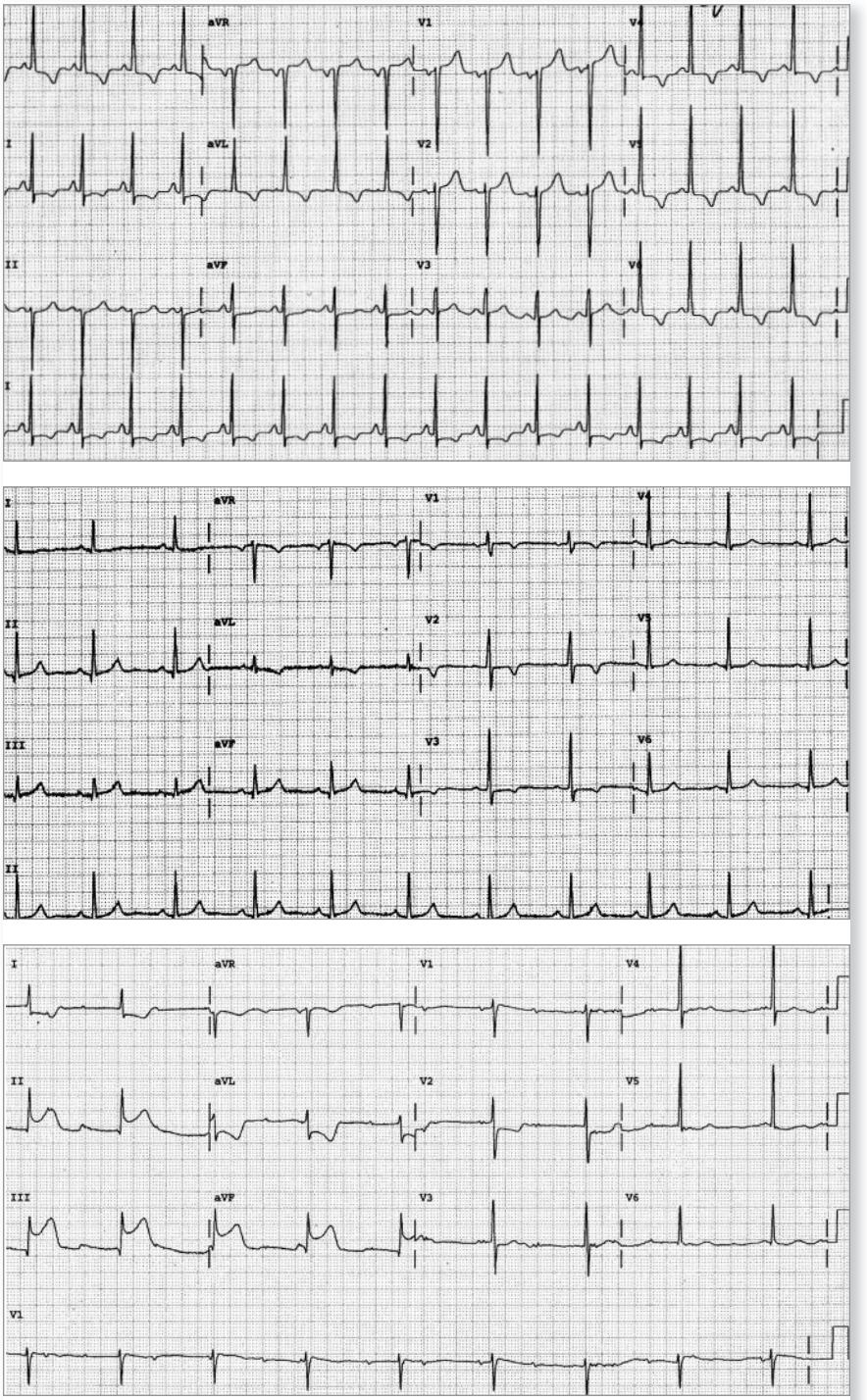
Blood tests

For patients who do not require urgent hospital transfer, the following investigations should be ordered:
- serum cholesterol and triglyceride levels
- full blood count (as anaemia can precipitate angina)
- serum creatinine level and estimated glomerular filtration rate (as chronic kidney disease is a risk factor for ischaemic heart disease)
- blood glucose level.

There is controversy about measurement of modern biomarkers of myocardial damage – troponins – in patients seen in the GP's surgery. If the patient's symptoms or ECG are worrying enough for an acute coronary syndrome to be considered then the patient should be sent to hospital. Receiving an abnormal troponin result after you have sent a patient home merely provokes anxiety for both doctor and patient. There may be an argument for measuring troponin levels for a patient who experienced an episode of chest pain at rest a few days before, as the early acute period when arrhythmias occur will probably have passed.

FURTHER INVESTIGATIONS AND MANAGEMENT

A suggested algorithm for the investigation of chest pain that is possibly due to



Figures 2a to c. ECG examples showing changes suggesting myocardial ischaemia. a (top). Inferolateral T wave inversion (leads I to III, aVL, aVF and V4 to V6). b (centre). Anterior T wave inversion (leads V1 to V3). c (bottom). Inferior ST elevation (leads II, III and aVF), indicating an acute inferior infarct.

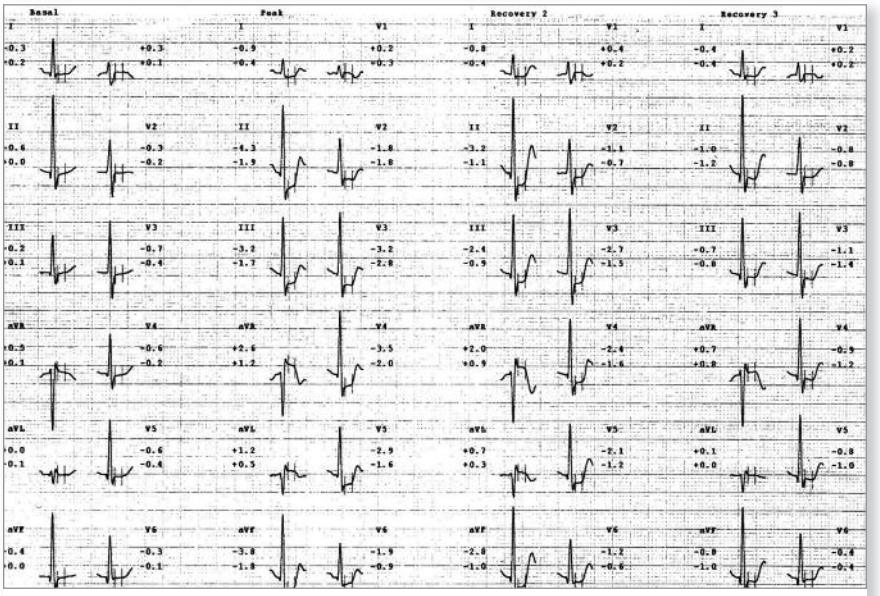


Figure 3. ECG during exercise stress testing showing a strongly positive result, with lateral ST depression (–3 mm in V4 at the peak of exercise), suggesting myocardial ischaemia.

myocardial ischaemia is shown in the flowchart on page 36.

Exercise stress testing

ECG monitoring during an exercise stress test is the traditional investigation for chest pain that is potentially due to myocardial ischaemia. The usual approach is to have the patient exercise on a treadmill using the Bruce protocol. This consists of up to seven three-minute stages of increasing speed and elevation. The test is limited by symptoms; the patient continues until prevented from going on by chest pain (typical or atypical), exhaustion, dyspnoea or other symptoms (e.g. claudication).

Certain patients should not be referred for an exercise stress test. These patients include those for whom such a test is:

- unreliable because of pre-existing ECG changes (e.g. left bundle branch block, left ventricular hypertrophy with strain)
- impractical as the patient is unable to exercise (e.g. has chronic obstructive pulmonary disease, claudication)
- contraindicated (e.g. patient has chest pain and ECG changes at rest, severe aortic stenosis).

Interpretation

Results of an exercise stress test are considered abnormal (positive) if significant ST-segment depression occurs in three complexes in a row in at least one lead (Figure 3).

The usefulness of exercise stress testing is limited. Its sensitivity for detecting significant coronary artery disease is reported as between 23 and 100% (mean, 68%) and the specificity as between 17 and 100% (mean, 77%).[2]

Exercise stress testing can also be used to stratify risk. The maximum exercise capacity is a consistent marker of prognosis. A negative test result at a high workload (e.g. Stage 4), indicates a good prognosis, even though it does not exclude coronary disease.

Management after exercise stress testing

Management after exercise stress testing depends on the abnormalities found and whether symptoms are typical or atypical of angina (see the flowchart on page 36).

Strongly positive result. The diagnosis of significant coronary disease is almost certain. The patient may have severe coronary disease (three vessel disease or left main stenosis). These patients may benefit from revascularisation – coronary artery bypass grafting or angioplasty – and should be offered coronary angiography. While waiting for angiography, they should receive medical treatment with aspirin, a β-blocker and a statin.

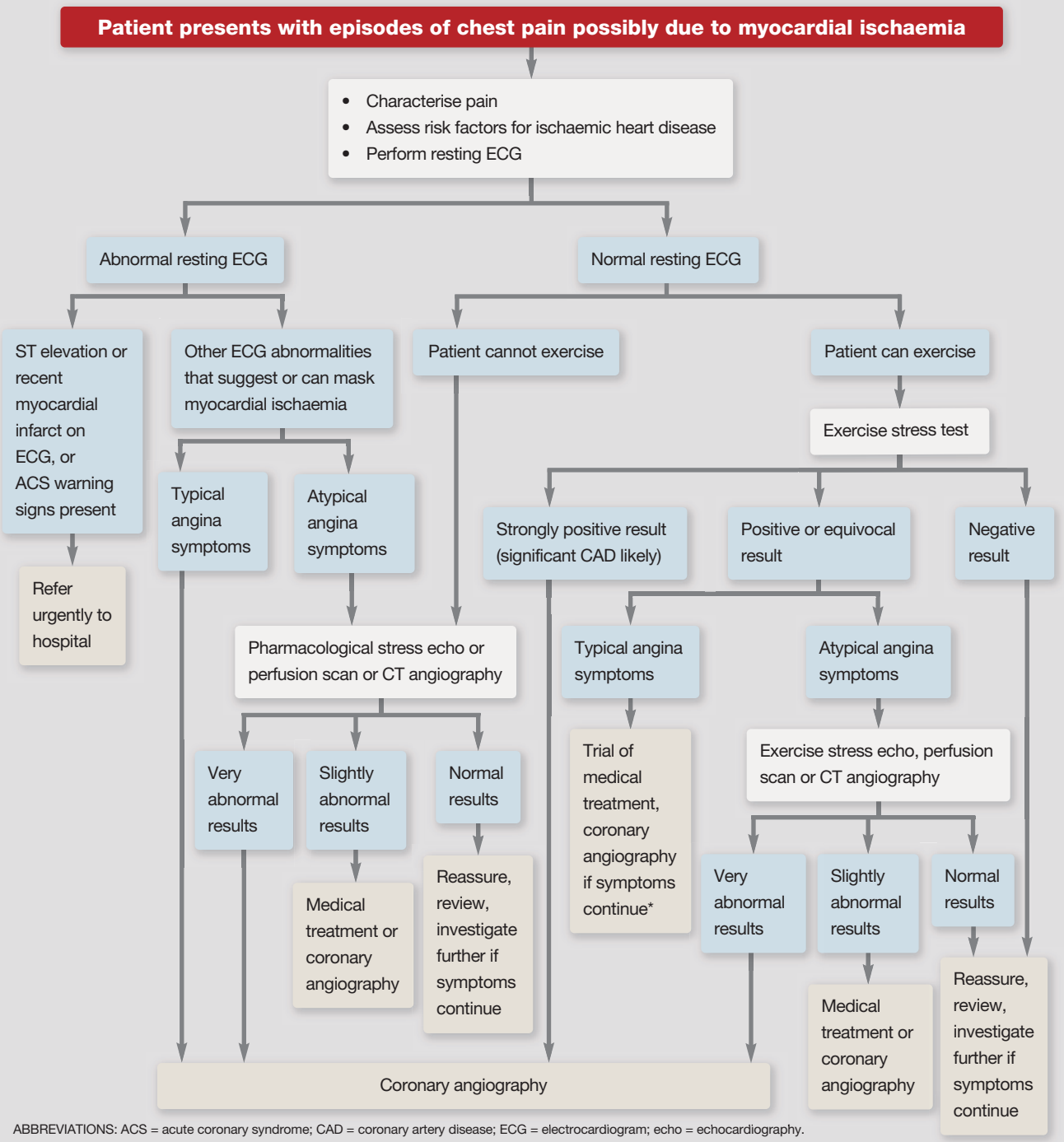
Positive result, typical symptoms. If the patient has typical or fairly typical symptoms of angina, the diagnosis of myocardial ischaemia is likely. These patients can usually be started on medical treatment and reviewed after a few weeks. If the patient is then asymptomatic and has a normal exercise tolerance for age, medical treatment for angina and treatment for risk factors should continue. The COURAGE trial showed that medical treatment of stable angina is safe.[3] If the patient is already being treated with antianginal drugs or is not free of symptoms when reviewed, coronary angiography should be considered.

Equivocal result, typical symptoms: A trial of medical treatment may be reasonable, but one should consider coronary angiography if a definite diagnosis is important for other reasons, such as relative youth or an occupation that would be affected by ischaemic heart disease.

Positive or equivocal result, atypical symptoms. Here the diagnosis needs clarification – the result may be a false positive. The usual approach is to perform a myocardial perfusion (sestamibi) scan while exercising, stress echocardiography or CT coronary angiography.

Negative result, typical symptoms. If the test was negative at a workload at which maximum predicted heart rate was achieved, reassurance and review may be reasonable. However, a negative test result does not exclude myocardial ischaemia, and continuing symptoms suggest the need for definitive investigation (usually coronary angiography).

AN APPROACH TO INVESTIGATING EPISODES OF CHEST PAIN POTENTIALLY DUE TO MYOCARDIAL ISCHAEMIA



ABBREVIATIONS: ACS = acute coronary syndrome; CAD = coronary artery disease; ECG = electrocardiogram; echo = echocardiography.
* Also consider coronary angiography for patients with an equivocal exercise stress test result and typical angina symptoms if a definite diagnosis is important because of relative youth or occupation.

Stress echocardiography and myocardial perfusion (sestamibi) scanning

Stress echocardiography and myocardial perfusion (sestamibi) scanning are more sensitive and specific than exercise stress testing, with around 85% sensitivity and specificity.[4]

Stress echocardiography does not involve radiation and when it is readily available, it is often reasonable to use this as the initial investigation rather than a conventional stress test. A reduction in left ventricular wall motion seen on echocardiography immediately after exercise suggests ischaemia of that territory. However, false-negative results are relatively common, and further investigations are needed if symptoms persist.

Myocardial perfusion scans expose the patient to at least as much radiation as a coronary angiogram and are less often appropriate as an initial investigation compared with stress echocardiography. Perfusion scans produce tomographic images of the heart. An area of reduced perfusion during exercise that returns to normal on a second scan a few hours later suggests ischaemia, while reduced perfusion on both scans suggests previous infarction.

Pharmacological stress testing, such as dipyridamole myocardial perfusion scanning and dobutamine stress echocardiography, can be performed for patients unable to exercise and those who have left bundle branch block.

CT coronary angiography

Fast CT scanners (64-slice or more) can produce images of the coronary arteries following a single intravenous bolus of contrast material, without the need for cardiac catheterisation.[5] CT coronary angiography has a sensitivity and specificity for detecting obstructive coronary disease of over 90% in experienced centres. The heart rate may have to be slowed with β-blockers to less than 60 beats per minute.

Modern CT scanners expose the patient to less radiation than a conventional coronary angiogram, and CT coronary angiography is less invasive than conventional angiography. However, it still exposes the patient to the risk of allergic reaction to contrast (now very rare) and nephrotoxicity. The test can detect luminal narrowing of the coronary arteries and atheromatous disease within the artery walls, but it cannot as yet identify vulnerable plaque that is at risk of erosion or rupture. A normal or near-normal appearance of the coronary arteries indicates an excellent prognosis.

CT coronary angiography is covered by Medicare for patients at 'intermediate risk' of obstructive coronary disease.

Coronary angiography

Selective coronary angiography remains the standard for detecting intraluminal narrowing of the coronary arteries. A normal or near-normal appearance of the coronary arteries on angiography excludes obstructive coronary disease as the cause of the patient's symptoms and indicates a good prognosis, but cannot rule out future rupture of a nonobstructive plaque.

SPECIALIST REFERRAL

Specialist referral is indicated for many patients who require stress testing and for those who have abnormal results on stress testing, CT coronary angiography or perfusion scanning not performed by a cardiologist. Referral is also important if results of noninvasive tests are normal but symptoms continue. Patients waiting for a specialist's appointment who have typical angina symptoms should be started on treatment with aspirin, a β-blocker (if not contraindicated) and a statin. Patients with symptoms or ECG changes suggesting an acute coronary syndrome should be sent to hospital.

CONCLUSION

Chest pain is a worrying symptom. It may have a benign cause or be an indication of a life-threatening disease. The assessment should begin with careful history taking, examination and the recording of an ECG. The results should be used to plan further investigations, if these are indicated, or may be enough to allow the patient to be reassured. A negative result on an exercise stress test is reassuring but does not exclude significant coronary artery disease, and referral for further investigation is indicated if the symptoms persist. MT

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