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Task Force Report

Task force on the management of chest pain

Members: L. Erhardt (Chairman), J. Herlitz (Secretary), L. Bossaert, M. Halinen, M. Keltai, R. Koster, C. Marcassa, T. Quinn and H. van Weert

Contents

Preamble

The Task Force on the management of chest pain was created by the committee for Scientific and Clinical Initiatives on 28 June 1997 after formal approval by the Board of the European Society of Cardiology.

The document was circulated to the members of the Committee for Scientific and Clinical Initiatives, to the members of the Board and to the following reviewers: J. Adgey, C. Blomström-Lundqvist, R. Erbel, W. Klein, J. L. Lopez-Sendon, L. Rydén, M. L. Simoons, C. Stefanadis, M. Tendera, K. Thygesen. After further revision it was submitted for approval to the Committee for Practise Guidelines and Policy Conferences.

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Correspondence: Leif Erhardt, MD, PhD, FESC (chairman), Department of Cardiology, Malmö University Hospital, SE-205 02 Malmö, Sweden.

The Task Force consists of nine members who were all active in the preparation of the document. A review of the literature and position papers was prepared by the members according to their area of expertize, and evidence-grading applied wherever possible. The literature search included the following: a Pub Med search for chest pain and for chest pain units, and a formal process of review and evaluation of scientific literature related to diagnostic imaging techniques, undertaken based on Medline literature searches. All relevant English language literature on each technology was reviewed, summarized and analysed.

The strength of evidence against or in favour of a particular treatment or diagnostic procedure will be cited. The strength of evidence depends on the available data on a particular subject and will be ranked according to three levels:

- Level of Evidence A=Data derived from multiple randomized clinical trials or meta-analyses.
- Level of Evidence B=Data derived from a single randomized trial or non-randomized studies.
- Level of Evidence C=Consensus opinion of the experts, retrospective studies, registries.

The recommendations are graded as follows:

- Class I: Conditions for which there is evidence and/or general agreement that a given procedure or treatment is useful and effective.
- Class II: Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment.
- II a: Weight of evidence/opinion is in favour of usefulness/efficacy.
- II b: Usefulness/efficacy is less well established by evidence/opinion.

For chest pain and the general practitioner, the authors searched Medline and Embase using Mesh-headings (combined): chest pain and family practice. For chest pain and patient delay, the authors made a systematic search of Medline, Embase, Bids etc. For chest pain and epidemiology, clinical findings and ambulance transport, PubMed was used; for clinical queries research methodology filters were used. For chest pain and the dispatch centre, the authors made a complete search in

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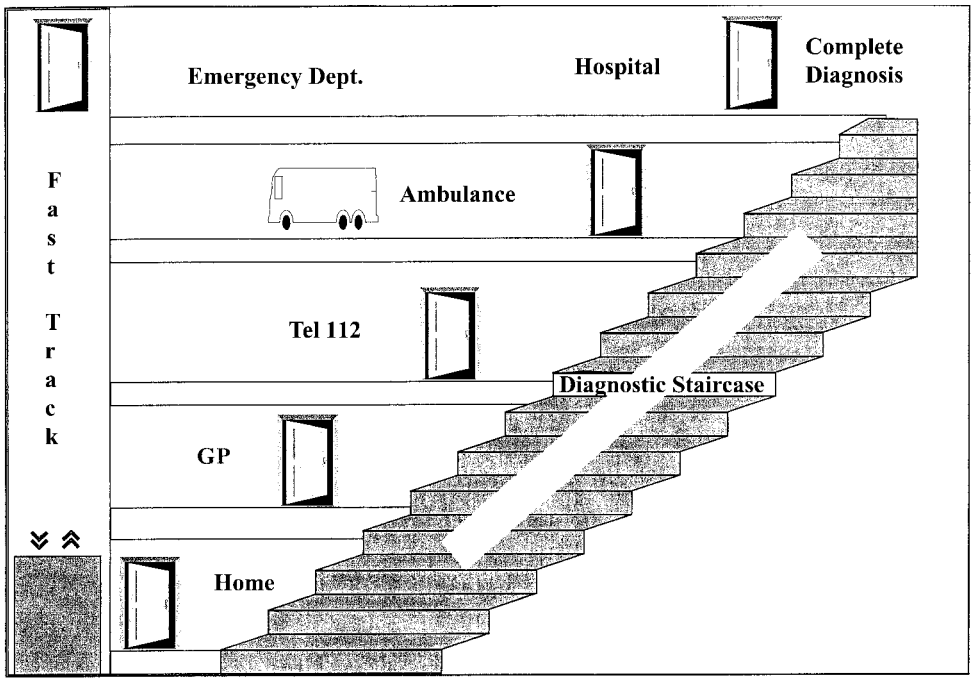

Figure 1 **The five doors representing five different levels of decision making.**

Medline, based on triggers such as 'dispatching', 'triage' emergency medical aystem etc., in various combinations.

Scope of the document

Chest symptoms are common and are most often caused by a benign condition. In situations when the condition is life-threatening, treatment is more successful if started immediately after onset of symptoms. Many patients with a serious condition wait too long before seeking professional help and not all patients in need of urgent medication or procedures are promptly identified in the health care system.

One of the major problems with chest symptoms is that they are variable and perceived very differently by patients. The severity of pain is a poor predictor of imminent complications such as cardiac arrest. Therefore there is an obvious need to better describe the various forms of chest discomfort that may be dangerous in order to reduce the current high mortality outside hospitals from cardiac arrest, as well as rapidly to be able to exclude benign conditions.

The underlying concept is that for many patients minutes lost are detrimental, early diagnosis is pivotal and early treatment may be life-saving. Patients with a potentially dangerous condition should be offered a 'fast track' in diagnosis and treatment.

Patients approaching the medical system may be seen as entering a door. At each door it is important to identify those with a potentially dangerous condition and offer them a fast track. The five doors correspond to the different levels of decision making. The first door represents the patient seeking help because of chest discomfort. The second door is opened by the General Practitioner seeing the patient at home or in his/her practice. The third door is opened by the dispatch centre when the patient calls such a centre. The fourth door is opened by the ambulance staff attending the patient at home or elsewhere outside hospital, and the final and fifth door is the door of the hospital's emergency department (Fig. 1).

At each door there are different possibilities for diagnostic evaluation. The common challenge at each door is to analyse and advise the patient, to reduce time delay, to identify life-threatening conditions and to maximize diagnostic and therapeutic alternatives and thereby improve outcomes.

Evidence grading has been applied (and indicated) wherever possible, but the majority of our statements are not based on firm evidence, but clinical experience gathered from the available literature, combined with expert opinion.

Recently a Task Force Report (2000)[1] and a consensus document (2000)[2] were published in European Heart Journal and another Task Force report was published in Circulation 2000[3], all of which include information related to parts of this document.

Epidemiology

The prevalence of chest pain or chest discomfort varies in different parts of Europe. A large proportion of people in the community have been reported to suffer from some type of chest discomfort. In a British study of 7735 men, angina pectoris or a history of possible acute myocardial infarction (AMI) was reported in 14% and a further 24% suffered from atypical chest pain[4–6].

Table 1 Aetiology to chest pain in various clinical settings

Aetiology	General practitioner (1–3) %	Dispatch centre (4) %	Ambulance crew (5) %	Emergency department (6) %
Cardiac	20	60	69	45
Musculoskeletal	43	6	5	14
Pulmonary	4	4	4	5
Gastro-intestinal	5	6	3	6
Psychiatric	11	5	5	8
Other	16	19	18	26

1. Lamberts *et al.*[7]
2. Klinkman *et al.*[8]
3. Svavarsdottir *et al.*[9]
4. Herlitz *et al.*[10]

The underlying cause of chest pain varies depending on whether a patient is seen by a general practitioner[7–9], calls the dispatch centre[10], is treated by the ambulance crew[11] or is seen at the emergency department[12]. The distribution of aetiologies in relation to these four scenarios is shown in Table 1. Not unexpectedly, chest pain of cardiac origin is less commonly seen by the general practitioner (20%), whereas musculoskeletal disorders are common.

A summary of prospective studies in general practices in the Netherlands, in England and in Iceland is shown in Table 2[7–9]. Most of the episodes were caused by musculoskeletal problems and only about 20% were of cardiac origin. Patients with chest pain without a somatic diagnosis often suffer from psychiatric problems such as anxiety, depression or alcohol abuse[13–15].

The ischaemic origin of calls about chest pain is much more frequent at dispatch centres. About 25% of all emergency calls to a dispatch centre are initiated because of chest pain[10,16]. Among such patients, 40% are reported to have confirmed myocardial ischaemia or infarction, and 66% either confirmed or possible myocardial ischaemia or infarction as the cause of their pain[10].

Patients with acute myocardial infarction who call for an ambulance are different from those who do not. They are older, more likely to be female and have a higher prevalence of previous cardiovascular disease and more severe symptoms. They develop more complications and present a higher risk of cardiac arrest and death[17–20].

The number and proportion of hospital admissions for chest pain vary. In Gothenburg, 20% of all non-surgical admissions are for chest pain[21]. Data from the U.S. showed that in patients with chest pain 17% ultimately met the criteria for cardiac ischaemia and 8% had myocardial infarction[22].

Overall, a similar proportion of men and women seek medical care due to non-ischaemic chest pain[23,24]. In some subsets such as patients with chest pain due to psychiatric causes there might be an over-representation of women[12]. Patients with non-ischaemic chest pain also have a lower prevalence of various risk indicators, such as a history of previous acute myocardial infarction, angina pectoris, hypertension and diabetes[23,25]. Smoking is more frequent in this patient population[25].

Symptoms and clinical findings

In order to decide whether a patient with chest pain has a dangerous condition i.e. needs a fast track, symptom evaluation is of utmost importance. Most studies evaluating symptom severity in relation to outcome have focused on patients having either a suspected acute coronary syndrome or suspected acute myocardial infarction. However, one has to keep in mind that other diagnoses, including aortic dissection, pulmonary embolism and pneumothorax, may allocate the patients to the fast track as well. Typical features of various types of chest pain are shown in Table 3.

Table 2 Diagnoses of patients with chest pain, in general practice (percentages)

Disorder/disease	Klinkman[8] n=396	Lamberts[7] n=1875	Svavarsdóttir[9] n=190
Psychiatric	8	11	5
Cardiac	16*	22†	18
Chest wall/musculoskeletal	36	45	49
Gastrointestinal	19	2	4
Respiratory/pulmonary	5	3	6
Pulmonary embolism			2
Other/no diagnosis	16	17	16

*Final diagnosis (episode). Of all cardiovascular diagnoses 13% was (possible) acute myocardial infarction and 87% was angina pectoris.
†Final diagnosis: of all cardiovascular diagnoses 29% was myocardial infarction, 37% was angina pectoris.

Table 3 Typical feature in various types of chest pain

Cause of pain	Type of pain	Referred pain	Response to posture/movement	Response to food/fluid	Tenderness	Response to nitroglycerin
Ischaemic cardiac pain	Visceral	Yes	No	No	No	Yes
Non-ischaemic cardiac pain	Visceral	Yes	No	No	No	No
Pulmonary disease	Visceral/cutaneous	Usually no	No	No	No	No
Pneumothorax	Visceral/cutaneous	No	Yes	No	Usually no	No
Musculoskeletal	Cutaneous	No	Yes	No	Yes	No
Gastrointestinal	Visceral	Sometimes	No	Yes	No	No
Aortic aneurysm	Visceral	Yes	No	No	No	No
Psychiatric	Visceral/cutaneous variable	No	No	No	No	No

Ischaemic cardiac pain

The severity of symptoms and the final outcome in patients with acute coronary syndrome are not directly related[26]. Some patients say 'It was the worst pain I could ever imagine', whereas others complain only of a slight chest discomfort. Patients with confirmed acute myocardial infarction more frequently use words such as 'tearing, intolerable, terrifying' and less frequently use words such as 'pricking and worrying' in order to describe their pain[27].

In a non-selected group of patients contacting a dispatch centre with symptoms of acute chest pain, those with a higher intensity of pain had a higher likelihood of developing acute myocardial infarction[28]. Patients with acute coronary syndrome mostly describe their pain as diffuse over a wide area of the anterior chest wall and not localized[29]. The pain might radiate to the left and/or right arm as well as to the neck and back. Social, professional and age related differences are influencing the presentation of symptoms, and it has been suggested that women differ from men in terms of the use of various word descriptors of symptoms. With regard to the sensory component of chest pain, women use the word 'tearing' more frequently and the word 'grinding' less frequently and for the emotional component women more frequently use the word 'terrifying', 'tiring' and 'intolerable' and less frequently the word 'frightening'[27]. Women suffering from acute myocardial infarction have been reported to have pain more frequently in the back[29–31], in the neck[29,32], and in the jaw[32].

Non-ischaemic chest pain

Table 4 summarizes different types of non-ischaemic causes of chest pain. In Fig. 2 an algorithm for the diagnosis of acute chest pain is presented.

Associated symptoms

Chest discomfort or pain that occur in acute coronary syndrome are generally accompanied by autonomic nervous system stimulation. Thus, the patient often appears pale, diaphoretic and cool to touch. Nausea and vomiting are frequently present and point to a cardiac cause of the chest pain[28,33]. Associated symptoms such as nausea, vomiting and dyspnoea are more frequent in women with acute myocardial infarction[30–32], whereas sweating is more frequent in men[30,32]. Severe pain in itself evokes reactions in the body with sympathetic activation, and non-cardiac disorders such as dissecting aortic aneurysm may also be accompanied by pronounced associated symptoms. Alarming pain with associated vegetative symptoms should put the patient on the fast track with any diagnosis. Importantly, associated symptoms should be assessed together with signs of other diseases, such as infection, fever, anxiety and nervousness.

Diagnostic tests in acute chest pain

The diagnostic procedure in patients with acute chest pain should serve two major purposes: (1) to quickly identify high risk patients quickly for the fast track and (2) to delineate patients in whom there is little or no suspicion of a life-threatening disease.

The sensitivity of the 12-lead ECG to identify ischaemia has been reported to be as low as 50%[34], and between 2% and 4% of patients with evolving myocardial infarction are discharged from the emergency department inappropriately because of normal ECG findings. This more often affects women than men[22,35]. Strategies including early stress testing and newer technologies such as echocardiography and perfusion imaging have recently been proposed to identify the minority of patients at high risk who were initially considered at low–moderate risk on the basis of history, ECG, and physical examination[36]. This approach will offer advantages for patients with acute coronary syndromes and a non-diagnostic ECG. In patients with non-cardiac origin of the chest pain, other causes should be addressed as soon as possible to avoid misdiagnosing life-threatening disorders such as aortic dissection and pulmonary embolism. Other less serious disorders such as gastrointestinal disease (e.g. oesophageal spasm, gastritis or peptic ulcer) and psychiatric disorders, frequently associated with chest pain, can be managed without high priority[37].

Table 4 Non-ischaemic causes of chest pain

Disease	Differentiating symptoms and signs
Reflux oesophagitis, oesophageal spasm	No ECG changes Heartburn Worse in recumbent position, but also during strain, such as angina pectoris A common cause of chest pain
Pulmonary embolism	Tachypnoea, hypoxaemia, hypocarbia No pulmonary congestion on chest X-ray May resemble inferior wall infarction: ST elevation (II, III, aVF) Hyperventilation PaO_2 and $PaCO_2$ decreased
Hyperventilation	The main symptom is dyspnoea, as in pulmonary embolism Often a young patient Tingling and numbness of the limbs, dizziness $PaCO_2$ decreased, PaO_2 increased or normal An organic disease may cause secondary hyperventilation
Spontaneous pneumothorax	Dyspnoea is the main symptom Auscultation and chest X-ray One sided pain and bound to respiratory movements
Aortic dissection	Severe pain with changing localization In type A dissection sometimes coronary ostium obstruction, usually right coronary with signs of inferoposterior infarction Sometimes broad mediastinum on chest X-ray New aortic valve regurgitation
Pericarditis	Change of posture and breathing influence the pain Friction sound may be heard ST-elevation but no reciprocal ST depression
Pleuritis	A jabbing pain when breathing A cough is the most common symptom Chest X-ray
Costochondral	Palpation tenderness Movements of chest influence the pain
Early herpes zoster	No ECG changes Rash Localized paraesthesia before rash
Ectopic beats	Transient, in the area of the apex
Peptic ulcer, cholecystitis, pancreatitis	Clinical examination (inferior wall ischaemia may resemble acute abdomen)
Depression	Continuous feeling of heaviness in the chest No correlation to exercise ECG normal
Alcohol-related	Young man in emergency room, inebriated

The electrocardiogram

The basic goal when performing an ECG in a patient with chest pain is to identify patients with myocardial ischaemia. However, the ECG may also reveal arrhythmias, signs of left ventricular hypertrophy, bundle branch block or right ventricular strain in patients with pulmonary embolism and therefore it is a generally applicable method in any patient with chest symptoms.

The presence of ST-segment elevation has been shown to be the most sensitive and specific ECG marker for acute myocardial infarction and usually appears within minutes after the onset of symptoms. The presence of new localized ST-elevations is a diagnostic sign of acute myocardial infarction in about 80–90% of the cases[38–40]. However, only 30–40% of patients with acute chest pain who develop acute myocardial infarction initially have ST-elevations on the hospital admission ECG[41]. It has been suggested that ST-elevations are more marked in men than in women with acute myocardial infarction[42].

The presence of ST-depressions indicates myocardial ischaemia but the power to identify an ongoing myocardial infarction is poor and only about 50% of patients with such changes will eventually develop an acute myocardial infarction[39].

Symmetrical T-wave inversions are a non-specific sign which might indicate various disorders including myocardial ischaemia, myocarditis and pulmonary embolism. About one third of patients with chest pain and such changes on the hospital admission ECG will eventually develop acute myocardial infarction[39]. Newly developed Q waves on the admission ECG among patients with acute chest pain are diagnostic of acute myocardial infarction, and about 90% of these patients have an evolving acute myocardial infarction[39].

About one third of patients admitted to the emergency department with acute chest pain have a normal ECG. Yet, among such patients, 5–40% have an evolving acute myocardial infarction[38,39,43,44]. Among patients with acute chest pain and absence of ECG signs of acute myocardial ischaemia, only 4% of patients with

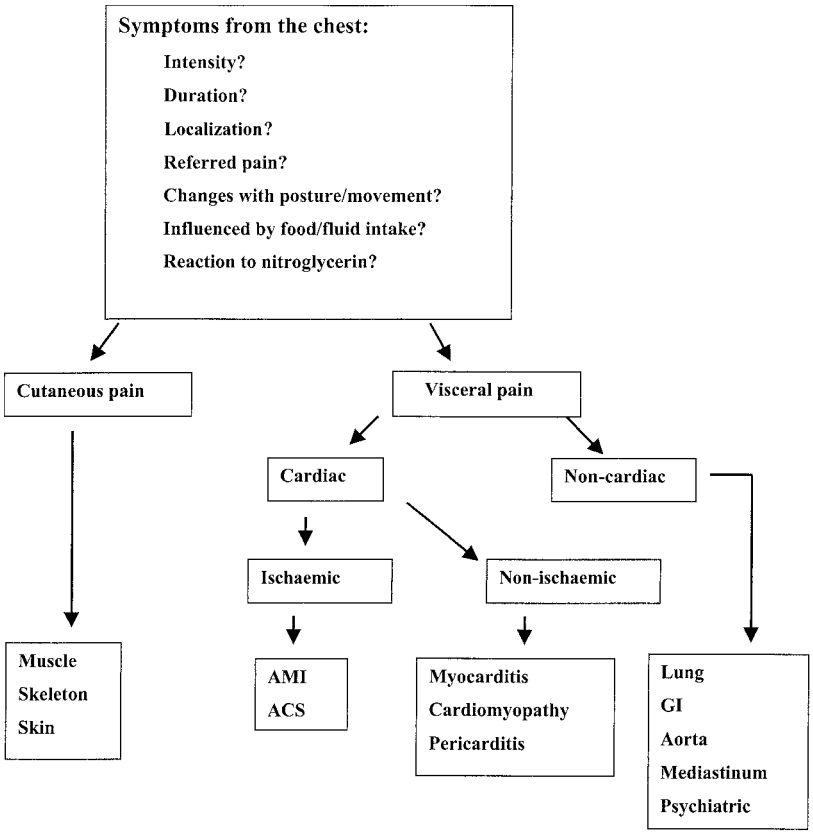

Figure 2 **Algorithm for the diagnosis of acute chest pain.**

a history of coronary artery disease and 2% of patients without such a history will develop an acute myocardial infarction[40].

Both the short- and long-term prognosis are clearly related to the admission ECG. In patients with a normal ECG, the mortality rate and the risk of complications is relatively low[38,43–48]. During long-term follow-up the mortality is similar among patients with a pathological ECG on admission regardless of whether there were signs of myocardial ischaemia or not[48]. The early case fatality rate is highest among patients with ST-elevation, intermediate among patients with ST-depression and lowest among patients with T-wave inversion on the admission ECG[45].

A 12-lead ECG is a helpful tool at doors 2 and 4 to decide whether the patient needs fast track management.

Biochemical markers

Biochemical markers in serum are measured to detect or exclude myocardial necrosis. Troponin T and troponin I[49–51], myoglobin[52,53] and creatine kinase (CK) MB[54–56], are the most often used. For ruling out acute myocardial infarction, myoglobin is a better marker from 3 h until 6 h after the onset of symptoms compared to CK MB mass and troponin T, but the maximal negative predictive value of myoglobin reaches only 89% during this time-frame[57]. Within the first 6 h after acute myocardial infarction, CK MB subforms appear to be both more sensitive and more specific than CK MB mass activity or even the troponins[58,59]. However, in one study of rapid assays for troponins T and I, 94% of 773 patients without ST-segment elevations subsequently developing an acute myocardial infarction had a positive test for troponin T and all patients had a positive test for troponin I within 6 h after the onset of chest pain[60]. From 7 h after onset of symptoms, CK MB and troponin T seem to have a higher negative predictive value than myoglobin[57]. Measurements of troponin T or I has been shown to be a more sensitive and more specific marker of acute myocardial infarction than CK MB[60,61].

Among patients admitted to a chest pain unit, troponin T may be superior to CK MB mass when assessing the prognosis for patients with acute chest pain[62].

Because of time-frame constraints, the use of a single necrosis marker determination is not generally advised at doors 1–4, but only in the emergency department.

Imaging techniques

Chest radiography

Chest radiography is often performed as a routine in the evaluation of patients attending the emergency

Table 5 Identification of ischaemia in 1519 patients with chest pain and non-diagnostic ECG by myocardial perfusion scintigrapy

Author	Tracer	Patients no.	Sensitivity	Specificity	Negative predictive value	Outcome
Wackers[74]	Tl-201	203	100	72	100	MI
Van der Wiecken[65]	Tl-201	149	90	80	96	MI
Mace[66]	Tl-201	20	100	93	100	MI
Hennemann[67]	Tl-201	47	74	42	95	MI
Bilodeau[68]	MIBI	45	96	79	—	CAD
Varetto[69]	MIBI	64	100	92	100	CAD
Kontos[73]	MIBI	532	93	70	99	MI
Heller[75]	Tetrofosmin	357	90	60	99	MI
Hilton[71,72]	MIBI	102	100	76	99	In-hospital events
Varetto[69]	MIBI	64	100	67	100	18-month events

MI=myocardial infarction; CAD=coronary artery disease.

department with suspected cardiac symptoms. In one large study, in patients collected from the emergency department, one quarter showed significant findings, including cardiomegaly, pneumonia and pulmonary oedema[63]. Although a significant number of these patients had some abnormalities on the chest X-ray that may affect clinical decision making, the value of chest radiography in patients previously defined at low risk by history and physical examination has not been evaluated.

Radionuclide imaging

Patients with acute chest pain and a non-diagnostic ECG have been evaluated by means of (thallium-201) radionuclide imaging in an attempt to identify patients at high risk[64,65]. Of interest, the majority of patients in these studies had no chest pain at the time of tracer injection. The occurrence of perfusion defects may be due to the persistence of subclinical ischaemia or post-ischaemic wall-motion abnormalities (myocardial stunning). The major clinical disadvantage with the use of thallium-201 injection in an acute setting is the need for rapid injection of the tracer and subsequent imaging, which may create logistic problems and safety concerns. Two small studies, using a portable planar camera in the emergency department, showed discordant results[66,67]. Another limitation of thallium-201 imaging, is the reduced accuracy for detecting coronary disease caused by attenuation artefacts in women and obese patients.

New technetium-99m labelled tracers (e.g. sestamibi, tetrofosmin) have more favourable physical imaging characteristics than thallium-201, because of a higher photon energy. Despite a similar flow-dependent myocardial distribution early after injection, these tracers show a limited redistribution over time, allowing image acquisition to be delayed until the patient's clinical condition is stable. An abnormal image will identify the initial 'risk area', which will not change even if reperfusion occurs. Several studies have assessed sestamibi single photon emission computed tomography (SPECT) imaging to rule out acute myocardial infarction or unstable angina[68–71]. The prognostic value of an early radionuclide imaging performed in the emergency department has been documented more recently[71–75].

Initial SPECT perfusion imaging may potentially reduce the cost of managing patients with chest pain in the emergency department. Radensky *et al.*, 1997[76] projected a 10%–17% cost saving with a strategy based on the results of early sestamibi imaging to decide whether to admit or discharge patients.

Experiences with perfusion scintigraphy are summarized in Table 5.

2D-echocardiography

This method may prove or rule out existing wall motion abnormalities in patients with chest pain. In such patients, and a non-diagnostic ECG on admission restricted to those with regional wall motion abnormalities, 2D-echocardiography may result in a reduction in hospital costs. Of note, the echocardiogram is not required to be done close to the episode of chest pain, since regional wall motion abnormalities may persist late after symptom resolution as a consequence of myocardial stunning[77,78]. The sensitivity of 2D for detecting an acute myocardial infarction was high (93%) but the specificity was limited, due to the inclusion of patients with previous myocardial infarction. Presence of regional wall motion abnormalities as a selection criterion for hospital admission in selected patients presenting to the emergency department with ST-segment elevation, could reduce hospitalizations and costs by about a third[79,80].

Echocardiographic assessment of patients evaluated in the emergency department for suspected cardiac ischaemia also provides prognostic information. The presence of systolic dysfunction has been shown to be an independent prognostic variable in predicting both short-[81] and long-term cardiac events[82].

Transoesophageal echocardiography is the method of choice for evaluating patients with suspected or known aortic dissection, and with the use of a biplane transducer most of the ascending aorta can be studied[83]. In

addition, 2D-echocardiography can be useful in the assessment of mechanical complications of myocardial ischaemia such as acute mitral regurgitation. Finally, recent studies have demonstrated the ability of Doppler echocardiography to accurately predict pulmonary systolic and wedge pressure[84].

Limitations of early imaging in the emergency department

Even if both myocardial perfusion imaging and 2D-echocardiography have been shown to be useful in the early risk stratification of patients with acute chest pain syndromes, each technique has potential advantages and limitations. Echocardiography has the ability to accurately detect structural abnormalities and to provide direct information on several haemodynamic parameters; however, particular training is required in interpreting emergency medicine echocardiography[85]. Perfusion scintigraphy may be advantageous in patients with a poor echocardiographic window and the higher count density of new technetium-labelled tracers allows ECG-gated acquisition and assessment of both regional and global ventricular function[86]. In a report evaluating patients with acute chest pain in the emergency department, the two techniques showed an overall concordance of 89% for diagnosing myocardial ischaemia (kappa=0·66)[87].

However, most institutions cannot offer a 24-h service for performing and interpreting cardiac imaging. Emergency imaging may also increase the initial cost of patient evaluation. In particular, the need for continuous 'standby doses' is one of the drawbacks of acute perfusion imaging. Finally, although the prognostic accuracy of perfusion scans is documented, neither their marginal discriminant accuracy nor the patient subset that would most benefit from its use has been adequately defined[88].

The diagnostic level of evidence for various imaging techniques are as follows: thallium scan: Grade C; Tc-99m labelled tracers: Grade B and echocardiography: Grade B.

Summary and recommendations

A 12-lead ECG is a readily available and inexpensive tool and should be considered a standard of care and always be recorded in patients suffering from acute chest pain if the cause of the pain is not sufficiently clear from the patients' history and physical examination (Class I, level C). Biochemical markers, particularly troponins in combination with CK-MB, are recommended as standard tests in the evaluation of chest pain (Class IIa, level B).

In conditions where the clinical history, ECG, and biochemical measurements for myocardial damage are equivocal or unavailable, imaging techniques may be particularly helpful in identifying low-risk patients, who can be eligible for early discharge or undergo early stress testing and avoid hospital admission, potentially reducing the utilization of hospital resources[89,90] (Class IIb, level B). Their use, however, depends on institutional accessibility, cost, and individual expertize.

Additional studies validating clinical algorithms, incorporating imaging techniques in conjunction with clinical, ECG and biochemical markers in large, consecutive cohorts of patients, are required in order to assess the true value of each technique in the risk stratification of patients presenting at the emergency department with chest pain.

Clinical decision making

When confronted with a patient suffering from acute chest pain the first important task is to decide whether the patient has a life-threatening disease or not. This judgement is based on the patient's previous history, actual symptoms, clinical signs on admission, ECG-findings, and other laboratory and investigational findings. Thus, the physician is confronted with a large amount of information and is required to make a relatively quick decision. It has been suggested that all this information might be more effectively handled by a computer, and decision supported algorithms have been constructed and evaluated in comparison with physicians judgements in terms of sensitivity and specificity for the detection of acute myocardial infarction.

Pozen *et al.*, 1980[91] investigated the usefulness of a predictive model in assisting emergency department doctors to reduce inappropriate admissions to the coronary care unit. The predictive variables incorporated into the mathematical model were: *prior myocardial infarction, abnormal T-waves, dyspnoea, ST-segment deviation, site and importance (to the patients) of chest pain and prior angina*. A reduction of inappropriate admissions to coronary care unit was observed with higher diagnostic accuracy using this model.

Selker *et al.*, 1988[92], developed a predictive model in patients with *acute chest pain* and *dyspnoea* which resulted in a 30% reduction of inappropriate admissions to the coronary care unit. However, there was little impact on physician decisions among patients with a high probability of acute coronary syndrome.

A clinical pathway for patients with acute chest pain has also been suggested by Nichol *et al.*, 1997[93]. Patients who were clinically judged to have a low risk of acute myocardial infarction stayed in hospital for 6 h. If there was no recurrent pain or any other complication the patient was subjected to an exercise test. Forty percent of the patients were eligible for this pathway and among them 93% had a benign clinical course. A majority of patients may thus be discharged to home using this protocol and markedly reduce the number of hospital admissions due to acute chest pain.

Several smaller studies have shown that performing an exercise test in this situation may be feasible and safe[94,95], even in selected patients with known coronary artery disease[96]. In a small, randomized trial, an aggressive diagnostic strategy with resting emergency department perfusion tomography and early exercise test has been shown to decrease the length of stay and in-hospital costs[97].

Lee *et al.*, 1985[98], defined a combination of four variables indicating a very low risk of development of unstable angina pectoris or myocardial infarction. They were *sharp or stabbing pain, no history of angina pectoris or myocardial infarction, pain with pleuritic or positional components and pain that was reproduced by palpation of the chest wall.*

Thus, diagnostic sensitivity and specificity can be increased markedly by computer programs, and the number of variables carrying additional information is much larger than the number of variables normally utilized by doctors and by other decision supporting systems[99–101]. Yet, their usefulness in practice seems questionable and of little value so far[33,102].

Summary and recommendations

It is evident that various decision making algorithms based on computerizing relevant information can improve the diagnostic accuracy in acute chest pain (Class IIb, level B). Their predictive value will differ in different circumstances. Before introducing such algorithms in clinical practice one should try to optimize the physicians' skilfulness with regard to the handling of patients with acute chest pain. Today there is no universally applicable and recommended algorithm that can be used for patients with chest symptoms. Clinical judgement is still the most important factor for proper management of patients.

The five doors and the fast track

The first door. The patient

Patient's response to chest discomfort

For patients with chest pain due to a life-threatening condition, the decisions and actions taken following symptom onset are of considerable importance for the outcome. Established therapies for reperfusion of an infarct related coronary artery occlusion are time dependent. The delay from symptom onset to initiation of reperfusion therapy is an important determinant of the likely benefit of treatment: the longer the delay, the less benefit derived from reperfusion. Moreover, seeking professional help in the early stages of symptoms may result in an increase in the proportion of patients developing ventricular fibrillation in the presence of emergency medical service personnel, improving the chances of successful resuscitation[103,104].

Factors influencing delay in calling for help

The influence of the patients' behaviour with respect to the delay in fibrinolytic treatment for acute myocardial infarction has been described in several reports. According to a survey in the U.K., patients waited a median of 60 min before seeking help when symptoms occurred at home but delays were shorter (median 30 min) if symptoms occurred at work or in a public place[105]. Patients at home who sought advice from a general practitioner waited longer (median 70 min) before seeking help than those who called the emergency ambulance service (median 54 min) but almost one quarter (23%) of the patients waited 4 h or more before seeking help. Patients in rural areas were more likely to call a general practitioner than those in urban areas. Other series have reported even longer delays in seeking medical help[106–108], with median times from onset to presentation between 2 and 6·5 h. A prior history of acute myocardial infarction is not associated with a shorter delay in seeking help[106].

Several factors will have an influence on the delay in treatment seeking behaviour. Developing symptoms in the presence of a family member (typically a spouse) has been associated with additional delay in seeking help, possibly influenced by a range of emotional factors including denial[109]. Older patients[107,110,111], women[112,113], those from minority ethnic groups[112,114], and people experiencing social and economic deprivation[115] generally take longer to come under medical care. Symptom severity may also influence patient delay and patients experiencing sudden onset, severe chest pain are more likely to call for help earlier[116] as well as those with symptoms associated with severe left ventricular dysfunction[117,118]. Patients calling an ambulance rather than the general practitioner have been shown to be more severely ill and to display shorter delays to coronary care unit admission[19,119].

Why have media campaigns failed to reduce patient delay?

Several media campaigns aimed at reducing patient delay in seeking professional help have been reported but most of them have had limited sustained impact[120]. One reason for this may be that the emphasis given to the term 'chest pain' may be inappropriate. Unfortunately, health professionals' advice attributing symptoms to other, non-cardiac causes considerably increased delay. The patients' perception of their personal risk of a heart attack prior to the onset of symptoms is inversely associated to delay. Importantly, many patients say that their personal experience had been very different from their concept of what a 'heart attack' would be like, as portrayed by both the media and public health campaigns[120]. Few patients used the term 'chest pain' until contact had been made with health professionals. Ruston *et al.* propose that '*the myth that a heart attack is a dramatic event needs to be dispelled*' since in this series most patients experienced symptoms that were gradual, rather than dramatic in onset. This observation should have important implications for future campaigns to reduce patient delay in seeking help, since current campaigns tend to emphasize the word 'pain', yet few patients recognize the sensation as such[121]. In Europe, where pre-campaign delay times have been relatively long, the campaigns have been more successful[122,123]. In the U.S., on the other hand,

where pre-campaign delay times were shorter, media campaigns have been less successful[124,125].

How should patients respond to chest discomfort and related symptoms

Educating high risk patients Approximately half of all myocardial infarctions and 70% of deaths from coronary heart disease occur in patients with a previous history of cardiovascular disease[126]. People with coronary artery disease, peripheral artery disease and stroke in their history therefore form a well-defined high risk group for subsequent life-threatening coronary events. They should receive targeted education and advice on actions to be taken if symptoms that may indicate a potential risk of a coronary event occur; general practitioners in particular are in a good position to identify the high risk patient. To date, there is no evidence that patients who have suffered a prior myocardial infarction seek help earlier than those developing symptoms for the first time[30,127]. In the United States, the National Heart Attack Alert Program, a multiprofessional initiative to reduce delays to treatment for acute myocardial infarction, have published detailed guidelines for health professionals to support education of high risk patients[128]. Deciding which patients should receive education, and the content of any advice given, will to a large extent be a matter of professional judgement based on a detailed knowledge of the individual. Any information given should be clearly documented in the patient's clinical record, to facilitate supporting advice from other health professionals the patient will encounter. Information provided to patients should be reinforced by the provision of written information which should be tailored to the needs of the individual, refer to all relevant options, be honest about benefits and risks and include checklists to act as patient-specific reminders. Such information should include an 'action plan' in the event of a subsequent recurrence of symptoms, and details of prescribed medication

Educating the wider public Several campaigns have been organized on a local basis to inform the public about actions to be taken in the event of symptoms suggestive of a heart attack. Given the diverse nature of the population, any public health message will need to be accessible to people from different cultures, social groups and with differing educational abilities. The local emergency medical services telephone number should feature prominently, together with information on actions to be taken in the event of heart attack symptoms, including guidance on simple first-aid measures and basic life support and guidance by phone. Posters, leaflets and credit card sized *aides-memoires* bearing a consistent message (and translated into different languages reflecting the ethnic make-up of the target population) should be developed and widely distributed in public places. The heterogeneous nature of 'heart attack' symptoms within and across a diverse population will need to be taken into account as described above, particularly the fact chest discomfort is often discrete and of gradual onset[121,129]. It would seem sensible to involve patients and their relatives, who have been through the experience of a heart attack, in developing the key messages. National broadcast media should be encouraged to portray heart attack symptoms realistically in storylines[121]. The search for the 'gold standard' public health message continues.

Summary and recommendations

Patient delay still forms the major part of the delay time between onset of symptoms and start of treatment in acute chest pain. Various factors, including severity of symptoms, age, sex, social and educational factors influence the patient's decision to seek help. Educational campaigns have been only moderately successful in shortening this delay (Class IIb level B). Maybe the message has not been clear enough since many patients with acute myocardial infarction have a gradual onset of pain rather than an abrupt onset, as was highlighted in previous campaigns.

The patient — call for action — fast track

Messages to the public

Early diagnosis and treatment is life-saving

- Chest symptoms may indicate a serious and life-threatening condition.
- Symptoms are highly individual and may appear as chest pain, oppression, dyspnoea, heavy chest or slight discomfort.
- Symptoms may radiate to the arm, the jaw, the neck or back.
- The onset of symptoms may be acute, gradual or intermittent.
- Other signs/symptoms accompanying chest discomfort are important to recognize as indicators of possible underlying severity of the symptoms.
- Indicators of a less severe condition are: pain (discomfort) which varies with respiration, body position, food intake, and/or is well localized on the chest wall and/or is accompanied by local tenderness.

A serious condition may be present if the symptoms:

- interrupt normal activity
- are accompanied by: cold sweat, nausea, vomiting, fainting, anxiety/fear

Action

- Make immediate contact with professional medical advice
- Do not wait for the symptoms to disappear since these are poor indicators of risk
- Take a fast acting aspirin tablet (250–500 mg)

The second door. The general practitioner

Triage of patients with acute chest pain

In many health care systems, the possibility of using technical equipment, such as ECG and rapid laboratory tests, are not available. The main tools to diagnose the cause of chest pain are history and a physical examination with a stethoscope and a blood-pressure cuff.

Severe prolonged chest pain of acute onset is rarely a decision-making problem. If not caused by a trauma (fractured ribs or contusion) this symptom calls for immediate action whatever its cause. The differential diagnosis of potentially life-threatening conditions encompasses a heart attack or unstable angina, aneurysm of the aorta, pulmonary embolism, pneumothorax, and other pulmonary conditions. For all of these conditions immediate hospital care is needed.

The physical examination contributes almost nothing in diagnosing a heart attack (unless there is an associated shock). General predictors for infarction are age, male gender, type of pain and pattern of radiation, nausea and sweating and prior cardiovascular disease[102,130,131]. When called by a patient with acute chest pain, who is suspected of having a heart attack the best a general practitioner can do is triage by telephone and call for an ambulance. This is specifically the case within 1 h of onset of the symptoms, when the risk for ventricular fibrillation is greatest[132]. If a heart attack is suspected, a short-acting nitrate may be given if there is no bradycardia or low blood pressure. Fast acting aspirin (chewable or water soluble) should be given as soon as possible. To relieve pain and anxiety, opiates should be considered. In such a case the general practitioner is obliged to stay with the patient until the ambulance arrives.

Attacks of chest pain which are experienced by the patient as not very severe or prolonged, but distressing enough to make contact with a general practitioner, present a more difficult problem in diagnosis and management. In the presence of a typical history of angina pectoris the odds for coronary artery disease are high and additional tests are not needed[133]. The likelihood of angina increases with age (for men from 67% in the age range 30–39 to 94% in the age range 60–69; for females the range is 26% to 90%)[134]. In patients without a previous history of coronary artery disease, the highest diagnostic information against the presence of angina is: pain affected by palpation, breathing, turning, twisting or bending or generated from multiple sites[135]. A patient with stable angina pectoris is usually managed by a general practitioner and only about 30% of patients are referred to a cardiologist[136]. This rate is probably lower than optimal. When stable angina does not respond well to the usual pharmacotherapy, referral to a cardiologist is also indicated.

Panic attacks have a sudden onset and build to a peak rapidly, usually in 10 min or less[137]. It may resemble (unstable) angina. In diagnosing a panic attack the general practitioner should look for other symptoms, such as trembling, dizziness, de-realization, paresthesias and chills or hot flushes.

Pain of a pleuritic type can be found in diseases of the lung, or pleurae. This pain can develop in the course of a febrile illness and is mostly one-sided, with or without pleural rubbing. Illnesses of the respiratory tract can usually be diagnosed with careful history and physical examination, sometimes an X-ray of the chest is necessary. Viral infections (e.g. Bornholms disease) and pneumonia can be treated in general practice. When not responding properly to usual therapy, referral is sometimes necessary to diagnose rare causes (e.g. cancer, tuberculosis, multiple embolism).

Pre-hospital thrombolysis

Several trials have shown the benefit of fibrinolytic therapy in patients with an acute myocardial infarction, both on survival and on morbidity. There exists a clear time/benefit ratio. The shorter the time from onset of symptoms to administration of fibrinolytic therapy the better the survival and reduction in morbidity[138, 139]. A meta-analysis of three trials of pre-hospital thrombolysis showed a reduction of mortality of 17%. The benefit/time gradient calculated is 23 lives saved per 1000 per hour[140,141]. The new generation of rapid action, easy-to-administer thrombolytics will probably increase the lifesaving potential.

When a general practitioner suspects a heart attack he is right in about 75% of the cases[142,143], but in order to give fibrinolytic therapy a correct diagnosis is mandatory. Guidelines have been developed for general practice, which emphasize two important issues: the need for an ECG before fibrinolytic therapy is administered and the utility of attempted reperfusion within an hour from the patient's call[140]. The need for an ECG prevents the use of pre-hospital fibrinolysis by many general practitioners, since the interpretation of an ECG may not be accurate enough[144,145]. However, skills vary and some report a high accuracy in terms of ECG-interpretation by general practitioners[127]. A survey among general practitioners showed that they were lacking in training and support from local cardiologists[146]. In order to reach the point where all patients with an acute heart attack living at a distance from hospital of more than half an hour, receive timely fibrinolysis, agreements at a local level have to be reached. A protocol for telemetrics used for at home fibrinolysis agreed on between general practitioners, the emergency medical service, cardiologists and insurance companies will improve the possibilities of offering this therapy on a wide scale.

The reperfusion of the acutely ischaemic myocardium may be achieved by primary coronary angioplasty with more favourable outcome than with thrombolytics. GPs must be informed about the local possibilities and the availabilities of such programmes in their regions.

Summary and recommendations

Chest pain is a common symptom in general practice and the range of possible diagnoses is wide.

Muskuloskeletal pain is the most prevalent diagnosis and cardiac problems only account for 10–34% of all episodes. Most of the time a general practitioner can make a diagnosis based on the medical history and simple investigations only. When confronted with pain of acute onset and signs pointing to a serious problem the patient has to be referred, sometimes already on information provided by telephone (Class I, level C). The patient's condition can be optimized by treatment with aspirin, relieving pain, reducing anxiety and by stabilizing any haemodynamic and/or electric disturbance before transportation (Class 1, level C).

In the situation, where a patient cannot reach the hospital within 30 min, local agreements and protocols on pre-hospital thrombolysis are necessary (Class II, level B).

In order to implement primary angioplasty a close collaboration between GPs and local hospitals based on protocols is warranted.

The general practitioner — call for action — fast track

- The degree of symptoms is a poor indicator of the patient's risk of having a serious condition.
- The type of chest discomfort (pain), pattern of radiation and concomitant symptoms, such as nausea, sweating and cold, pale skin are valuable signs of a possible serious condition.
- A patient who is haemodynamically unstable (shock, low blood pressure) or who displays an arrhythmia (severe bradycardia/tachycardia) needs immediate attention regardless of the underlying cause.

If a serious, life-threatening condition is suspected:

- Do not lose time in reaching a diagnosis unless there are therapeutic options such as fibrinolysis and a defibrillator available
- Optimize the patient's condition by relieving pain, reducing anxiety and stabilizing any haemodynamic and/or electrical disturbance
- If a heart attack is suspected treatment should be initiated with
  - aspirin
  - short-acting nitrate
  - morphine
  - beta-blocker (bearing in mind heart rate, systolic blood pressure and high degree AV block)
  - and in selected cases based on ECG findings fibrinolytics
- Other treatment may be given on special indications
  - i.v nitrates
  - diuretics

The third door. The dispatch centre

The performance of a dispatch centre is determined by its organizational structure, the characteristics of the dispatchers and to what extent the use of protocols govern the decisions. External factors influencing the range of allowed decisions (and thus the performance) are the organization and quality level of the ambulance service and possible legal constraints. All these factors may determine the way calls are handled.

Organization

Dispatch centres may be organized as independent bodies, without connections to other emergency services, such as the police and fire brigade. Alternatively, various levels of integration between these bodies are possible. A dispatch room may be shared, but with independent activities (co-location), or technology may be shared at various levels of integration. The higher the level of integration, the easier it will be to adjust the quality of response between the organizations (such as first tier by fire squad and second tier by paramedic or nurse, etc). Shared technology information on screens entered by one service made visible to other services may speed up the dispatch process.

Dispatchers

Dispatchers themselves may be specialized or have a more general training, allowing them to be active for more than one emergency service. The more specialized, the higher the medical quality of the interaction with the caller. Their decisions can then be expected to be more accurate and less dependent on rigid protocols. The more general in training, the more posts can be shared, lowering cost but at a certain expense of quality and relying more on inflexible protocols. In dedicated medical dispatch centres, trained laymen, paramedically trained personnel (e.g. nurses) or even physicians can be employed, the latter on standby for consultation or performing the second line of contact. It is clear that the higher the level of training the better the level of medical discussion with the caller, and the more independent the medical decisions, including not dispatching help. In centres where the dispatchers are shared between emergency services, the level must necessarily be lower and decisions primarily based on protocols.

Protocols

Several protocols have been developed incorporating handling patients with chest pain. Some of the more widespread and best known protocols are the Emergency Medical Dispatch Priority Reference System (EMDPRS)[147], and the system developed in King County, Washington[148]. They are primarily designed to differentiate between dispatch priorities and dispatching the most appropriate type of response[149].

A specific subgoal of dispatching is the application of telephone guided Cardio-Pulmonary Resuscitation, as initiated in King County Washington, U.S.A.[150]. This

strictly trained protocol can successfully increase the rate of bystander-cardiopulmonary resuscitation in circulatory arrest.

Criteria for performance
Most studies addressing the question of performance of a dispatch centre focus on speed of delivery of appropriate care to patients[151,152]. Less frequently, effectivity is judged by the rate of justified and unjustified dispatches, which can be a criterion of cost-effectiveness of the system[16,153]. Efficacy can also be estimated by the appropriateness of the level of response[153,154]. When general practitioners are also incorporated in the system a decrease in dispatched ambulances and hospital admissions is usually observed[155,156].

Dispatcher's management of chest pain
Information from patients and witnesses is often limited and there is obviously a high risk of misunderstanding and misinterpretation. Thus, the obstacles for provision of medical guidance can be uncertainty and fear of judgmental errors. The volume of incoming calls can also be a stressful factor, sometimes leading to hesitation in initiating time-consuming interventions.

The various activities of dispatchers centre around the following elements:

- interviewing the caller
- deciding the level of priority
- dispatching and directing the rescue units
- advising and instructing in cases where it is possible, as for example, to give an instruction in cardiopulmonary resuscitation when the dispatcher suspects a cardiac arrest.

Phase 1: Identification of the problem In the identification phase, the dispatcher has to find out if help is necessary or not. At the time of an emergency call, the caller either describes symptoms, an event, or asks for a specific resource, i.e. ambulance, fire, rescue, or police. Ambulances should only be dispatched after interpretation of the caller's description of an event or presentation of symptoms. This process may be limited when the caller is not the patient or near the patient. If a protocol is used, the questions may be protocolized, but the interpretation of the answer is not; this is a necessary step before the next question can be asked. This element is frequently ignored in studies on dispatch protocols.

Phase 2: priority When the need for an ambulance is established according to phase 1, assessment of urgency and the level of ambulance should be made from the description of the patient's symptoms or type of event.

Phase 3: activity The activity phase comprises deciding on an adequate response with regard to urgency and type of event. If the case is judged to be life-threatening, another dispatcher can be connected into the call. The second dispatcher's task is to dispatch and direct the correct rescue units. In the mean time the dispatcher who received the call secures the address, and, in cases where it is possible, gives advice and instructions according to the type of emergency, for example instructions in cardiopulmonary resuscitation when suspecting a cardiac arrest (pre-arrival instructions). The second dispatcher communicates with the ambulance staff and should give them relevant information about the assignment, such as preparing them to confront the patient or situation.

Dispatcher training and certification
Formal emergency medical dispatch training are systemized and include recurrent medical and practical training, interrogation skills, protocol compliance and the provision of pre-arrival instructions. Certification should include requirements for continuing education and recertification.

Summary and recommendations

Organization of dispatch centres differ widely as does the background and training level of dispatchers. The higher the training level, the higher the level of interrogation of the caller to define the medical problem. The lower the training level, the more the dispatcher must adhere to standard protocols.

The process of handling a call is divided into phases:

Phase 1: Identification of the problem at the symptom level, not a diagnosis.Phase 2: Determine the priority and level of the dispatch.Phase 3: Activity. Dispatching, giving the caller instructions, including telephone cardiopulmonary resuscitation when indicated.

Dispatchers should be formally trained and certified. Continuing education and evaluation of their performance should be standard (Class I, level C).

The dispatch centre — call for action — fast track

- Assess symptoms and signs to give priority to, not to make a diagnosis
- Send an ambulance when the following conditions are present:
  - –severe discomfort (either pain, heavy feeling, difficulty breathing, etc.) lasting more than 15 min and still present while the call is made.
- Location anywhere in the chest, possibly including neck, arms, back, high abdomen.
- Symptoms associated with sweating, nausea, vomiting.
- Factors favouring fast track decision:
  - age over 30 years, either gender
  - discomfort similar to previous known angina pectoris or previous heart attack
  - discomfort includes right arm
  - intermittent loss of consciousness

Table 6 The hospital — call for action — fast track

Feature	High risk — Urgent response mandatory
Symptom	Continuous and ongoing chest pain possibly associated with any of: dyspnoea cold sweating constriction heaviness radiation to throat, shoulder, arms or epigastrium recurrence of chest pain
Breathing	Increased respiratory rate (>24/min), severe dyspnoea, use of 'helping' respiratory muscles
Consciousness	Depressed level of consciousness
Circulation	Heart rate (<40/min or >100/min) Blood pressure (systolic <100 mmHg or >200mmHg) Cold hands and feet Elevated jugular venous pressure
ECG	ST-elevation/depression, undiagnostic ECG due to arrhythmia, conduction disturbance, or high degree atrioventricular conduction block, ventricular tachycardia
Blood oxygenation–haemoglobin oxygen saturation	<90%

The fourth door. The ambulance

Evaluation and treatment of chest pain in the ambulance

The main goals in assessing and treating patients when first seen by the ambulance crew are to:

- correct vital function
- stabilize the condition
- start a diagnostic work-up
- begin treatment in order to relieve symptoms
- prevent development of complications and permanent damage

The first assessment is to decide whether the patient needs the fast track (i.e. urgent care). This decision is most appropriately made along the lines illustrated in Table 6. The need for an urgent response is increased if the patient has a history of coronary artery disease or a high risk for atherosclerosis, e.g. hyperlipidaemia, diabetes, smoking, hypertension, male sex and age more than 50 years, female sex and age more than 60 years, or a family history of coronary artery disease. However, such information might be difficult to obtain by the ambulance crew while on scene or in the ambulance.

Recording of ECG

In addition to history and clinical assessment the ECG is the most powerful tool to diagnose myocardial ischaemia prior to hospital admission. The use of ECG prior to hospital admission has been reported to be associated with a lower mortality among patients with acute chest pain[157]. Furthermore it has been shown to reduce the in-hospital delay time[158]. With regard to further aspects of ECG recording prior to hospital admission, we refer to the Guidelines on the pre-hospital management of acute heart attacks[132].

Ideally an ECG will be recorded and interpreted on site shortly after the first contact with the patient. In the absence of a system for immediate ECG interpretation, the tracing should be transmitted to a hospital for interpretation by a physician[159]. This must be accomplished with speed and without loss of quality. High quality transfer may be possible with standard telephone lines or digitized networks for computerized communication.

Biochemical markers

Theoretically a blood sample, to quickly determine whether there are signs of myocardial damage, could be of value in the pre-hospital setting. However, the scientific documentation of the value of such a procedure is not available. Preliminary data indicate that in areas with a short transport time, a rapid test for troponins performed at the point of care prior to admission to hospital identified only a minority of patients with acute myocardial infarction[160].

Treatment

With regard to treatment including pain relief, use of aspirin, fibrinolytic agents, nitrates, heparin and beta-blockers we refer to Guidelines on the prehospital management of acute heart attacks[132].

Transport

Patients must be transported to a hospital. They can be referred to the chest pain unit, to the emergency department or directly to a Coronary Care Unit or Intensive Care Unit or to a general internal medicine ward if no intensively monitored beds are available. In some countries special arrangements are being made for primary percutaneous transluminal coronary angioplasty (PTCA) in acute myocardial infarction. Under such circumstances the patient may be transported to a hospital with facilities for coronary angiography and

PTCA. The latter alternatives might reduce the delay time until start of treatment in a life-threatening condition. This is particularly important for patients of high risk such as those with severe left ventricular dysfunction (shock, pulmonary oedema).

Summary and recommendations

The main goals in assessing and treating patients with acute chest pain by the ambulance crew are to: correct vital function, stabilize the condition, start the diagnostic work-up, begin treatment in order to relieve symptoms and to prevent development of complications and permanent organ damage (Class I, level B). The use of ECG prior to hospital admission has been shown to reduce the in-hospital delay time and can furthermore be used to start various treatments prior to hospital admission with the intention to limit or sometimes even abort myocardial infarction (Class I, level B).

The ambulance — call for action — fast track

- In most ambulance organizations the majority of patients seen by the ambulance staff need urgent attention
- The action taken may depend on whether the patient has been seen by a doctor, called a dispatch centre or is seen directly by the ambulance crew
- The first priority is to check vital signs and stabilize the condition
- If possible, record and interpret an ECG within 5 min
- Treatment is given according to symptoms and signs, e.g. aspirin, pain relief (morphine), nitrates (myocardial ischaemia, congestive heart failure) and beta-blockers (myocardial ischaemia or tachyarrhythmia)
- A proper diagnosis based on ECG is mandatory if thrombolytic therapy treatment is planned
- An i.v. line should be established whenever possible
- Monitoring cardiac activity facilitates rapid defibrillation of ventricular tachycardia/ventricular fibrillation
- If facilities are available, the ambulance crew may decide whether to transport the patient directly to intensive care (based on clinical presentation and ECG pattern)

The fifth door. The hospital

The main goals in assessing and treating patients in the emergency department are to:
- correct vital functions
- stabilize the condition of the patient
- prevent development of permanent damage
- start the diagnostic work-up
- begin treatment

The time window in an emergency department varies from an immediate response in cases of cardiac arrest, to diagnostic work-up and possibly follow-up in a chest pain unit for 24 h. Some obligatory assessments are needed when a patient arrives in the emergency department and it is mandatory to assess the condition of a new patient immediately after admission. If the patient is brought in by the Emergency Medical Technicians they should be able to report the patient's condition and give their opinion on the urgency of further procedures. This first assessment is to decide on the implementation of the diagnostic and therapeutic procedures in terms of urgency and intensitivity (Fig. 3).

All emergency departments admit both patients needing urgent treatment and those who can be treated safely with a delay of hours and discharged home after an individual diagnostic work-up, and after a plan for further examinations and therapy. The rate of benign causes is high, if a great number of patients arrive directly without consulting a primary care physician, or if the emergency medical service transports all patients seeking help for any chest pain to the emergency department. On the other hand, if mainly referred patients are admitted, the rate of serious pathological conditions will be high.

Management of patients with a high risk and need of urgent response in the emergency department

Abnormalities in vital functions Check, correct and stabilize respiration, blood oxygenation and haemodynamic abnormalities (Table 6). Hypoxaemia is an insidious cause of depressed consciousness and confusion, of conduction disturbance and arrhythmia. Treat arrhythmia and acute heart failure according to the European Society guidelines on the pre-hospital management of acute heart attacks[132].

Recording of ECG in case of chest pain, dyspnoea or syncope In addition to history, ECG is the most powerful tool to diagnose myocardial ischaemia in the emergency department. ECG must be recorded and assessed by a doctor or qualified nurse within 5 min after admission of a patient with chest pain.

Pain relief Pain should be relieved even before ECG interpretation. Pain, as such, causes anxiety and results in sympathetic activation and increased blood pressure. Morphine given intravenously is the preferred drug. The dose should be titrated according to the severity of pain, to the individual patient, and to other drugs given, possibly anxiolytics.

Beta-blocking drugs given intravenously are efficient if myocardial ischaemia is suspected, particularly in cases of tachycardia and hypertension. Nitrates should be used liberally to decrease ischaemia and when needed to reduce cardiac filling pressures.

Aspirin and fibrinolytic treatment Fast acting aspirin should be given in the earliest possible phase to patients with a suspected acute coronary syndrome. Few clear

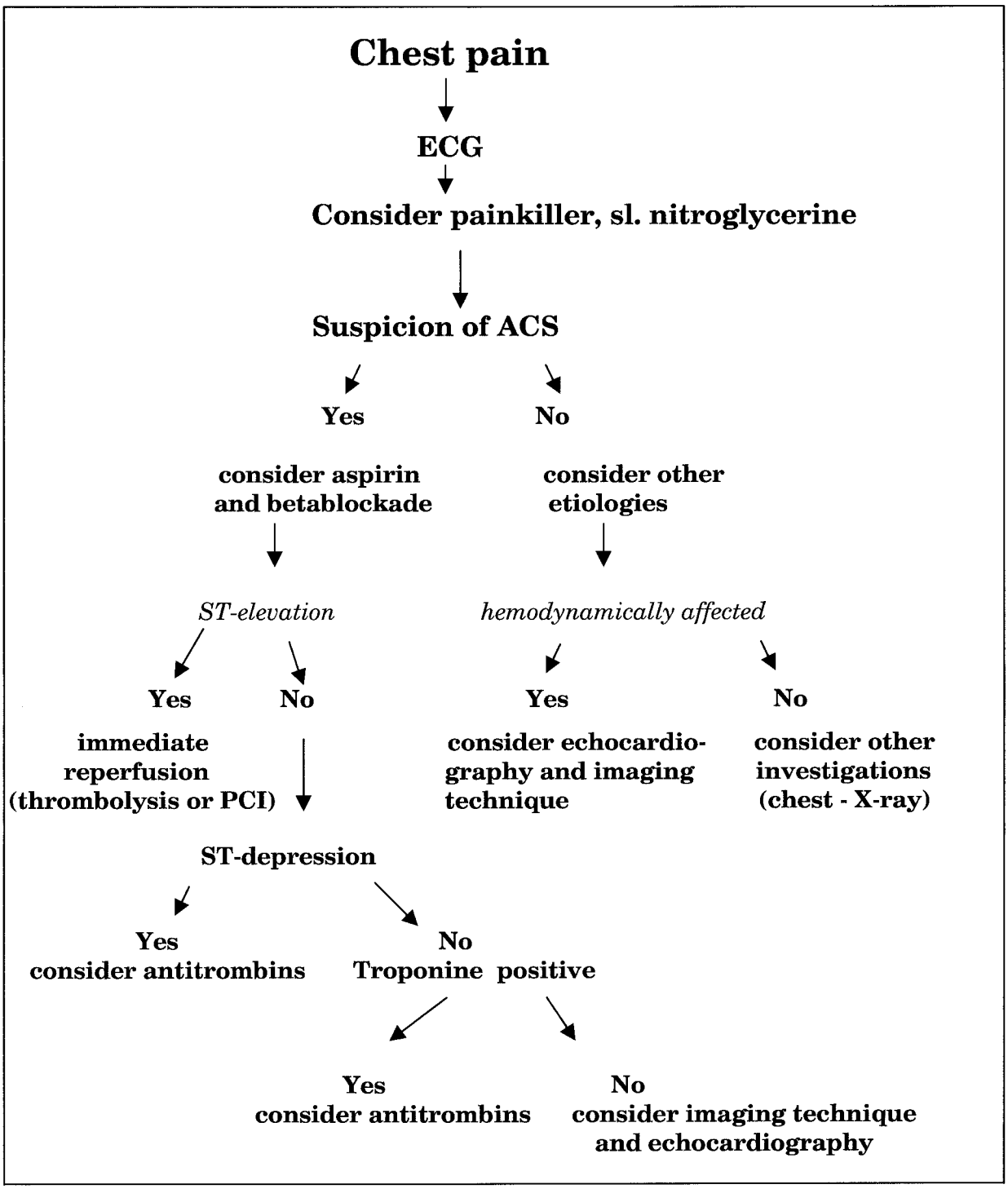

Figure 3 **Evaluation and treatment of patients with chest pain in the emergency department.**

contraindications exist but should be checked. If fibrinolytic therapy has not already been given in the pre-hospital phase, it must be started promptly in the emergency department when indicated. Any delay to the start of fibrinolytic therapy of more than 30 min calls for a critical examination of the system. Is the door-to-needle time should be regularly measured and kept under 30 min. Patients might also be directly transferred to undergo immediate coronary angiography for primary percutaneous coronary intervention if facilities are available.

Antiplatelet and antithrombotic treatments Patients with acute coronary syndrome but without indications for

Table 7 Diagnostic work-up of a patient without overt signs of acute coronary syndrome

- Physical examination (consciousness, respiration, blood pressure, heart rate, body temperature and temperature of the extremities, sweating etc.)
- Chest X-ray
- Blood gas determination from arterial blood
- Clinical chemistry (Hb, RBC, WBC, platelets, CRP, CK, CK-Mb, TnT, TnI, Creatinin etc.)
- Transthoracic echocardiography (if haemodynamic disturbances or new murmurs are found). Transoesophageal examination if aortic dissection is suspected
- A CT or MR scan if aortic dissection is suspected
- Pulmonary scintigraphy, alternatively spiral CT examination when pulmonary embolism is suspected
- Exercise test before discharge to reveal possible severe myocardial ischaemia at low work-load

fibrinolysis benefit from antithrombin treatment with heparin. If they have an elevated level of troponin T ($>0{\cdot}1\ \mu g\ .\ l^{-1}$) treatment with low-molecular-weight heparin improves prognosis[161]. Platelet glycoprotein (GP) IIb/IIIa inhibitors have been shown to be beneficial in high risk patients treated with percutaneous coronary interventions. High risk is associated both with ECG-ST-T changes and with increased levels of biochemical markers[162–164]. Aspirin combined with clopidogrel reduced the incidence of death, stroke, and myocardial infarction in the recently published CURE trial[165].

For further details see the European Society Guidelines on unstable angina and non-Q wave infarction[1].

Admission into the coronary care unit Patients having ongoing chest pain should be admitted to a specialized coronary care or intensive care or chest pain unit without delay. Rapid availability of reperfusion therapy with drugs and with invasive procedures was associated with a 53% reduction of mortality in a recent study from Israel. The age adjusted 30-day mortality of patients treated in coronary care units was 6·8%, and of patients treated in general internal medicine wards 10·9%, respectively[166].

If there is shortage of beds in the coronary care unit, the risk should be individually assessed and priority given to those at highest risk. Particularly, severe continuing pain, ischaemic ECG changes, a positive troponin test, left ventricular failure and other haemodynamic abnormalities are findings selecting high risk patients into the coronary care unit.

Patients with normal ECG A careful history, clinical examination and more laboratory examinations are needed when the ECG is normal and biochemical markers are normal but the patient has severe chest pain or other features indicating a serious condition. Pulmonary embolism, aortic dissection, acute pericarditis, and pneumothorax are rare compared to acute coronary syndromes in Europe, although they all are life-threatening, serious clinical conditions.

Management of patients without features of high risk
Routine examinations A careful history focusing on the symptoms that caused the admission to the emergency department and a thorough physical examination, including observation of the respiratory rate and palpation of the chest wall and epigastrium, auscultation of the heart and lungs is the key to all further investigations, procedures and therapy.

Laboratory examinations ECG must be recorded in all patients with chest pain in the emergency department. Up to 30% of myocardial infarctions have atypical symptoms or are symptomless[167]. A chest X-ray should be taken in patients with chest pain and no obvious myocardial ischaemia to reveal e.g. pleuritis, pleuropneumonia, pneumothorax and intrathoracal tumours.

A blood sample to determine myocardial damage should be taken even without ischaemic ECG changes. Troponins and CK-MB are the most specific tests for cardiac cell damage[168].

Bedside tests may save up to 30 min compared to a more precise laboratory serum analysis. They are reliable in detecting higher than the cut-off level of troponins when done in the appropriate way. Yet, interpretation of the results, when looking at colour change of bands, may be difficult even for the experienced technician. A semi-quantitative determination is available with a handy reading apparatus, and it is as reliable as the quantitative troponin T analysis in detecting positive values above the cut-off level and to exclude even minor myocardial damage[169].

To rule out a myocardial infarction, approximately 10 h are needed between the beginning of the index symptom and the time when the blood sample is taken[170]. This holds true also for the use of bedside tests.

The patient can be discharged home if she/he has been asymptomatic for 6 h in the follow-up, if there are no new ischaemic ECG changes and if there are no biochemical signs of recent myocardial necrosis. An exercise test can be done before discharge and it may be useful to determine severity of symptoms and ischaemia at exercise (Table 7).

Chest pain units
Chest pain is one of the most common symptoms in emergency departments comprising 5–20% of emergency department visits[21,171], yet only 10–15% of chest pain patients have AMI[131,172,173]. Attempts have therefore

been made to organize the management of these patients outside the traditional CCU. Patients at high risk and with an immediate diagnosis of an acute coronary syndrome should be admitted to the coronary care unit without delay. Patients with intermediate risk are those who will benefit from treatment in the chest pain unit[174,175].

Around 50% of patients admitted with chest pain to hospital have a non-cardiac cause of their symptoms[176]. Most of these patients can be better evaluated in chest pain units than in the emergency department for 10 to 12 h after the beginning of symptoms. The risk of patients discharged without correctly diagnosing acute coronary syndrome is high without proper observation. One way to estimate this risk is to compare it with the risk in the pre-aspirin and pre-heparin era; 20–30% of patients either died or had a myocardial infarction within 4 weeks in unstable angina. The corresponding risk today is 8%[177]. Many strategies are currently under investigation for better identification of patients at high risk of death and/or development of an acute myocardial infarction. These strategies include thallium[66], and sestamibi[68] scans and echocardiogram[178] but so far no algorithm is available for recommendation.

Design, staff and organization of a chest pain unit The design of a chest pain unit will vary between hospitals because of different emergency department configurations. The chest pain unit should be equipped to resuscitate patients, and have appropriate monitoring equipment for cardiac rhythm, blood pressure and blood oxygenation. Constant human surveillance of the monitors is not always possible and not even necessary. Monitors with arrhythmia alarm is the rational choice and continuous ST-segment monitoring should be available. ST-segment monitoring with continuous 12-lead ECG provides early diagnostic, as well as prognostic information additional to other markers[179]. Simple three-lead continuous ECG monitoring also appears to be a useful non-invasive tool for further risk stratification[180].

The important features of chest pain units are experienced physicians and nurses, careful diagnostic work-up and prompt treatments, not the actual physical conditions. The number of patients with chest pain varies from day to day even in large emergency departments. Thus, the staff and beds of a chest pain unit can also be used to treat patients with other diagnoses in need of close follow-up.

Chest pain units have been shown to be a safe, effective and cost-saving means of ensuring appropriate care to patients with unstable angina and at intermediate risk of cardiovascular events[175].

Summary and recommendations

Immediate assessment of patients with chest pain is mandatory on arrival at the emergency department (Class I, level C). ECG should be recorded and assessed within 5 min (Class I, level C). Pain relief, correction and stabilization of haemodynamic changes should be done without delay (Class I, level C). If ST-segment change indicates evolving Q wave infarction, thrombolytic treatment should be started within 30 min (Class I, level B). If acute coronary syndrome is suspected aspirin should be given as soon as possible and low-molecular-weight heparin can be started in the emergency department (Class IIb, level C). Blood samples should be drawn for assays of CK-MB mass and troponin T or I on admission, and at 10–12 h after the beginning of the index chest pain or symptom for diagnosis of possible myocardial infarction, and for assessment of risk of the patient (Class I, level B). If the symptoms are not related to myocardial ischaemia the patient should be examined for other cardiovascular causes and for acute illnesses in need for urgent intervention. A great proportion of patients have a benign cause of chest pain and further diagnostic work-up can be done in a chest pain unit or as outpatients.

Quality assessment

It is recognized that health care systems must be controlled for quality of the care they deliver[181]. Quality may be measured in a number of ways. Audits may be performed analysing a particular situation at a certain point in time. This gives a snapshot of how a system works, but it does not give information about the dynamic process involved. Furthermore, an audit may often be conceived as a control and thus less appreciated by those involved — both doctors, nurses and other medical staff.

In order to examine the quality of care it is necessary to identify specific quality indicators for the management of patients with chest pain. These quality indicators should be recognized as meaningful both for the medical profession and patients. They should be easily acquired, possible to measure and reflect the specific quality issues; structure and process. Important characteristics of structure that can be used as indicators of quality are

- Presence of clinical practice guidelines for patients with chest pain.
- Monitoring of care and outcomes by a quality assessment programme specific for patients with chest pain.

Structural quality indicators may also include location of health care facilities, laboratory and testing facilities, medical equipment, information system technology, telecommunication systems and the qualifications of the staff.

With respect to the process in the management of chest pain there are special quality indicators: the time to relief of pain; access to dispatch centre by telephone; access time for ambulances to arrive to the patient the time to diagnosis; proper and timely use of drugs and interventions (physician).

Once a preliminary diagnosis is achieved the quality of management will definitely be related to

the time it will take to solve the problem. If the diagnosis is unstable coronary artery disease or acute myocardial infarction the quality of this care will be a matter for guidelines dealing with those specific conditions.

Emergency dispatch quality control and improvement

To ensure safe and effective patient care, evaluation of the emergency medical dispatch components are essential, and should be an integral element in the continuing education of dispatchers without being hampered by claims of privacy protection by the dispatchers. The quality control consists of reviews of emergency medical dispatchers cases, evaluation of performance and adherence to dispatch protocol.

By evaluating tape recordings one can judge the emergency medical dispatcher's ability to (a) identify the problem, (b) give the case the right priority, (c) identify suitable cases, and (d) perform pre-arrival instructions. This also serves to improve quality and gives the emergency medical dispatchers feedback for cases they handled well. The emergency medical dispatchers need encouragement and medical support in their difficult assignment; they are alone when making critical decisions.

The review of unusual cases, both problematic and successful, is also an important source of experience. This quality control should be carried out under the medical direction of a responsible emergency medical service physician.

Evaluation of methods to better delineate patients with a life-threatening condition already at the dispatch centre should have priority.

Close contact and co-operation with various health care providers, for continuous development of the dispatchers work should be ongoing. Included is prospective and retrospective follow-up studies to evaluate the enterprise.

These recommendations, including criteria-based dispatch as a foundation for priority decisions with advice and instructions, should be decisive in the management of emergency calls concerning acute chest pain.

Summary

In order to ensure the quality of the care delivered, quality indicators need to be registered in all patients. If we know, for instance, that the mean time to reach a diagnosis is 3 h this would represent the current quality.

A new goal for quality improvement could then be to reduce the time by 33% to 2 h. This would be an improvement in quality, which could be measured. Similarly, by knowing the actual situation for a number of quality indicators goals can be set and improvements may be achieved by this type of quality development.

Quality indicators in the management of chest pain

Structure

- Presence of clinical practice guidelines
- Monitoring care and outcomes by a programme specific for patients with chest pain
- Equipment and availability of drugs

Process

Indicator measuring all steps from onset of pain to final diagnosis and treatment.

- Public awareness and knowledge as expressed by e.g. interviews and polls of when and how to act when chest symptoms occur
- The accessibility of general practitioners to handle a patient with chest symptoms
  - 24 h service
  - waiting times both at office visits and home calls
  - home or office visits
- Performance of the dispatch centre
  - proportion of correct diagnoses (case by case)
  - time from call to a preliminary diagnosis
  - time from call to order ambulance
- Performance of the ambulance service
  - availability of ambulances when called
  - waiting time to send ambulance
- The organization of emergency department to handle patients with chest discomfort
  - ECG availability (<5 min)
  - door to needle time for thrombolytic therapy
  - immediate access to coronary care unit care

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