# Management of Acute Chest Pain with Low Likelihood Acute Coronary Syndrome

## *DÜŞÜK OLASILIKLI AKUT KORONER SENDROM HASTALARININ YÖNETİMİ*

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## Abstract

**Objective:** The management of chest pain patients remains problematic despite the clinical acumen, ECG and highly sensitive cardiac markers. The 2-5% of patients with acute myocardial infarciton (AMI) is discharged inadvertently from the emergency department (ER). We tested the hypothesis that the low likelihood acute coronary syndrome (ACS) patients according to the ACC/AHA classification can be managed as outpatients.

**Material and Methods:** We performed a prospective cross sectional study with chest pain patients classified as low likelihood ACS according to the ACC/AHA guideline. Follow-up of low likelihood ACS patients was performed 1 month after their ER presentation to determine the adverse cardiac events. The adverse cardiac events were defined as AMI and death.

**Results:** During the six month study period, 136 of 577 patients with chest pain who presented to the ER were diagnosed as low likelihood ACS. Follow up data were obtained for 120 patients after one month. During the one month follow-up period there were no patients who died or had AMI. However, six patients had a diagnosis of coronary artery disease.

**Conclusion:** Low likelihood chest pain patients according to ACC/AHA classification should be safely discharged from ER with a normal cardiac troponin at 6 hours after symptom onset.

**Key Words:** Emergency service; cardiac, adverse effects; angina pectoris

## Özet

**Amaç:** Klinik deneyim, EKG ve yüksek duyarlılıklı kardiyak belirteçlere rağmen göğüs ağrılı hastaların yönetimi halen bir problem teşkil etmektedir. Akut miyokard infarktüslü (AMİ) hastaların %2-5'i acil servislerden uygunsuz biçimde taburcu edilmektedir. Bu çalışmada ACC/AHA sınıflamasına göre düşük olasılıklı koroner arter hastalığı (KAH) olarak sınıflandırılan hastaların ayaktan takip edilebileceği hipotezini test etmeyi amaçladık.

**Gereç ve Yöntemler:** Bu çalışma ileriye dönük, randomize ve kesitsel çalışma olarak tasarlandı. ACC/AHA kılavuzuna göre düşük olasılıklı anstabil angina pektoris (USAP) olarak sınıflandırılan hastalar çalışma popülasyonunu oluşturdu. Düşük olasılıklı USAP olarak sınıflandırılan hastalar acil servis başvurularından bir ay sonra telefonla arandı ve istenmeyen kardiyak olay sorgulandı. İstenmeyen kardiyak olay, ölüm ve AMİ olarak tanımlandı.

**Bulgular:** Altı aylık çalışma periyodunda, acil servise 576 göğüs ağrılı hasta başvurdu ve 136 hasta düşük olasılıklı USAP olarak sınıflandırıldı. Bir ay sonra 120 hastaya ulaşıldı. Bir aylık takip periyodu sonunda hiçbir hastada ölüm ve AMİ görülmedi. Ancak 6 hastaya KAH tanısının koyulduğu saptandı.

**Sonuç:** ACC/AHA kılavuzuna göre düşük olasılıklı olarak sınıflandırılan göğüs ağrılı hastalar semptomların başlamasından sonraki altıncı saatte troponin değerleri normalse taburcu edilebilirler.

**Anahtar Kelimeler:** Acil servis; istenmeyen kardiyak olay; angina pektoris

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Chest pain is the second most common cause of all emergency deparooment (ER) presentations and still remains a challenge for ER physicians.[1] One third of chest pain patients eventually have a diagnosis of acute coronary syndrome (ACS).[2] The 2-5% of chest pain patients with acute myocardial infarction (AMI) are discharged inadvertently from the ER despite the clinical acumen, ECG and highly sensitive biomarkers resulting in a poor outcome.[3-5] These inappropriate discharges are not only life-threatening for the patients but also form one the most important reasons of malpractice suits in ER. Despite the existence of all these risks mentioned above, to

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hospitalize all chest pain patients for further evaluation does not seem a cost-effective method.

Quick and accurate risk stratification of chest pain patients in the ER is essential for the early medical and interventional management of non ST segment elevation acute coronary syndromes. There are some published tools to perform this stratification including Goldman chest pain protocol, the Pozen-Selker Acute Cardiac Ischemia Time-Intensive Predictive Measurement (ACI-TIPI), neural network and American College of Cardiology/American Heart Association (ACC/AHA) guidelines for the management of patients with unstable angina and non-ST segment elevation myocardial infarction.[6-10] The ACC/AHA unstable angina guideline estimates the likelihood of coronary artery disease (CAD) by dividing patients into high, moderate and low likelihood of ACS. And it recommends discharging the patients classified as low likelihood ACS if the 4-8 hours follow up ECG and cardiac marker measurements are normal.[8]

Despite the highly sensitive cardiac markers, new inflammatory and coagulation biomarkers, risk stratification protocols and chest pain units, there is no consensus about the safe discharge of patients with symptoms suggesting possible ACS. The objective of this study is to determine whether the low likelihood CAD patients predicted to be ACS can be followed outpatient. We preferred to use the ACC/AHA protocol because of suggesting discharging the low likelihood patients after a normal troponin obtained 6 hours after the symptoms onset. Furthermore, the chest pain algorithms above are computer based and they all have been tested with a clinical study except ACC/AHA. In this study one of the most important things is to realize the difference between the low likelihood and low risk, because low likelihood CAD patients composed our study population.

## Material and Methods

### Study Design and Setting

In this prospective observational study, we tested the hypothesis that low likelihood CAD patients presented with chest pain to the ER can be followed as out patient. The study was performed in an urban tertiary care hospital (annual census of approximately 50.000 adult visits) between March 2004 and September 2004. The study was approved by the local ethical committee.

### Selection of Participants

All patients with an age equal or older than 24 years who presented to the ER with a chief complaint of chest pain without trauma were enrolled to our study.

### Data Collection and Processing

The residents enrolled the patients and performed the collection of data. The information collected from the patients included demographic information, cardiac risk factors, medication, the onset, duration and characteristics of chest pain, associated symptoms, ECG interpretation, cardiac enzymes and the outcome of patients in ER. After the data collection patients were classified as atypical chest pain, stable angina pectoris and ACS. The unstable angina pectoris patients among the ACS were classified as low, moderate and high likelihood of CAD according to the ACC/AHA guideline (Table 1). The low likelihood ACS patients composed our study population. Follow-up of low likelihood ACS patients was performed 1 month after their ER presentation to determine the adverse cardiac events. Adverse cardiac events were the composite of death and MI. Patients' information was obtained by telephone interview and hospital records. Venous blood samples were obtained from all study patients presenting to the ER. Cardiac troponin T and creatinine kinase myocardial band (CK-MB) mass were measured by electrochemiluminescense method with a Roche Elecys 2010 analyzer. Levels greater than 0.1 ng/ml for TrT and 5 ng/ml for CK-MB Mass were considered increased.

Low likelihood CAD patients predicted to be ACS was defined according to ACC/AHA guideline: probable ischemic symptoms in absence of any of the intermediate or high likelihood characteristics (history of CAD, diabetes mellitus, older than 70 years old and male sex) or recent cocaine use, chest discomfort produced by palpation, T

**Table 1.** Likelihood signs and symptoms represent an ACS secondary to CAD.

| Feature | High Likelihood | Intermediate likelihood | Low Likelihood |
|---|---|---|---|
| | Any of the following | Absence of high-likelihood features and presence of any of the following | Absence of high or intermediate likelihood features but may have: |
| **History** | ▪ Chest or left arm pain or discomfort as chief symptom reproducing prior documented angina<br>▪ Known history of CAD, including MI | ▪ Chest or left arm pain or discomfort as chief symptom<br>▪ Age 70 years<br>▪ Male sex<br>▪ Diabetes Mellitus | ▪ Probable ischemic symptoms in absence of any of the intermediate likelihood characteristics<br>▪ Recent cocaine use |
| **Examination** | ▪ Transient MR, hypotension, diaphoresis, pulmonary edema, or rales | ▪ Extracardiac vascular disease reproduced by palpation | ▪ Chest discomfort |
| **ECG** | ▪ New, or presumably new, transient STsegment deviation (> 0.05 mV) or T-wave inversion (> 0.2 mV) with symptoms | ▪ Fixed Q waves<br>Abnormal ST segments or T waves not documented to be new | ▪ T-wave flattening or inversion in leads with dominant R waves<br>▪ Normal ECG |
| **Cardiac Markers** | ▪ Elevated cardiac TnI, TnT, or CK-MB | ▪ Normal | ▪ Normal |

Abbreviations: ACS: acute coronary syndrome; CAD: coronary artery disease, MI: myocardial infarction; MR: mitral regurgitation

wave flattening or inversion in leads with dominant R wave or normal ECG and normal cardiac enzymes.[8]

The ECG analyses was performed according to these definitions: ST elevation of ≥ 1 mm in 2 contiguous leads, ST depression of ≥ 1 mm in 2 contiguous leads, T-wave inversion ≥ 2 mm in 2 contiguous leads, Q wave ≥ 0.04 seconds and amplitude ≥ 25% of the Q:R ratio. And also transient ST segment deviation (≥ 0.05 mV) or T-wave inversion (≥ 0.02 mV) with symptoms and left bundle-branch block were categorized as an indicator of myocardial injury.

Acute coronary syndrome was defined as a diagnosis of acute myocardial infarction in accordance with the World Health Organization criteria and the Consensus Document of the Joint European Society of Cardiology/American College of Cardiology Committee for the Redefinition of Myocardial Infarction[11] or unstable angina that was classified according to the Braunwald classification.[8]

### Data Analysis

Data were analyzed with the SPSS 10.0 for Windows statistical package. The continuous data are presented as mean ± SD and the categorical data are presented as percentiles. Univariate comparisons between groups were made with nonparametric tests: Fischer's Exact test or Mann-Whitney U test for 2-group comparisons. A two-sided P value < 0.05 was considered significant.

## Results

Of the 577 patients presented with chest pain during the study period, 136 patients were low likelihood ACS, 247 were moderate and high likelihood ACS, 18 were stable angina pectoris and 176 were atypical chest pain. The final study population comprised the 136 low likelihood ACS patients. The patient flow chart is demonstrated in Figure 1. Study subjects had a mean age of 49 ± 11 and 59% were men. There were 22 (16%) patients with a history of hypertension and 14 (10%) patients with hyperlipidemia. Patient demographic, historical, other presenting and chest pain characteristics are shown in Table 2. The ECG of 119 (87.5%) patients was normal. In the ECG of 17 (12.5%) patients, there were some findings not suggesting ischemia like incomplete right bundle branch block, sinus tachycardia and T wave flattening. All patients had a normal cardiac tropanin T and CK-MB mass during the ER observation

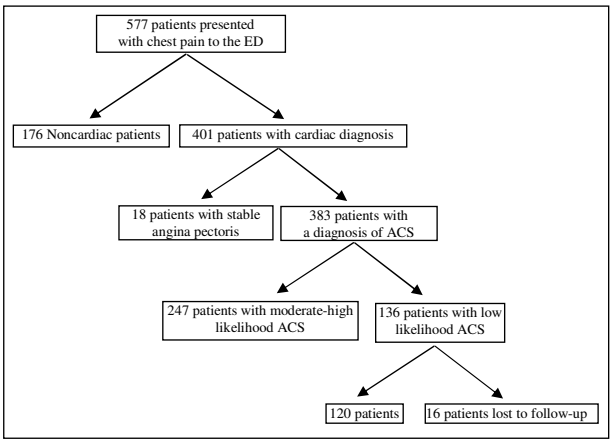


**Figure 1.** Patient flow of 577 patients presenting with chest pain to the ER.

**Table 2.** Patients' characteristics.

| Variable | n=136 | % |
|---|---|---|
| **Mean age (years)** | 49.04±10.56 | |
| **Sex** | | |
| Male | 80 | 58.8 |
| Female | 56 | 41.2 |
| **Chest pain characteristics** | | |
| Chest pain described as stabbing | 64 | 47.1 |
| Chest pain described as pleuritic | 19 | 14 |
| Chest pain described as burning | 18 | 13.2 |
| Chest pain described other than the characteristics above | 31 | 22.8 |
| Chest pain radiates to neck, shoulder and left arm | 31 | 22.8 |
| Chest pain radiates to back, right arm or more than one region | 46 | 33.8 |
| **Cardiac risk factors** | | |
| Hypertension | 22 | 16.2 |
| History of smoking | 65 | 47.8 |
| Alcohol | 29 | 21.3 |
| Family history | 40 | 29.4 |
| Diabetes mellitus | 0 | 0 |
| Hyperlipidemia | 14 | 10.3 |
| History of coronary artery disease | 0 | 0 |
| **ECG findings** | | |
| Normal | 119 | 87.5 |
| Other | 17 | 12.5 |

period. One hundred eleven patients' cardiac enzymes were studied after the sixth hour period in respect of the onset of symptoms. The cardiac enzymes of remaining 25 patients were studied before the 6 hour period, 12 of them were between 5 and 6 hours period. Forty nine patients had cardiology consultation. One hundred twenty one (89%) patients discharged home and 13 (9.6%) patients admitted to the cardiology service. Among the low likelihood ACS patients one month follow-up data were available for 120 patients, 111 by telephone and 9 by hospital records. The follow-up of 16 patients couldn't be performed either telephone or medical record. During the one month follow-up period there were no patients who died or had myocardial infarction. Six patients had a diagnosis of coronary artery disease. One of the patients who had a diagnosis of CAD after admission to the cardiology service couldn't be reached at the end of the one month follow-up period. And we haven't been aware whether she had an adverse cardiac event or not. Despite there was no statistically significant difference in the diagnosis of CAD between the patients consulted and not consulted with cardiology ($p > 0.05$), there was significant difference between the discharged and admitted patients ($p < 0.01$).

## Discussion

In the initial evaluation of chest pain patients in the ER, physicians use ECG, cardiovascular risk factors, chest pain characteristics and clinical impression. But they are not enough to risk stratify the chest pain patients to prevent future adverse cardiac events. There is not a consensus throughout the world whether which patients can be discharged home safely and how can we prevent the unnecessary admissions and diagnostic tests causing extravagance.

Although the computer based algorithms can successfully risk-stratify patients, they are not commonly used by the physicians in the clinical practice and they do not influence the admission rates of chest pain patients in the ER.[12,13] Furthermore they are not superior to physicians' decisions in determining acute myocardial infarction.[6]

There are few studies asking for the safe discharge of the low likelihood chest pain patients in the medical literature. Koukkunen et al. evaluated 297 low likelihood chest pain patients discharged from ER and chest pain unit. They found 4 deaths (0.1%) during 4 weeks follow-up and supposed that low likelihood chest pain patients can be

safely discharged home from the ER.[14] This study is a retrospective study and the exact drawing time of cardiac troponins in regard of symptom onset is unclear. Limkakeng et al.[15] evaluated 998 low likelihood chest pain patient with a Goldman risk score < 4% and a "normal" initial cTnI. They found 23 myocardial infarctions in a month follow-up, but 17 of these patients were diagnosed during their index visit to the hospital. And the median time of onset of chest pain was 4 hours. This study shows the insufficiency of initial cardiac troponin in determining low risk chest pain patients and AMI in ER. In another study Smith et al.[16] evaluated 588 low likelihood patients retrospectively. They basically defined the low risk chest pain patients according to a negative electrocardiogram and a single normal cardiac troponin I at sixth hour after symptom onset. During 30 days follow-up they found two patients have non-ST elevation MI and no death. Both patients had a history of CAD, one of the patients ECG revealed 0.5 mm ST depression and had a history of diabetes mellitus. The other one was discharged from ER without drawing a troponin in 6-9 hours after onset of symptoms. This study is valuable to use sixth hour cardiac troponin after symptom onset, but it is a retrospective study and two patients found to have MI in the follow-up are classified high likelihood ACS according to this study's risk stratification. Both having a history of diabetes mellitus and CAD is a major risk factor for predicting the likelihood of chest pain whether it is an angina and the adverse cardiac events. In a recent study by Miller et al. the odds ratio of CAD to predict adverse cardiac events is 4.44 for the chest pain patients diagnosed as noncardiac in the ER and 2.18 for diabetes mellitus.[17] The most important point to pay attention in choosing the low likelihood patients is proper risk stratification. We think that ACC/AHA stratification is appropriate to classify the chest pain patients as cardiac or noncardiac. Because, the patients with a history of CAD and diabetes mellitus are included to the high and moderate likelihood ACS group. It also uses the advantages of ECG and cardiac troponin 6 hours after symptom onset in determining ACS patients in the ER. Meanwhile, it is not a classification system figured out by a computer. Perhaps the ER physicians should be more inclined to use this stratification instead of a computer algorithm. The results of this study confirms that the ACC/AHA classification should be an agreeable risk stratification to determine the low likelihood ACS patients and the prudence that low likelihood patients can be discharged home safely. Further studies using ACC/AHA classification with greater sample size should provide more accurate information about the management of low likelihood patients in the ER.

There are some limitations to this study. Some of the patients diagnosed as noncardiac had cardiac biomarkers drawn. It may also be a reflection of daily practice or some of low likelihood patients might be misclassified. Although the sample size of this study is not too small, if this study was performed with a greater sample size, it could provide more accurate outcomes about low likelihood patients. Particularly the elderly patients have been followed up with serial ECG and cardiac markers in our clinical practice even they have atypical chest pain. However some of them could still be acute coronary syndrome. Furthermore male gender has been attributed as intermediate likelihood of acute coronary syndrome in the ACC/AHA guideline. However males were classified as low likelihood ACS in this study in the absence of other criteria for high-intermediate likelihood ACS. The reason for this application was to avoid a study population that was composed of women. We think that this application did not have a negative effect on the results. Because neither a death nor a MI was established during the follow-up.

## Conclusion

In summary, low likelihood chest pain patients according to ACC/AHA classification should be discharged from ER with a normal cardiac troponin 6 hours after symptom onset. More prospective studies are required to define better the features of low likelihood ACS patients and to verify that low likelihood ACS patients should be discharged from ER and managed as outpatients.

## REFERENCES


1. McCaig LF, Burd CW. National Hospital Ambulatory Medical Care Survey: 2002 emergency department summary. Adv Data 2004;18:1-34.
2. Solinas L, Raucci R, Terrazzino S, et al. Prevalence, clinical characteristics, resource utilization and outcome of patients with acute chest pain in the emergency department. A multicenter, prospective, observational study in northeastern Italy. Ital Heart J 2003;4:318-24.
3. Pope JH, Aufderheide TP, Ruthazer R, et al. Missed diagnosis of acute cardiac ischemia in the emergency department. N Engl J Med 2000;342:1163-70.
4. McCarthy BD, Beshansky JR, D'Agostino RB, Sekler HP. Missed diagnosis of acute myocardial infarction in the emergency department: Results from a multicenter study. Ann Emerg Med 1993;22:579-82.
5. Lee TH, Rouan GW, Weisberg MC, et al. Clinical characteristics and natural history of patients with acute myocardial infarction sent from the emergency room. Am J Cardiol 1987 1;60:219-24.
6. Goldman L, Cook EF, Brand DA, et al. A computer protocol to predict myocardial infarction in emergency department patients with chest pain. N Engl J Med 1988;318:797-803.
7. Selker HP, Beshansky JR, Griffith JL, et al. Use of the acute cardiac ischemia time-intensive predictive instrument (ACI-TIPI) to assist with triage of patients with chest pain or other symptoms suggestive of acute cardaic ischemia. Ann Intern Med 1998;129:845-55.
8. Braunwald E, Antman EM, Beasley JW, et al. ACC/AHA guidelines for the management of patients with unstable angina and non-ST segment elevation myocardial infarction. JACC 2000;36:978-1062.
9. Baxt WG, Shofer FS, Sites FD, et al. A neural computational aid to the diagnosis of myocardial infarction. Ann Emerg Med 2002;39:366-73.
10. Baxt WG, Shofer FS, Sites FD, et al. A neural network aid for the early diagnosis of cardiac ischemia in patients presenting to the emergency department with chest pain. Ann Emerg Med 2002;40:575-83.
11. Alpert JS, Thygesen K, Antman E, et al. Myocardial infarction redefined: A consensus document of The European Society of Cardiology/American College of Cardiology committee for the redefinition of myocardial infarction. J Am Coll Cardiol 2000;36:959-69.
12. Kennedy RL, Harrison RF, Marshall SJ. Do we need computer-based decision support for the diagnosis of acute chest pain? J Royal Soc Med 1993;86:31-4.
13. Hollander EJ, Sease KL, Sparano DM, et al. Effects of neural network feedback to physicians on admit/discharge decision for emergency department patients with chest pain. Ann Emerg Med 2004;44:199-205.
14. Koukkunen H, Pyorala K, Halinen MO. Low risk patients with chest pain and without evidence of myocardial infarction may be safely discharge from emergency department. Eur Heart J. 2004;25:329-34.
15. Limkakeng A Jr, Gibler WB, Pollack C, et al. Combination of Goldman risk and initial cardiac troponin I for emergency department chest pain patient risk stratification. Acad Emerg Med 2001;8:696-702.
16. Smith SW, Tibbles CD, Apples FS, et al. Outcome of low risk patients discharged home after a normal cardiac troponin I. J Emerg M 2004;26:401-6.
17. Miller CD, Lindsell CJ, Khandelwal S, et al. Is the initial diagnostic impression of "noncardiac chest pain" adequate to exclude cardiac disease? Ann Emerg Med 2004;44: 565-74.