Initial Experience with a Cardiologist-Based Chest Pain Unit in an Emergency Department in Israel*

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Abstract

Background: Emergency room triage of patients presenting with chest pain syndromes may be difficult. Under-diagnosis may be dangerous, while over-diagnosis may be costly.

Objectives: To report our initial experience with an emergency room cardiologist-based chest pain unit in Israel.

Methods: During a 5 week pilot study, we examined resource utilization and ER diagnosis in 124 patients with chest pain of uncertain etiology or non-high risk acute coronary syndrome. First assessment was performed by the ER physicians and was followed by a second assessment by the CPU team. Assessment was based on the following parameters: medical history and examination, serial electrocardiography, hematology, biochemistry and biomarkers for ACS, exercise stress testing and/or 64-slice multi-detector cardiac computed tomography angiography. Changes in decision between initial assessment and final CPU assessment with regard to hospitalization and utilization of resources were recorded.

Results: All patients had at least two cardiac troponin T measurements, 19 underwent EST, 9 echocardiography and 29 cardiac MDCT. Fourteen patients were referred for early cardiac catheterization (same/next day). A specific working diagnosis was reached in 71/84 patients hospitalized, including unstable angina in 39 (31%) and non-ST elevation myocardial infarction in 12 (10%). Following CPU assessment, 40/124 patients (32%) were discharged, 49 (39%) were admitted to Internal Medicine and 35 (28%) to the Cardiology departments. CPU assessment and extended resources allowed discharge of 30/101 patients (30%) who were initially identified as candidates for hospitalization after ER assessment. Furthermore, 13/23 patients (56%) who were candidates for discharge after initial ER assessment were eventually hospitalized. Use of non-invasive tests was significantly greater in patients discharged from the ER (85% vs. 38% patients hospitalized) ($P < 0.0001$). The mean ER stay tended to be longer (14.9 ± 8.6 hours vs. 12.9 ± 11, P = NS) for patients discharged. At 30 days follow-up, there were no adverse events (myocardial infarction or death) in any of the 40 patients discharged from the ER after CPU assessment. One patient returned to the ER because of chest pain and was discharged after reassessment.

Conclusions: Our initial experience showed that an ER cardiologist-based chest pain unit improved assessment of patients presenting to the ER with chest pain, and enhanced appropriate use of diagnostic tests prior to a decision regarding admission/discharge from the ER.

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The number of patients who present to the emergency department and are admitted with acute chest pain is increasing [1-3]. Medico-legal issues and "defensive medicine" lead to high rates of hospitalization and to unnecessary tests and costly procedures [1-4]. Some additional procedures carry the risk of unwanted complications and pose an inconvenience to the patient and the patient's family. On the other hand, patients with acute myocardial infarction, mistakenly discharged from the emergency department, have increased short-term mortality rates of up to 25%, at least twice to three times the expected mortality rate if they had been admitted [5,6]. Widespread use of cardiac troponin measurements has significantly improved diagnostic accuracy and sensitivity in identifying patients with myocardial necrosis who are at higher risk for short-term major adverse cardiac events, but has also led to an increase in hospitalization rates for chest pain in most countries, including Israel [7,8].

In several countries chest pain diagnosis and observation units have proven to be a safe and cost-effective option for the evaluation of patients with unexplained chest pain or unstable angina who are not immediately categorized as high risk for adverse events [9]. Recent trends in ER practice emphasize the usefulness and efficacy of a problem-oriented and sophisticated workup in the ER setting to prevent unnecessary hospitalizations in patients presenting with chest pain syndromes and other common complaints such as syncope [10]. Chest pain units have not been widely implemented in Israel for various reasons: firstly,

* The main findings of this study were presented at the Israel Heart Society annual meeting, 13-14 April 2005, Tel Aviv, Israel.

ER = emergency room
CPU = chest pain unit
ACS = acute coronary syndrome
EST = exercise stress testing
MDCT = multi-detector cardiac computed tomography angiography

appropriate reimbursement is lacking, and secondly the feasibility and usefulness of operating a CPU protocol in Israel is still unclear. We conducted a pilot study to examine the feasibility and usefulness of running a CPU protocol in a heavily burdened Israeli ER during the busy winter months.

Patients and Methods

During a 5 week period (December 2004 to January 2005) we evaluated a CPU protocol based on immediate availability of routine ER tests, a cardiologist, treadmill exercise stress testing (Modified Naughton protocol) and 64-slice multi-detector cardiac CT angiography (Brilliance 64, Philips Medical Systems, Cleveland, OH, USA). Patients presenting to the ER with chest pain had their first triage performed by the ER team. ER diagnosis and decision regarding hospitalization or discharge were recorded. A cardiology assessment was then performed by the CPU team (in the main ER treatment area) with additional non-invasive testing if indicated, followed by a second patient triage. CPU assessment was limited to patients in whom there was doubt regarding cardiac status, so those patients with a clear non-cardiac or non-ischemic diagnosis were not included in this CPU assessment. Also excluded from CPU analysis were patients with clear-cut acute coronary syndromes and high risk features requiring early admission defined as: a) ongoing/prolonged angina or rest pain or angina with minimal effort, b) ECG changes typical of ischemia (ST segment elevation or depression), c) elevated cardiac markers for myocardial necrosis (troponin T level > 0.1 ng/ml or creatine kinase-MB mass > 6 ng/ml) on initial assessment, d) symptomatic congestive heart failure, and e) ventricular arrhythmia [11-13].

The CPU protocol at second patient triage included: 12-lead ECG every 4–6 hours and during recurrent symptoms, confirmation of results of at least two assays of cardiac troponin T (taken at least 6 hours apart and the later test taken > 9 hours from onset of chest pain), and TIMI risk score assessment for non-ST elevation ACS. If tests were negative and patients did not have markers of increased risk (as specified above) during observation they were referred to non-invasive testing (exercise treadmill testing or other). A working diagnosis and a decision to hospitalize or discharge the patient from the ER were then made by two senior cardiologists. Regarding risk assessment, we used the five accepted criteria mentioned above to define high risk ACS [11-13], three of which are part of the 7 point TIMI risk score for non-ST elevation ACS (elevated biomarkers/ischemic ECG changes and recurrent angina). Thus, patients eligible for non-invasive testing typically had a TIMI risk score of 4 or less.

Results

Altogether, 124 patients were treated in the CPU during the evaluation period (mean age 64.4 ± 13.6 years, range 26–92; 71 males, 53 females). The chief complaint was chest pain in 90 patients (73%) and in 42/90 (47%) pain was atypical and of uncertain etiology. Other common complaints encountered in this cohort with suspected ACS were: palpitations (24, 19%), dyspnea (24, 19%) and syncope (13, 10%). Previously diagnosed coronary artery disease was present in 67 patients (54%) and 45 (36%) had a previous history of coronary revascularization.

Risk factors and co-morbidity

Risk factors and co-morbidities are shown in Table 1. During the period of observation: there were no ECG changes in 79 (64%) of the patients, whereas 30 (24%) had non-specific ST-T changes. ST segment depression was noted in 12 patients (10%) and ST elevation appeared in one.

Utilization of diagnostic tests

Biomarker assay (troponin T) was measured in all patients. Other tests were performed according to physician preference [Table 2]. A new generation (64 slice) cardiac CT (Brilliance 64, Philips Medical Systems) was readily available in our institution and was utilized in 29 patients. Non-invasive tests (treadmill stress testing, echocardiography, lung scan or CT) were used more often in patients who were discharged than in patients subsequently hospitalized: 34/40 (85%) vs. 32/84 (38%), chi-square = 24, $P < 0.0001$.

Patient disposition

The overall length of stay in the ER (ER and CPU combined) was 13.6 ± 10.3 hours. Mean ER stay was 2 hours longer in patients

Table 1. Baseline characteristics among 124 patients

Age (yrs)	64.4 ± 13.6 (range 26–92)
Females	53 (43%)
History of CAD	67 (54%)
Prior PCI	34 (27%)
Prior CABG	25 (20%)
History of symptomatic CHF or LVEF< 40%	14 (11%)
Hypertension	106 (85%)
Diabetes mellitus	42 (34%)
Hyperlipidemia	82 (66%)
Smoking	25 (20%)
Family history of CAD	9 (7%)
History of PVD	15 (12%)
Chronic renal failure	12 (10%)
Prior CVA	3 (2%)

CAD = coronary artery disease, PCI = percutaneous intervention, CABG = coronary artery bypass grafting, CHF = congestive heart failure, PVD = peripheral vascular disease, CVA = cerebrovascular accident.

Table 2. ER based resource utilization in 124 patients

Diagnostic tool	Tests performed N (%)	Tests positive N (% of tests)
Cardiac TnT assay	In all patients	12 (10% of patients)
Treadmill exercise stress test	17 (14)	5 (29)
TL 201-MIBI perfusion scan	2 (1.6)	0 (0)
Trans-thoracic echocardiogram	9 (7)	
64-slice cardiac CTA	29 (23)	
Lung scan	2 (1.6)	0 (0)
Pulmonary CTA	2 (1.6)	1 (50)
Aortic CTA	5 (4)	1 (20)
D-dimer (rapid ELISA)	7(6)	1(14)

CTA = CT angiography

discharged (14.9 ± 8.6 hours) than in patients hospitalized (12.9 ± 11 hours), but the difference was not statistically significant.

After ER and CPU triage, 40 patients (32%) were discharged, 49 (39%) were admitted to an Internal Medicine department and 35 (28%) to the Department of Cardiovascular Medicine. A specific working diagnosis for chest pain was reached in the CPU in 71 (85%) of 84 patients hospitalized and included 39 with unstable angina, 12 who were eventually found to have non-ST elevation myocardial infarction, 15 with symptoms that were considered to be related to congestive heart failure (diastolic or systolic and usually of mild degree as obvious heart failure was an exclusion criteria), and 3 with pericarditis. Other important diagnoses (pulmonary embolus, aortic dissection) were made in one patient each. The other 13 were hospitalized with chest pain of uncertain etiology and required further in-hospital evaluation.

The mean TIMI risk score of all patients hospitalized with non-ST elevation ACS (n = 50) was 2.3 ± 1.1 (range 0–5). Based on the CPU workup, early referral for in-hospital coronary angiography was facilitated (same/next day), thus saving days of admission and avoiding much in-hospital workup and consultations. Among the 84 patients eventually hospitalized, 13 were designated for discharge after the first ER triage (a decision changed by following CPU workup) [Figure 1]. Among those 13 additional hospitalizations, 7 underwent revascularization during the index hospitalization.

Of the 40 patients finally discharged from the ER, 30 (75%) had initially been designated for hospitalization by the ER staff [Figure 1]. At 30 days follow-up, only one of these 30 patients was readmitted for observation due to recurrent angina and he was discharged again soon after reassessment. There were no instances of myocardial infarction or death in any of the 40 patients discharged from the ER after CPU assessment.

In summary, the additional evaluation afforded by the CPU allowed discharge of 30/101 patients (30%) previously designated for admission after initial ER triage and resulted in hospitalization of 13/23 patients (56%) previously designated for discharge after initial assessment at the ER.

Discussion

Our initial experience with a chest pain unit in the ER demonstrated that a focused workup by a cardiology-based CPU could potentially save many unnecessary days of hospitalization and prevents unwarranted discharge from the ER. Importantly, the rapid patient assessment and use of selected relevant diagnostic tests clearly saved further community-based physician consultations and batteries of tests in patients discharged from the ER's CPU.

Effect of the CPU pilot study on patient hospitalization and ER discharges

The CPU allowed us to better refine indications for hospitalization – based on increased utilization of non-invasive testing and improved assessment of outcomes of acute or recent diagnostic and therapeutic procedures by a cardiologist – before any decision to hospitalize was made. Operating the CPU resulted in a saving of limited hospital beds and in-patient resources and earlier referral for coronary angiography (in several instances directly to the catheterization laboratory from the ER). It is clear that the length of hospital stay was shortened in many patients as a result of the CPU workup.

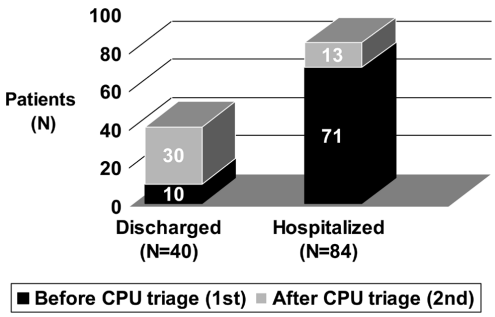

Figure 1. Change of ER decision following CPU evaluation in 124 consecutive CPU patients

Many patients who present with chest pain do not have coronary artery disease or have stable disease not requiring immediate hospitalization. Improvement in diagnostic accuracy in these patients improves hospital efficiency and patient welfare [14]. Although the overall time spent in the ER in this study may have been longer than routine in some other hospitals in Israel, or in the ER studied, outside the confines of the study this was more than compensated for by the savings achieved in days of hospitalization for reassessment by a new team of physicians, consultations and booking of further tests required in hospitalized patients. More complete ER evaluation allowed a sizeable number of safe additional ER discharges, with considerable saving in hospital beds.

Study limitations

The relatively small sample size in this pilot study mandates caution in assessing the extent of the beneficial effects attainable from the initiation of an ER-based CPU. Nonetheless, the study patients are probably quite typical of those presenting to most public hospital ERs and the findings can be considered to represent a relevant guide as to what could be achieved overall. The study population was pre-selected in that only patients referred to the CPU by the ER staff were examined. This, however, might be the case in any CPU set-up and, in effect, the case-mix examined was quite heterogeneous. Our frequent use of 64-slice cardiac CT played an important role and greatly improved our diagnostic accuracy. This modality may not be available in all medical centers but is likely to become routine in the near future. The study protocol was individualized for the medical center in which the study was performed. It is likely that each center would modify the CPU protocol in keeping with local resources, availability of specific diagnostic tests, and physician preferences. Since implementation of national or international guidelines are desirable but yield and performance of various tests may vary among different institutions, we suggest careful evaluation of local protocols and tests for real-life patients in every institution.

This includes among others: "ACS rule-out protocol" (repeated ECG/troponin and treadmill tests or perfusion scan if available) and "pulmonary emboli" rule-out protocol (d-dimer assays, lung scans, bilateral leg ultrasonography or CT angiography). In our experience, a negative treadmill test or perfusion scan or normal coronary vessels at the non-invasive 64-slice CT angiography (together with a normal troponin assay and no ischemic ECG changes) enables patient discharge in most cases. The same is true for patients with a low pre-test probability for pulmonary emboli and a normal d-dimer assay (rapid enzyme-linked immunosorbent assay).

Unresolved issues

Several issues regarding a CPU are relevant and need to be addressed in the context of the Israeli healthcare system:

- Location of the CPU – a separate unit or in the main ER (as in the present study) – will probably depend on local circumstances
- Hospital reimbursement issues, particularly since patients undergo sophisticated and sometimes expensive tests under the ER label before (or instead of) being hospitalized. At present this obviates regular hospital reimbursement for individual tests and provides a negative financial incentive to the hospital to improve efficiency.
- The timing and availability of specialized tests may need to be reorganized locally. An example is the availability of exercise stress testing for patients whose initial troponin test is negative.
- Although we found that new generation high resolution 64-slice cardiac CT angiography was invaluable in patient triage, its precise role and accuracy in the ER/CPU situation is currently being examined [15]. In addition, the interesting concept of "triple rule-out" for chest pain by CT angiography during one session (coronary anatomy + pulmonary emboli + thoracic aortic dissection scans), however appealing, deserves further study.
- Pre-hospital workup for ACS, including the rapid stat-kit for cardiac biomarkers, was already shown to be of high negative predictive value and may be a promising tool for pre-hospital triage or even serve as a gatekeeper for CPU admissions. However, the exact role of pre-hospital workup and its integration with in-hospital resources is still unclear [16].

Resolution of these issues may certainly facilitate plans to establish chest pain units in Israeli hospitals.

References

1. Pozen MW, D'Agostino RB, Mitchell JB, et al. The usefulness of a predictive instrument to reduce inappropriate admission to the coronary care unit. *Ann Intern Med* 1980;92:238–42.
2. Pozen MW, D'Agostino RB, Selker HP, Sytkowski PA, Hood WB Jr. A predictive instrument to improve coronary-care unit admission practices in acute ischemic heart disease: a prospective multicenter clinical trial. N *Engl J Med* 1984;310:1273–8.
3. Goldman L, Cook EF, Johnson PA, Brand DA, Rouan GW, Lee TH. Prediction of the need for intensive care in patients who come to emergency departments with acute chest pain. N *Engl J Med* 1996;334:1498–504.
4. Selker HP, Beshansky JR, Griffith JL, et al. Use of the acute cardiac ischemic time-insensitive predictive instrument (ACI-TIPI) to assist with triage of patients with chest pain or other symptoms suggestive of acute cardiac ischemia: a multicenter, controlled clinical trial. *Ann Intern Med* 1998;129:845–55.
5. Lee TH, Rouan GW, Weisberg MC, et al. Clinical characteristics and natural history of patients with acute myocardial infarction sent home from the emergency room. *Am J Cardiol* 1987;60:219–24.
6. Rusnak RA, Stair TO, Hansen K, Fastow JS. Litigation against the emergency physician: common features in cases of missed myocardial infarction. *Ann Emerg Med* 1989;18:1029–34.
7. Hamm CW, Goldmann BU, Heeschen C, Kreymann G, Berger J, Meinertz T. Emergency room triage of patients with acute chest pain by means of rapid testing for cardiac troponin T or troponin I. N *Engl J Med* 1997;337:1648–53.
8. Amit G, Gilutz H, Cafri C, et al. What have the new definition of acute myocardial infarction and the introduction of troponin measurement done to the coronary care unit? Impacts on admission rate, length of stay, case mix and mortality. *Cardiology* 2004;102:171–6.
9. Farkouh ME, Smars PA, Reeder GS, et al. A clinical trial of a chest-pain observation unit for patients with unstable angina. Chest Pain Evaluation in the Emergency Room (CHEER) Investigators. N *Engl J Med* 1998;339:1882–8.
10. Shen WK, Decker WW, Smars PA, et al. Syncope evaluation in the emergency department study (SEEDS). A multidisciplinary approach to syncope management. *Circulation* 2004;110:3636–45.
11. Braunwald E, Jones RH, Mark DB, et al. Unstable angina: diagnosis and management. Clinical practice guideline number 10. Agency for Health Care Policy and Research, National Heart, Lung, and Blood Institute, May 1994. (AHCPR publication no. 94-0602.)
12. American College of Emergency Physicians. Clinical Policy: Critical Issues in the Evaluation and Management of Adult Patients Presenting With Suspected Acute Myocardial Infarction or Unstable Angina. www.acep.org
13. Lee TH, Goldman L. Evaluation of the patient with acute chest pain. N *Engl J Med* 2000;342:1187–95.
14. Fox KF. Investigation and management of chest pain. *Heart* 2005;91:105–10.
15. Rubinshtein R, Halon DA, Gaspar T, et al. 64-slice cardiac CT in triage and management of patients presenting with chest pain to the emergency department. *Eur Heart J* 2005;26(Suppl):545.
16. Roth A, Malov N, Golovner M, et al. The "SHAHAL" experience in Israel for improving diagnosis of acute coronary syndromes in the prehospital setting. *Am J Cardiol* 2001;88:608–10.

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