EDUCATION AND PRACTICE

Differences between Chest Pain Observation Service Patients and Admitted "Rule-out Myocardial Infarction" Patients

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ABSTRACT

Objective: To compare and contrast the patient characteristics of ED patients at low risk for acute cardiac ischemia who were assigned to a chest pain observation service vs those admitted to a monitored inpatient bed for "rule-out acute myocardial infarction" (R/O MI).

Methods: This was a retrospective, cross-sectional comparison of adult patients considered at relatively low risk for cardiac ischemia and who were evaluated in 1 of 2 settings: a short-term observation service and an inpatient monitored bed. All patients had an ED final diagnosis of "chest pain," "R/O MI," or "unstable angina" during the 7-month study period. Demographic features and presenting clinical features were examined as a function of site of patient evaluation.

Results: Of 531 study patients, 265 (50%) were assigned to the observation service. Younger age (OR = 1.75, 95% CI 1.26, 2.44, for each decrement of 20 years), the complaint of "chest pain" (OR = 2.35, 95% CI 1.34, 4.12), and the absence of prior known coronary artery disease (OR = 1.64, 95% CI 1.13, 2.38) were the principal independent factors associated with assignment to a chest pain observation service bed.

Conclusions: Patients evaluated in a chest pain observation service appear to have different clinical characteristics than other individuals admitted to a monitored inpatient bed for "R/O MI." Investigators should address differences in clinical characteristics when making outcome comparisons between these 2 patient groups.

Key words: chest pain; observation service; acute ischemic heart disease (AIHD); coronary artery disease; emergency services; decision making, myocardial infarction.

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Chest pain observation units are increasingly available as an alternative to inpatient hospital admission for individuals needing to be "ruled out" for a myocardial infarction (R/O MI).[1–15] Care is typically rendered in a distinct area of the ED or in a separate observation unit. Observation service patients tend to have a shorter length of stay (LOS) and a lower total cost of care than do patients admitted to a traditional monitored, inpatient service for an R/O MI evaluation.[2–4] Many chest pain observation services have a high rate of noninvasive diagnostic testing performed within 9–24 hours of presentation,[3,5,6,10,12,14] a method of evaluation that appears to be safe in this setting.[6,14–17] In addition, proponents of observation services contend that the quality of care delivered on these observation services is higher than traditional inpatient care for the low-risk R/O MI patient.[2,8–11]

Despite the potential advantages of observation services, many patients at "low risk" for acute ischemic heart disease (who are not candidates for release home from the ED) are admitted to inpatient monitored hospital beds to R/O MI evaluation. These low-risk inpatient R/O

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MI patients do not include those high-risk individuals admitted to the coronary care unit or other intermediate care units.[2-4,10,11] At hospitals where chest pain observation services are available, the characteristics of the patients admitted to these inpatient monitored units vs assigned to an observation service have not been fully characterized.[2,3,10] We sought to determine 1) which factors had the strongest association with assignment to an observation service and 2) what proportion of the observed practice could be explained by a multivariate model incorporating those factors.

METHODS

Study Design: A retrospective, cross-sectional analysis was performed to compare demographic characteristics and presenting findings in patients at relatively low risk for cardiac ischemia who are assigned to an observation service vs admitted to an inpatient, monitored site. The study was considered exempt by the local institutional review board.

Setting and Population: This study was based at a university hospital ED with an annual census of approximately 50,000 visits. Since March 1994, patients seen in our ED triage area with a complaint of "chest pain" or other symptoms suggestive of acute cardiac ischemia have been identified as *ED Chest Pain Center* patients and undergo a similar initial assessment (see the Chest Pain Center Protocol, below).

For the purposes of this study, information on all eligible patients related to age, gender, complaint, the number and type of comorbid medical conditions, and disposition was extracted from the ED Chest Pain Center database (see Measurements, below). All patients during the study period (1/1/95 to 7/31/95) with an ED final diagnosis of "chest pain," "R/O MI," or "unstable angina" who were either assigned to the hospital's observation service or admitted to an inpatient bed were identified retrospectively. Patients were excluded if they were admitted to an intensive or intermediate care bed on the basis of 1) ECG changes not known to be old, 2) an elevated first set of cardiac enzymes, 3) any recurrent or ongoing symptoms suggestive of cardiac ischemia, or 4) any significant hypotension, bradycardia, or new dysrhythmia. Patients were also excluded if they were triaged to the ED Chest Pain Center as a planned admission to an inpatient cardiac unit pending availability of the inpatient bed. Patients were *not* excluded based on the presence of other ED final diagnoses that might necessitate further treatment or monitoring after 23 hours of observation (e.g., congestive heart failure).

Chest Pain Center Protocol: Patients at risk for acute cardiac ischemia are identified using their age, gender, and complaint in a manner similar to the IMIR[18] (Imminent Myocardial Infarction Rotterdam) criteria and other studies of chest pain in the ED setting.[18-22] The selection (modified IMIR) criteria for the ED Chest Pain Center include 1) all men aged ≥30 years and women aged ≥40 years with chest pain not attributable to either trauma or abnormalities on chest radiograph, 2) all individuals ≥50 years old with shortness of breath *not* due to chronic obstructive pulmonary disease (COPD), asthma, or trauma or explained by radiographic findings, and 3) all individuals ≥50 years old with complaints of syncope (nonseizure), near-syncope, dizziness, nausea, vomiting, leg edema, and generalized weakness not readily explained by other entities diagnosed in the ED.

All ED Chest Pain Center patients undergo a standardized, multidisciplinary assessment, which includes physician, nursing, and respiratory therapy components. Routine testing includes immediate ECG, and chest radiography, pulse oximetry on room air, blood pressure (BP) measurements in both arms, and serum testing for total creatine kinase (CK) and CK-MB fraction. A toxicology screen for cocaine is optional, and prior ECGs are automatically requested.

Chest pain center patients are considered candidates for either low-risk inpatient admission, observation service assignment, or release home if they meet the following criteria: 1) a normal or unchanged initial ECG—i.e., no new ST-T wave changes suggestive of acute ischemic heart disease; 2) an initial total CK and CK-MB that are both within the normal range (i.e., not diagnostic of acute MI); 3) no ongoing symptoms suggestive of acute ischemic heart disease; and 4) a benign ED course (e.g., no hypotension, significant bradycardia, other new dysrhythmia, or recurrent chest pain considered possibly due to cardiac ischemia).

Patients assigned to the chest pain observation service must 1) have a pulse oximetry of ≥92% (or unchanged from baseline), 2) have a chest radiograph showing no significant new abnormalities, 3) have differential arm BPs of ≤10 mm Hg, and 4) be without active psychiatric illness (e.g., not suicidal, and not suffering the ill effects of either substance intoxication or withdrawal). Patients assigned to the chest pain observation service are sent to 1 of 4 dedicated beds located on an inpatient cardiology floor. These beds have hard-wired ECG monitoring, and are staffed with cardiology nurses at a ratio (usually 2:1) similar to that in the adjacent intermediate cardiac care unit. Patients on the observation service receive ECG and serum CK/CK-MB testing every 4 hours for the first 12 hours, and then most (~75%) undergo a noninvasive test for coronary ischemia during the remainder of their stays (up to 23 hours). Fewer than 5% of patients undergo same-day cardiac catheterization as outpatients. Approximately 30% of observation service patients are subsequently admitted to the hospital.

Measurements: The ED chart for each chest pain center patient is reviewed retrospectively on an ongoing basis to determine the appropriateness for inclusion in the ED chest pain center population. Information on each patient is extracted retrospectively from each ED chart using a standardized protocol, and the information keyed directly into the ED Chest Pain Center database (Epi Info, Version 5.01b, USD Inc., Stone Mountain, GA). Data points include patient disposition, age, gender, the presence of "chest pain" as the chief complaint, and the presence of previously known coronary artery disease (CAD) as well as the presence of 8 other comorbid medical conditions (congestive heart failure, diabetes mellitus, hypertension, COPD/asthma, end-stage renal disease, non-remote malignancy, stroke, or peripheral vascular disease). This database was used to compare features of low-risk patients assigned to the observation service vs those admitted to a monitored inpatient setting.

For those low-risk patients for whom additional data were available, a single physician reviewer (JD) provided ECG interpretation, and calculated the predicted likelihood of acute cardiac ischemia using the ACI-TIPI instrument.[20] The physician reviewer, after review of the ED chart, but blinded to the final patient disposition, answered the following question for each patient:

"Does this patient need to be admitted to the hospital for reasons other than the risk of acute ischemic heart disease?"

not at all	not likely	possibly	very likely	absolutely
1	2	3	4	5

The numerical response to this question was recorded as the "need for hospital admission" variable.

To determine the proportion of patients who were diagnosed as having an acute MI in the period immediately after presentation, we reviewed physician billing diagnosis codes for 1 day prior and up to 30 days after the date of presentation for each patient. Any individual with an ICD-9 diagnosis code of 410.** underwent a physician review (JD or HWS) of the hospital's on-line dictation system to verify that the code represented an acute MI, rather than a prior or suspected MI. Patients were given a final diagnosis of acute MI based on serial elevations of both the total CK and the CK-MB fraction, or ECG changes consistent with acute MI. When necessary, the full hospital chart was obtained for clarification.

Data Analysis: The relationship between chest pain observation service use (vs low-risk, inpatient admission) and each hypothesized factor (e.g., age, symptoms of chest pain) was examined using a standard 2 × 2 table to determine the strength of association (univariate odds ratio; OR) and its significance (χ^2 or Fisher's exact test). Nonparametrically distributed variables such as age, need for admission score, and number of comorbid medical conditions were tested for an association with the site of evaluation using the Kruskal-Wallis test.

In addition, the proportion of study patients assigned to the chest pain observation service for each emergency medicine attending physician was determined, and a set of dummy variables was created to reflect the observed practice variation of the ED physicians in the use of the chest pain observation service. Among the emergency physicians, both "low" (≤40%) and "high" (≥60%) users of the observation service were identified, and these individuals were compared with the mid-range reference group.

A multivariate logistic regression analysis was also performed using the Statistical Applications Software (SAS Ver. 6.04, Cary, NC) to calculate an adjusted OR (OR_{adj}). The OR_{adj} was created to determine whether the association of each major factor persisted *after controlling for other differences* between the observation service patients and the low-risk patients admitted as inpatients for "R/O MI." For interval variables (e.g., age and the number of comorbid medical conditions), it was verified that incremental increases in the variable were linear with respect to the log odds (logit) of the outcome variable—in this case, assignment to observation status.

RESULTS

During the 7-month study period, there were 30,556 patient visits to the ED. Of these, 1,802 visits (5.9%) were evaluated in the ED Chest Pain Center for complaints of chest pain or other symptoms suggestive of acute myocardial ischemia or infarction.

From the group of 1,802 ED Chest Pain Center patients, 731 patients with an ED diagnosis of "acute chest pain," "R/O MI," or "unstable angina" were screened for the study. Two hundred patients (27%) were excluded from this group. Most commonly, patients were excluded because of evidence suggesting acute cardiac ischemia or infarction that necessitated their admission to an intensive or intermediate care bed (n = 157)—such as interval ECG changes or elevated cardiac enzymes. The other 43 patients were excluded because they were a direct admission to an inpatient cardiac bed.

The final study group consisted of the remaining 531 patients at "low risk" for acute ischemic heart disease. These individuals, who by definition had no known (interval) diagnostic ECG changes and a normal first set of cardiac enzymes, were otherwise eligible for assignment to the chest pain observation service.

The mean age of the 531 patients in the study group was 60 ± 14 years [range 27–94], and 52% were male. Most (80%) had symptoms of chest pain among their tri-

TABLE 1 Chest Pain Observation Service vs Low-risk Inpatient R/O MI Admissions

	Observation Service (n = 265)	Low-risk Inpatients (n = 266)	p-value
Age (years)			
Mean ± SD	58 ± 14	62 ± 13	<0.001
[Range]	[30–93]	[27–94]	
Gender—male	50%	53%	NS
Complaint of "chest pain"	87%	73%	<0.001
Prior coronary artery disease	46%	67%	<0.001
No. comorbid medical conditions	0.90	0.86	NS
[Range]	[0–5]	[0–6]	
No. "rule-in" for myocardial infarction within 30 days	8	5	NS

age complaints, and 55% had a prior history of CAD. The mean number of comorbid medical conditions was 0.88 ± 1.0 [range 0–6]; only 5.3% of the patients had ≥3 of these. A total of 265 patients (50%) were assigned to the chest pain observation service, and 266 were admitted to an inpatient hospital bed.

When compared with their inpatient counterparts, the patients assigned to the chest pain observation service tended to be slightly younger, have symptoms of chest pain (vs shortness of breath and other symptoms suggesting acute cardiac ischemia), and have no prior history of CAD (Table 1). There was no difference in the number of comorbid medical conditions between the observation and inpatient groups. There was no significant difference in the proportion of study patients assigned to chest pain observation by either low or high users among the ED attending physicians. A similar number of patients in the observation service and inpatient R/O MI groups were diagnosed as having an acute MI within 30 days of initial presentation (3.0% vs 1.8%, respectively; p = 0.40).

A multivariate logistic regression model was used to determine which factors were independently associated with assignment to chest pain observation. After correcting for gender and the observed practice variation of the emergency physicians (EPs), only younger patient age (OR_{20yr} = 1.75, 95% CI 1.26, 2.44, for each decrement of 20 years), the presence of chest pain (OR = 2.35, 95% CI 1.34, 4.12), and the absence of prior known CAD (OR = 1.64, 95% CI 1.13, 2.38) were significant independent factors associated with assignment to chest pain observation status. This multivariate model explained 71% of the observed variation in observation service assignment during the study period. To illustrate this model, a 40-year-old with chest pain would be *4 times more likely* (OR = 4.17) to be assigned to observation service than a 60-year-old without chest pain symptoms (despite the latter's having an ED diagnosis of "R/O MI" or "unstable angina").

Information on ECG interpretation and the need for hospitalization was available for only 121 (23%) of the study patients. Among these patients, 34 (28%) were assigned to the observation service; 1 patient (0.8%) was diagnosed as having an acute MI within 30 days of initial presentation. These patients had clinical characteristics (e.g., age, gender, complaint of chest pain, and frequency of prior CAD) that were comparable to those of patients in the main study group. Patients assigned to observation had scores on the ACI-TIPI instrument[20] (predicted likelihood of acute ischemic heart disease) similar to those of the hospitalized R/O MI patients (31% vs 33%, p = NS). Despite this similarity, there was a strong but nonsignificant tendency for the observation service patients to have a completely "normal" 12-lead ECG (58% vs 45%, p = 0.066). Patients assigned to the observation service had significantly lower scores (scale of 1–5) on the subjective "need for hospitalization" rating (1.2 vs 1.8, p = 0.013).

Because of the possibility that patients with significant ischemic ECG changes were "missed" in our study group, we assessed whether this phenomenon would affect our principal study findings. To accomplish this, we examined the association between the factors associated with observation service use (e.g., age, symptoms of chest pain, and history of CAD) and the presence of abnormal ST or T-wave changes in patients for whom an ECG interpretation was available (n = 121). The association between a given factor (e.g., age, chest pain, or history of CAD) and assignment to the observation service could not be affected by a third variable (e.g., ST or T-wave changes) unless the factor and this third variable were correlated. Among patients with and without ECG abnormalities, there was no important correlation between age and the presence of previously known CAD.

Patients with abnormal (and possibly "missed") ECGs were slightly *less* likely to have chest pain than those with a normal tracing (80% vs 92%)—i.e., low-risk patients without chest pain tended to have an abnormal-appearing ECG. In addition, patients with abnormal ECGs tended to *not* be assigned to observation (OR = 0.58, 95% CI 0.20, 1.64). This "double-negative" correlation means that the association of chest pain symptoms with assignment to the observation service might be slightly overestimated.

We also examined the possibility that availability of observation beds had a significant effect on our principal study findings. During the 2 months of the adoption study period, there were only 3 occasions when ≥3 observation service assignments over 24–48 hours threatened to close the observation service to new patients. There was only 1 case when an observation bed was not available when requested by the ED staff for an eligible patient. In any event, because availability of observation beds would not be expected to correlate with a given patient's presenting characteristics, it should not confound our principal study

findings. Although inpatient cardiology attending physicians occasionally contested observation service assignments (typically for patients without chest pain or with multiple medical problems), frank refusals were rare.

DISCUSSION

A lot has been written about the use of a chest pain observation service as a short, less expensive alternative to formal inpatient admission for low-risk R/O MI. However, less attention has been paid to the differences between these patients and comparable individuals undergoing inpatient R/O MI evaluation. These differences may need to be considered when making a direct comparison of LOSs, costs of care, and the types of evaluation received by patients in these 2 groups. In addition, these differences may point toward problems in extending the chest pain observation service to a broader spectrum of R/O MI patients.

Our study findings demonstrate that the observation service patients at our institution tended to be younger, have symptoms of chest pain, and be less likely to have known CAD when compared with their inpatient counterparts. Moreover, these 3 factors by themselves explained 71% of the observed ED practice variation in the disposition of low-risk R/O MI patients. As one might expect for a short-stay service, the observation patients were also found to have a lower score on a subjective "need for hospitalization" question. This difference is not surprising, given that we did not exclude patients from consideration for chest pain observation based on the presence of other ED diagnoses or medical conditions that might require the patient to be hospitalized after 23 hours of observation. Patients with abnormal but unchanged ST-T wave morphology on the static 12-lead ECG were also slightly (but not significantly) more likely to be formally admitted for R/O MI rather than assigned to the observation service. Other factors such as the number of comorbid medical conditions and the availability of observation beds did not seem to strongly affect assignment to the observation service.

We also found a surprising lack of difference in the risk of acute cardiac ischemia between our observation service and admitted R/O MI patients. Although the observation service patients had a higher risk of acute cardiac ischemia because symptoms of chest pain were more common, this increased risk was counterbalanced by their tendency to be younger and without known CAD. Two other findings in our data support this similarity in risk; the 2 groups had similar predicted likelihood of acute ischemic heart disease as based on ACI-TIPI scores, and like proportions of patients in the 2 groups ruled in for an MI within 30 days of presentation. Therefore, although a 40-year-old with chest pain at our institution has a much higher chance of being assigned to observation status (OR = 4.17) than does a 60-year-old without chest pain, these 2 individuals have almost identical cardiac risks (5–7% predicted likelihood of acute cardiac ischemia).[20]

If there were no appreciable differences in coronary risk between the observation service and inpatient R/O MI patients, what else might explain the differences we observe in age, complaint, and prior history of CAD? One very likely possibility is that chest pain observation may be a useful alternative only for a specific subset of patients requiring R/O MI evaluation. Such patients may be the younger, healthier individuals who can readily accommodate (and may prefer) their testing in a short-stay outpatient setting, and who are otherwise unlikely to require hospital admission. Patients with chest pain may be also more straightforward for an outpatient evaluation, as their symptoms may be more readily assessed using exercise testing prior to disposition. Finally, although patients with known CAD have been safely evaluated in many chest pain observation services, certain patients with severe and complex CAD may still be deemed too "high-risk" by the ED or inpatient attending physician to be assigned to a short-stay bed. These and other factors probably contribute to a natural limit of the proportion of R/O MI patients who may be practically managed using outpatient chest pain observation.

Because of these differences between observation service and inpatient R/O MI patients, it may not be entirely valid to directly compare the costs of care and LOSs in these 2 settings. Rather, it may be that the subset of patients appropriate for outpatient observation evaluation are, as a group, more amenable to a cheaper, streamlined outpatient evaluation. Other R/O MI patients requiring hospital admission probably cannot achieve this savings, and may have an above-average cost of care when compared with all R/O MI patients.

LIMITATIONS AND FUTURE QUESTIONS

Several important methodologic issues and limitations of our study findings are important to consider. First, because of differences in general ED patient populations, eligibility criteria and exclusions for chest pain observation, threshold for admission of chest pain patients, and practice style regarding chest pain evaluation in the ED, our findings may not generalize to all other institutions and systems of chest pain observation.

Second, we used retrospective data, which has inherent limitations. Data may not be collected in a standard, regular, or uniform fashion. For example, the criteria for prior CAD and the method of documenting this feature may have varied considerably between physicians. Similarly, the method of identifying and documenting the presence of chest discomfort symptoms was nonstandardized. Hence, group differences in the complaint of "chest pain" must be viewed cautiously. Complete ECG interpretation

data were available for only 23% of the study patients. We also did not evaluate the impact of presentation time of day, arrival by ambulance, or accompanying family members on site of evaluation. That is, other unmeasured factors may account for the associations we observed or may further reduce the variability in our model.

Third, the practice variation in the use of the observation service among the inpatient attending physicians was not accounted for in our multivariate model. Although it was rare for an inpatient attending to refuse admission or observation assignment, we could not account for ED attending bias based on an awareness of which inpatient attending was on call. Since observation service assignment is largely determined by the ED attending, knowledge of the admission preferences of the inpatient attending may have affected these decisions. Primary care and cardiology attendings who are not offered the option never have the opportunity to "refuse" assignment to observation. Finally, in this retrospective analysis, we relied on a combination of census, recent observation service assignments, and EP reports, rather than real-time assessment of bed status, to assess problems with observation bed availability.

CONCLUSION

Patients assigned to our chest pain observation service may differ clinically from their counterparts admitted to an inpatient service for low-risk R/O MI evaluation. At our institution, the chest pain observation patients tended to be younger, have symptoms of chest pain (vs shortness of breath and other symptoms suggestive of acute cardiac ischemia) and generally have no prior history of CAD. They were also more likely to have a normal 12-lead ECG, and tended to have a lower score on a subjective "need for hospitalization" rating. However, the predicted risks of acute cardiac ischemia (ACI-TIPI instrument) were similar for the 2 groups. Studies that seek to compare outcomes between low-risk patients admitted to the hospital vs assigned to a chest pain observation service will need to account for these differences.

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