Litigation Against the Emergency Physician: Common Features in Cases of Missed Myocardial Infarction

Adverse outcome data from two insurance companies were retrospectively studied to determine whether a constellation of clinical circumstances, data-gathering behaviors, or physician variables were common to cases of missed acute myocardial infarction (AMI) and, if so, to formulate quality assurance recommendations to decrease future occurrences of misdiagnosis. We studied AMI because missing this diagnosis accounts for the highest dollar losses in emergency department malpractice cases. Our study group consisted of 65 patients with undiagnosed AMI seen in EDs between 1982 and 1986. Univariate differences between undiagnosed cases and correctly diagnosed concurrent controls were analyzed using Student's t test and χ^2 analysis. Insurance losses for our cases averaged $113,806 \pm $178,330 (SD). Compared with concurrent controls, study patients were significantly younger, presented more atypically, and had fewer ECGs that were diagnostic of AMI. Undiagnosed patients were evaluated by physicians who documented less detailed histories, misread more ECGs, had less ED experience, and admitted fewer patients to the hospital. Preventive strategies are outlined. [Rusnak RA, Stair TO, Hansen K, Fastow JS: Litigation against the emergency physician: Common features in cases of missed myocardial infarction. Ann Emerg Med October 1989;18:1029-1034.]

INTRODUCTION

Missing myocardial infarction is the leading cause of malpractice loss in the ED setting. In 1985, the Insurance Committee of the American College of Emergency Physicians analyzed the claims submitted by its medical liability carriers; the committee found that from 1974 through 1985 insurance losses due to missed myocardial infarction amounted to $5.3 million, or 19.7% of the total dollar losses incurred for insuring EDs.[1] Similarly, from 1982 through 1986, the St Paul Fire and Marine Insurance Company recorded 134 claims alleging failure to diagnose acute myocardial infarction (AMI) in hospital EDs. The average cost of these claims was $98,054; this figure represents the status of these claims whether open or closed and includes reserve amounts.[2]

Diagnosing AMI in ED patients with acute chest pain is a challenging problem for physicians. The signs and symptoms of AMI may be non-specific; accurate confirmation of the diagnosis may require 24 to 48 hours; and delay in diagnosis or missed diagnosis may result in increased morbidity or death.[3,4] Decision analysis algorithms have been published to help physicians decide how to treat patients with chest pain of questionable origin.[5,6] However, these algorithms do not work infallibly: using the regression coefficients from one of these algorithms[6] to calculate the probability of cardiac chest pain results in an unacceptable error rate of 4.0%.[7]

To address the problem of missed myocardial infarction, a retrospective study of adverse outcomes was undertaken to identify a constellation of symptoms, signs, patient presentations, and physician behaviors that are most frequently correlated with misdiagnosis of AMI. The results of this study could lead to quality assurance approaches that would prevent some adverse clinical outcomes in adults with AMI.

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METHODS

Closed medical malpractice claims against the St Paul Fire and Marine Insurance Company and Spectrum Emergency Care, Inc, were examined using the following criteria for admission to the study: a diagnosis of MI was supported by autopsy findings, by characteristic evolution of serum creatine kinase MB isoenzymes, or by ECGs showing development of new Q waves, or ST segment elevation 1 mm or more in the limb leads and 2 mm or more in the precordial leads; and the missed diagnosis occurred in an ED.

The St Paul Fire and Marine Insurance Company maintains an electronic data base, which searched for claims that met any of the following criteria: claims with any indemnity payments; claims in which at least $1,000 was spent on legal fees; claims that had as descriptors of loss the failure to diagnose or the improper treatment of an AMI; claims that occurred in an ED; and claims that were reported by either physicians or hospitals. The initial data sort identified claims closed between 1981 and 1985; 739 were reported by hospitals, and 122 were reported by physicians. Individual files then were reviewed; 28 claims that met all study inclusion criteria were retrieved and analyzed.

Claims filed against Spectrum Emergency Care, Inc, were also evaluated. These were indexed according to the following allegations: failure to diagnose, failure to admit, or failure to properly treat an acute myocardial infarction. We received 40 such claims; 37 were found to meet the study inclusion criteria. Thus, 65 cases were reviewed.

Records reviewed included the ED chart; insurance adjustors' reports; depositions of physicians, nurses, plaintiffs, and expert witnesses; inpatient charts; correspondence between insurance companies and defendants; physician *curriculum vitae*; and settlement amounts (which included indemnity payments and legal fees). Data gathered from the ED record (written at the time of that visit that resulted in the adverse· outcome) included historical factors bearing on the presenting complaint, the physical examination, the emergency physician's interpretation of the ECGs (if one was obtained), the ultimate ECG interpretation done by a cardiologist

or an internist, the results of cardiac enzyme tests, treatment in the ED (and the results of that treatment, if recorded), discharge diagnosis, and patient disposition. Other parts of the patient record were used to recover the physician information, autopsy findings, criteria used to diagnose AMI, and settlement amounts, including both indemnity payments and legal fees. Results of court trials also were noted.

The closed-claim data from insurance carriers provide a description of cases that resulted in malpractice loss, but might be no different from a description of ED AMI patients in general (this was our null hypothesis). An ideal control group would consist of patients seen at the same time in the same EDs and correctly diagnosed as having AMI, but these records were not available. We made every effort, however, to construct a control group that was demographically similar to the missed AMI cases. Therefore, we assembled a concurrent (1982-1986) control group comprised of patients evaluated in

various EDs and correctly diagnosed as having an AMI. These patients were seen in hospitals similar to those that generated the experimental cases; each control hospital provided full-time ED service and had ED medical directors.

To ensure that the control group reflected the same mix of hospitals that existed in the experimental group, the following procedure was used: this group of hospitals was first stratified according to the number of yearly ED visits (less than 5,000, 5,000 to 20,000, and more than 20,000). A random number generator then was used to select five hospitals from each group. The medical directors of the EDs were asked to arbitrarily select years. The first 65 charts to arrive were taken as the control group. These charts were reviewed as described above for the experimental group. For both groups we required that a diagnosis of AMI be made or missed in an ED, and we required objective evidence of an AMI.

Clinical and outcome data were abstracted using a standard form;

TABLE 1. *Patient characteristics (N = 65)*

	Missed AMI	Controls	P
Average age (yr)	49.7 ± 14.6	62.6 ± 13.3	< .001*
Atypical complaints	23	4	< .001
ECGs	38	65	< .001
Abnormal ECGs	11	54	< .001
Admitted	8	65	< .001
Died	53	2	< .001

*P by Student's t tests, others by χ^2.

TABLE 2. *Physician characteristics (N = 65)*

ED Charting Documentation	Missed AMI	Controls	P
Chest pain descriptors recorded on ED chart	2.97	3.62	.04*
ED charts with cardiac risk factors recorded	32	46	.02†
ED charts with lung examination recorded	48	58	.04†
ED charts with cardiac examination recorded	42	56	.02†
Average years' ED experience	2.62	5.09	< .001*

*P value by Student's t test.
†P value by χ^2.

TABLE 3. *ECG results (N = 65)*

	Done	Done and (+)[†]	P
Control	65	54	.001*
Missed AMI	28	11	.001*

Number of ECGs obtained during initial ED visit in undiagnosed patients and concurrent controls.
*P value by χ^2.
†Findings suggestive of acute myocardial ischemia or infarction on final ECG report.

TABLE 4. *CPK at the time of initial ED evaluation (N = 65)*

	Missed AMI	Controls	P
No	51	29	
			< .001[†]
Yes	13	30	
			> .10[‡]
Yes and (+)*	1	6	

Number of patients who had a CPK enzyme determination during their initial ED evaluation.
*Level above the upper limit of normal.
†P value by χ^2.
‡P value by Fisher's exact test.

TABLE 5. *Factors that correctly classified 80% of cases based on stepwise discriminant analysis*

	Wilks' Lambda
ECG obtained	.738
Age of patient	.664
CPK obtained	.630
Physician board certification	.603
Years' ED experience	.583
Cardiac examination documented	.561
Chest radiograph obtained	.551

Stepwise discriminant analysis based on the equation Discriminant score = −4.518 + 1.655 (ECG obtained) +0.032 (age of patient) + 0.936 (CPK obtained) + 0.894 (physician board certification) +0.111 (years' experience) + 0.763 (cardiac examination documented) −0.45 (chest radiograph obtained). To solve equation, multiply the constant preceding each parenthesis by either a 0 (not obtained or documented), a 1 (obtained or documented), or the number of years of ED experience and add.

Student's *t* test and χ^2 analysis were used to analyze univariate differences between these two groups; stepwise discriminant analysis was used to determine whether and how these two groups differed on a given set of variables.[8] These variables included all parameters except disposition and autopsy. Data were analyzed on a Control Data Corporation CYBER computer running SPSS-X.

RESULTS

Some clinical and outcome characteristics of control patients and patients who sued for missed AMIs are summarized (Tables 1 and 2). There were important differences between the two groups in terms of age, type of presentation (atypical or classic),

documentation in the ED charts, studies done in the ED, patient disposition, and physician credentials. Fifty-three of the 65 patients died (81.5%); of the 32 autopsies done on these 53 patients, 31 revealed either an AMI or an acute thrombosis in one of the coronary arteries; the one other autopsy revealed significant coronary artery disease in a 47-year-old woman.

The missed AMI patients were significantly younger (49.7 years vs 62.6 years); had more atypical presentations (23 vs four); had seen a physician within the past week for similar complaints; and had fewer ECGs, a significantly smaller percentage of which were diagnostic of AMI (Table 3). These patients were seen by a group of physicians who had significantly less ED experience, performed less thorough histories (as suggested by the significantly lower number of historical and physical examination items documented on the ED record) and who misinterpreted more ECGs. Ten (15%) of 65 sued physicians were board-certified: four in family practice, three in internal medicine, and one each in pediatrics, urology, and general surgery. Only one physician was board-certified in emergency medicine (this physician was also board-certified in internal medicine). Eleven of 65 physicians (17%) were foreign medical graduates, none of whom was board certified. Twenty-two (34%) of 65 physicians (34%) had two or fewer years of postgraduate training.

Cardiac enzymes (total CPK or CPK-MB) were not helpful in distinguishing missed AMI patients from controls. Although a significantly greater percentage of control patients had a cardiac enzyme determination, there was no significant difference between the two groups in the number of abnormal results (Table 4).

Stepwise discriminant analysis[8] using the equation D = −4.518 + 1.655 (if ECG obtained) + 0.032 (age of patient) + 0.936 (if cardiac enzymes obtained) + 0.894 (physician board certified) + 0.111 (years' ED experience) + 0.763 (if cardiac examination documented) − 0.452 (if chest radiograph obtained) correctly classified 86.2% of the control group and 75.4% of the experimental group (Figure). The following characteristics tended to typify the missed AMI cases: not obtaining an ECG, not ob-

taining a cardiac enzyme test, no documentation of a cardiac examination, obtaining a chest radiograph, and, for the emergency physician, fewer years of ED experience and not being board certified in any specialty.

Insurance losses for the study group averaged \$113,806 ± \$178,330 (SD) and ranged from none (plaintiff's lawyers failed to file the suit within statutory limits) to more than \$1,000,000. The amount actually received by patients or their families was frequently much higher than the settlement amount because annuity policies were often purchased with a portion of the total indemnity payment. Attorneys' fees ranged from 20% to 50% of the settlement figure. In the one case that went to trial, the jury found on behalf of the defendant physician.

DISCUSSION

Historically, many patients presenting in the ED with acute chest pain have AMIs that go undiagnosed. The incidence of patients with AMI misdiagnosed in an ED setting is reported to be between 4% and 8%.[3,9] However, this is probably a low estimate:[3,9] data from the Framingham study reveal that 28% of ECG-documented infarctions are unrecognized.[10] Autopsy data from our study demonstrate that patients with missed AMI had unrecognized serious illness and constitute a group of true misses. Can such serious illness be identified and adverse outcomes prevented? Our data suggest that there are a large number of adverse outcomes nationwide and that they have grave consequences both for patients in mortality and morbidity and for emergency physicians in terms of their liability exposure and cost of malpractice insurance.

Previous studies[3,11] have identified factors related to the misdiagnosis of acute chest pain in the ED. However, no studies have correlated these factors with litigation. Our study identified the following major factors associated with litigation: failure to take and record a careful history, misinterpretation of the ECG, failure to recognize atypical presentations, and reluctance to admit patients with vague or suspicious symptoms. Other factors include the misguided use of laboratory evidence and the inadequacy of the physician's ED training and experience.

FIGURE. *Profile of circumstances associated with misdiagnosis of AMI in the ED.*

Failure to take and record an adequate medical history and physical examination was strongly associated with claims in our study group. In no case was a complete chest pain history recorded on patients, even when the presenting complaint was nontraumatic chest pain (Table 2). In our study cases, plaintiff and defense attorneys and expert witnesses criticized emergency physicians for incompleteness and poor documentation in their medical records. A complete and carefully taken history is especially important in EDs[12] where sophisticated cardiac diagnostic equipment is not available and careful auscultation of the heart is sometimes not possible because of background noise. Using standardized data-collection forms (checklist type) or dictating ED records might reduce this significant problem of incomplete documentation in ED records.

A prospective study of chest pain patients using a checklist-type form to strictly document and record history and physical examination findings had a 0.58% rate of missed AMI; this study also required that all patients have ECGs and cardiac enzymes and referred all discharged patients to a chest pain clinic.[3] Dictated ED records can be accurately, completely, and inexpensively transcribed.[13] Voice- or pointer-driven desktop computer technology is currently available and can produce a complete, symptom-specific record. In addition, this structured approach could include the use of algorithms with high predictive value for AMI. One study of malpractice in the ED has shown that a significant number of errors leading to claims were potentially avoidable and could be prevented by simple measures such as performing an adequate but not extensive history and physical examination.[14]

Failure to perform and correctly interpret ECGs on patients who presented to the ED with acute nontraumatic chest pain is another factor related to the misdiagnosis of AMI. Chest pain was the presenting complaint in 41 (63%) of our 65 patients, yet ECGs were performed on only 28

Patient less than 49 years old

Atypical presentation for AMI

ED physician has less than 2.6 years' ED experience

ED physician does not document a careful history and physical examination

ED physician does not obtain an ECG

(68%) of these 41 patients. Of these 28 ECGs, 11 (39%) revealed ischemia or infarction missed by the emergency physician.

Even if ECGs are appropriately obtained on all patients with chest pain, changes diagnostic of AMI may not always be apparent. One study[3] has shown that 62% of patients with missed AMI do not have ECG evidence of new ischemia or infarction, even when the ECG was read by a cardiologist. This assertion is supported by an inpatient autopsy study.[15] In this study, 21 of 33 patients (64%) with autopsy-proven AMIs had antemortem ECGs that were normal or nonspecific.

Studies have repeatedly emphasized that ECGs alone cannot reliably diagnose AMI in ED patients.[16-18] However, when changes suggestive of AMI are present on the ECGs of patients presenting to the ED with acute chest pain, careful emergency physicians admit these patients to hospital for ECG monitoring, serial ECGs, and CPK-MB determinations. In our study group, if all ECGs diagnostic or suspicious of AMI were interpreted correctly by emergency physicians and these patients were admitted to the hospital, 15 of the 65 adverse outcomes (23%) may have been avoided; this assertion is consistent with Lee.[3]

Atypical presentations in patients with AMI are common,[19] with a 25.5% incidence reported in one study.[20] The average age of patients with MI reported in the latter study was 69.1 years; these patients had a 50% mortality. This compares with a 37% (24 of 65) incidence of atypical complaints in our study, and a 42% (ten of 24) mortality in this subset of our patient group. The average age of patients in our study was 49.7 years; six of 65 were 30 years old or younger. These results are consistent with those of Lee,[11] who noted that atypi-

cal complaints were just as predictive of MI as typical complaints.

Of the 24 patients in our study group who presented with a complaint other than chest pain, only six had ECGs. This may reflect the tendency of less experienced, less educated (unfinished residencies in any clinical specialty), or hurried ED physicians to dismiss atypical or referred pain patterns in this patient population. Had a detailed history been taken and documented, perhaps factors in the history of the present illness (such as shortness of breath, dyspnea, or diaphoresis) or in the medical history (such as prior angina, hypertension, diabetes mellitus, or a positive family history) would have prompted physicians to obtain ECGs. However, because historical documentation was so poor in our study group, this assertion cannot be supported definitively.

Because six of the 65 patients (9%) were 30 years old or younger and 20 (31%) were 40 years old or younger, the diagnosis of cardiac disease may not have been considered because of their youth. However, it has been known since 1953, when Enos, Holmes, and Beyer[21] reported on autopsy findings in 300 young soldiers killed in action in Korea, that young people can have significant coronary artery disease (3.0% with total occlusion of one or more vessels). Myocardial infarction with normal coronary arteries also occurs in younger patients, average age 27.5 years, as has been previously reported.[22]

Laboratory data were sometimes inappropriately used in the diagnosis of AMI. Thirteen of our 65 study patients (20%) had a CPK determination drawn during the ED visit; for 11, the results were known before discharge and, of these, nine were normal. One misdiagnosed patient with a CK level of 6,981 IU/L died during transfer to another hospital without the diagnosis of AMI being considered. Another patient with a CK of 270 IU/L experienced recurrent symptoms within four hours of discharge; this patient was subsequently admitted and survived to sue the emergency physician.

One study[23] of missed AMI during an initial ED visit reported CK levels 200 IU/L or more in four of five discharged patients, and CK-MB of more than 12 IU/L in three of five patients. These abnormal levels were not

known at the time of the patients' discharge from the ED and consequently did not help the initial patient disposition; these abnormal results were noted during follow-up in a chest pain clinic or by phone follow-up within 24 to 72 hours of the initial visit. Because 45 of 53 patients died suddenly within 24 hours of discharge (with 37 of 45 dying within 12 hours of discharge), this laboratory adjunct to diagnosis would not have been very helpful in preventing adverse outcome. The assertion that cardiac enzymes are not helpful adjuncts in the diagnosis of chest pain in the ED is supported by Lee[11] and Seager.[24]

Obviously, patients should be admitted if they present with vague or suspicious symptoms, and elevated enzyme levels are known before discharge. Other strategies before discharge that could reduce the adverse outcome of missed AMI with resultant sudden outpatient death include using adjunctive confirmatory biochemical tests, such as obtaining a myoglobin level,[25] referring patients to a chest pain clinic,[3] or establishing and following a hospital policy that allows admission to monitored beds outside the CCU pending results of serial enzymes and ECG studies.[26,27] Such a policy, however, may be at variance with acute care utilization review regulations in force at hospitals.

An examination of the characteristics of physicians involved in cases of missed AMI indicate that lawsuits are weighed toward physicians who lack ED experience or physicians who are not board certified in any specialty (Tables 2 and 5). There are a few possible reasons for this. First, physicians with more experience or training might have better ECG readings skills and might diagnose more patients with acute chest pain as having an AMI. Second, physicians with more training or experience might be more careful evaluators in the stressful ED setting. Finally, such physicians might be more willing to hospitalize patients with ambiguous symptoms when there is limited information.

CONCLUSION

On the basis of our analysis, a case of AMI with the highest risk of being missed in the ED would match the following description (Figure): a pa-

tient less than 49 years old with an atypical presentation for an AMI who is evaluated by a physician with less than 2.6 years of ED experience or who is not board certified in any specialty who does not document a careful history and physical examination and does not obtain an ECG. Our study indicates that for quality assurance, physicians should obtain and document more detailed histories, consider atypical presentations, obtain more ECGs (and read them more accurately), and readily admit patients with vague or suspicious symptoms. In addition, EDs should be staffed with physicians who are board certified (in any specialty) or who have three or more years of ED experience.

REFERENCES
1. Dunn JD: Foresight. High-risk loss prevention. ACEP News April 1986.

2. Wood M: Internal data. The St Paul Fire and Marine Insurance Company.

3. 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;60:219-224.

4. Goldman L, Batsford WP: Risk-benefit stratification as a guide to lidocaine prophylaxis of primary ventricular fibrillation in acute myocardial infarction: An analytical review. Yale J Biol Med 1979;52:455-466.

5. 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.

6. Pozen MW, D'Agostino RB, Selker HP, et al: A predictive instrument to improve coronary-care-unit admission practices in acute ischemic heart disease. N Engl J Med 1984;310:1273-1278.

7. Personal communication, Gatewood JH, Spectrum Emergency Care, Inc.

8. Kleinbaum DG, Kupper LL: Applied Regression Analysis and Other Multivariable Methods. North Scituate, Massachusetts, Duxbury Press, 1978.

9. Schor S, Behar S, Modan B, et al: Disposition of presumed coronary patients from an emergency room. A follow-up study. JAMA 1976; 236:941-943.

10. Margolis JR, Kannel WB, Feinleib M, et al: Clinical features of unrecognized myocardial infarction — Silent and symptomatic. Eighteen year follow up: The Framingham Study. Am J Cardiol 1973;32:1-7.

11. Lee TH, Cook EF, Weisberg M, et al: Acute chest pain in the emergency room. Identification and examination of low risk patients. Arch Intern Med 1985;145:65-69.

12. Constant J: The clinical diagnosis of non-anginal chest pain: The differentiation of angina from nonanginal chest pain by history. *Clin Cardiol* 1983;6:11-16.

13. Klimt CR, Becker S, Fox BS, et al: A transcribed emergency record at minimum cost. *Ann Emerg Med* 1983;12:556-558.

14. Trautlein JJ, Lambert RL, Miller J: Malpractice in the emergency department — Review of 200 cases. *Ann Emerg Med* 1984;13:709-711.

15. Zarling EJ, Sexton H, Milnor P: Failure to diagnose acute myocardial infarction. The clinicopathologic experience at a large community hospital. *JAMA* 1983;250:1177-1181.

16. Brush JE Jr, Brand DA, Acampora D, et al: Use of the initial electrocardiogram to predict in-hospital complications of acute myocardial infarction. *N Engl J Med* 1985;312:1137-1141.

17. Stark ME, Vacek JL: The initial electrocardiogram during admission for myocardial infarction: Use as a predictor of clinical course and

facility utilization. *Arch Intern Med* 1987; 147:843-846.

18. Behar S, Schor S, Kariv I, et al: Evaluation of the electrocardiogram in the emergency room as a decision making tool. *Chest* 1977;71:486-491.

19. Bean WB: Masquerades of myocardial infarction. *Lancet* 1977;1:1044-1046.

20. Uretsky BF, Farquhar DS, Berezin AF, et al: Symptomatic myocardial infarction without chest pain: Prevalence and clinical course. *Am J Cardiol* 1977;40:498-503.

21. Enos WF, Holmes RH, Beyer J: Coronary artery disease among United States soldiers killed in action in Korea. *JAMA* 1953;152:1090-1093.

22. Rosenblatt A, Seltzer A: The nature and clinical features of myocardial infarction with normal coronary arteriogram. *Circulation* 1977;55:578-580.

23. Hedges JR, Rouan GW, Toltzis R, et al: Use

of cardiac enzymes identifies patients with acute myocardial infarction otherwise unrecognized in the emergency room. *Ann Emerg Med* 1987;16:248-252.

24. Seager SB: Cardiac enzymes in the evaluation of chest pain. *Ann Emerg Med* 1980; 9:346-352.

25. Almog C, Isakov A, Ayalon D, et al: Serum myoglobin in detection of myocardial necrosis in patients with "coronary insufficiency." *Clin Cardiol* 1987;10:347-349.

26. Fineberg HV, Scadden D, Goldman L: Care of patients with a low probability of acute myocardial infarction. Cost effectiveness of alternatives to coronary-care-unit admission. *N Engl J Med* 1984;310:301-307.

27. Mulley AG, Thibault GE, Hughes RA, et al: The course of patients with suspected myocardial infarction. The identification of low-risk patients for early transfer from intensive care. *N Engl J Med* 1980;302:943-948.