

Electronic Medical Record Review as a Surrogate to Telephone Follow-up to Establish Outcome for Diagnostic Research Studies in the Emergency Department

Jeffrey A. Kline, MD, Alice M. Mitchell, MD, Michael S. Runyon, MD,
Alan E. Jones, MD, William B. Webb, BSPH

Abstract

Background: Follow-up for diagnostic research studies might be facilitated if medical record review (MRR) could be used instead of telephone calls. **Objectives:** The authors hypothesized that MRR would yield similar accuracy to telephone follow-up. **Methods:** This was a secondary analysis of 2,178 initially disease-free patients who were followed after enrollment in a diagnostic study of either acute coronary syndrome (45 days) or pulmonary embolism (90 days) conducted in an urban teaching emergency department (ED). Disease status (positive or negative) was defined explicitly. Using structured data forms, trained researchers performed MRR using a comprehensive electronic database, and formulated an opinion about disease status. Trained researchers, blinded to the MRR, then dialed telephone numbers, asked questions from a script, and categorized disease status. The criterion standard was adjudication by consensus of two of three physicians who independently determined disease status based on explicit

criteria and access to all follow-up data. **Results:** Adjudicators found that 13 of 2,178 patients developed disease during follow-up; all 13 true positives occurred among the 2,054 (94.3%) of patients who acknowledged intent to return to the study hospital. Telephone follow-up was successful in 81% of patients, and found all 13 true positives (sensitivity 100%) but with three additional false-positive cases. MRR disclosed 12 of 13 cases of disease (sensitivity 92%) with no false-positive cases. Further review of the one false-negative case from MRR revealed that it occurred after the prescribed time limit for follow-up. **Conclusions:** Under limited circumstances, accurate clinical follow-up for diagnostic studies conducted in the ED can be obtained by medical record review. **Key words:** thromboembolism; pulmonary embolism; Health Insurance Portability and Accountability Act 1996; follow-up studies; informed consent; diagnosis; medical record review. *ACADEMIC EMERGENCY MEDICINE* 2005; 12:1127–1133.

Research studies of diagnostic accuracy performed in the emergency department (ED) often use data obtained from clinical follow-up as part of a criterion standard.¹ Specifically, investigators use follow-up data from telephone calls to determine whether a patient converts from disease-negative status to disease-positive status within a few weeks or months after study enrollment. However, telephone follow-up has drawbacks. Many institutional review boards (IRBs) require investigators to obtain written informed consent, a measure that can complicate and

bias data collection.^{2,3} Moreover, in ED populations, even rigorous and diligent methods of telephone follow-up can leave up to one-third of research subjects lost to follow-up.⁴

Research studies of diagnostic accuracy also frequently incorporate data from medical records to supplement telephone follow-up data. This step can be facilitated by the use of electronic medical records (e.g., laboratory values, radiographic interpretations, transcriptions, diagnostic and procedure codes) that are centralized into one comprehensive database.⁵ Follow-up by review of electronic medical records could afford certain advantages to researchers. For example, IRBs and privacy boards may be more willing to allow waiver of informed consent and waiver of authorization for noninterventional diagnostic protocols if follow-up is performed by review of medical records without a telephone call to the patient.⁶

To our knowledge, no study has quantitatively compared the diagnostic accuracies of telephone interview versus systematic review of electronic medical records. We submit that patients or their families

From the Department of Emergency Medicine, Carolinas Medical Center (JAK, AMM, MSR, AEJ, WBW), Charlotte, NC.

Received February 28, 2005; revision received April 4, 2005; accepted April 8, 2005.

Supported by grants from the National Institutes of Health (R41 HL074415-01 and R42 HL074415-02A1) and the Emergency Medicine Foundation to Dr. Kline.

Address for correspondence and reprints: Jeffrey A. Kline, MD, Department of Emergency Medicine, Carolinas Medical Center, PO Box 32861, Charlotte, NC 28323-2861. Fax: 704-355-7047; e-mail: jkline@carolina.rr.com.

doi:10.1197/j.aem.2005.04.012

can inadvertently and unintentionally provide ambiguous or erroneous information about disease status. Specifically, we hypothesized that telephone interview is vulnerable to false-positive designations compared with independent interpretation of the medical record documentation of the event(s) described by the patient. In this report, we use data obtained from a diagnostic study of pulmonary embolism (PE) and a diagnostic study of acute coronary syndrome (ACS) to directly compare the 2×2 diagnostic tables that would be generated if telephone follow-up or electronic medical record review each was used as the diagnostic test, versus adjudicated outcomes as the criterion standard.

METHODS

Study Design. We performed a preplanned secondary analysis of two diagnostic research studies conducted in the years 2002–2004 in the ED of Carolinas Medical Center. Both studies were approved by the IRB; written informed consent was waived in the PE study but was required in the ACS study. Both studies were funded by extramural peer-reviewed grants; both grant applications included plans for the present study.

Study Setting and Population. Carolinas Medical Center is an acute care hospital and part of Carolinas HealthCare Systems, Inc. (CHS), which owns and operates three other hospitals with EDs in Charlotte, North Carolina. The first research study examined the diagnostic accuracy of a point-of-care PE rule-out protocol, and the second study examined the diagnostic accuracy of a pretest probability instrument for ACS. Patients with PE were identified by a prespecified protocol that has been previously described.⁷ ACS patients were identified by a clinical picture raising enough suspicion for ACS that the clinician ordered a structured evaluation via a protocol performed in a chest pain observation unit that is certified by the American Society for Chest Pain Centers. Details of the diagnostic evaluation for ACS are described separately.⁸

Study Protocol. Clinicians or research associates completed structured data-collection forms for all patients that included their addresses and telephone numbers. The content of the data form for the PE study has been published and the contents of the ACS data form are presented in Appendix A (available as an online Data Supplement at <http://www.aemj.org/cgi/content/full/j.aem.2005.04.012/DC1>).⁶ Clinicians and research associates were instructed to ask for the single best phone number that would allow phone contact in three months. To confirm accuracy of the number, the data collector read the phone number back to the patient. Patients were

also asked to provide a phone number of a relative who would be knowledgeable of the patient's condition. Each data form also asked for a yes/no response from the patient to the question "After you are discharged from this visit, if you get worse, will you return to Carolinas Medical Center for a recheck?"

Explicit Criteria for Disease-positive Status. Criteria for PE diagnosis required image-proven evidence of clot prompting treatment, or patient death with an autopsy positive for PE.⁷ Images could include scintillation ventilation-perfusion lung scanning, computed tomography chest angiography, or venous ultrasonography interpreted by a board-certified radiologist as positive for either PE or deep venous thrombosis (DVT). The inclusion of isolated DVT as a positive outcome for PE has been justified previously.⁹ Treatment was defined as systemic anticoagulation or vena caval interruption.

Criteria for ACS-positive status required diagnosis of myocardial infarction according to the European Society of Cardiology criteria, the need for revascularization via intracoronary stent placement or coronary artery bypass grafting, discovery of coronary stenosis $>60\%$ prompting new medical therapy, or death during follow-up with autopsy showing cardiac ischemia.¹⁰

The criterion standard was established by adjudication. Two independent research-oriented clinicians reviewed all clinical and demographic data collected prospectively on all patients (>70 data fields), as well as the telephone follow-up and the electronic medical record review data for evidence of the explicit criteria to define disease. For convenience, the data were entered into a spreadsheet with one patient per row and each column representing a data field (Excel, Microsoft Corp., Redmond, WA). All abbreviations and column header fields were defined in a separate data dictionary. Each adjudicator, who conducted neither the telephone call nor the medical record search, evaluated the spreadsheet data to generate a "yes/no" opinion as to whether the patient developed PE or ACS after leaving the hospital at the time of enrollment. Upon request, the adjudicating clinicians were provided with printed copies of source medical record documents, including written notes made on the telephone follow-up forms and photocopies of written progress notes for hospitalized patients. Each clinician was blinded to the other's opinion; both had to agree on the presence or absence of a positive outcome using the prespecified definitions of both diseases. In the event of disagreement, a third clinician independently reviewed the data, and the consensus (two out of three) opinion was used as the criterion standard.

Follow-up Procedures. Medical record review was completed first, and then telephone calls were placed.

Follow-up was performed from days 45–90 after enrollment for the ACS study and from days 90–180 for the PE study. Follow-up by either method had the goal of disclosing a relevant event (such as return visit to the ED) that occurred during the “active” follow-up interval, which was from the day of enrollment to 45 or 90 days for the ACS and PE studies, respectively. Follow-up was performed by physicians (3), registered nurses (2), medical students (2), and a research coordinator with a BS degree (1). These researchers performed both methods of follow-up, but no researcher performed both methods of follow-up on the same patient.

To conduct electronic medical record follow-up, the reviewer used the patient’s identifier information (medical record number, last name, Social Security number) to search a comprehensive computerized database (Horizon Physician Portal, McKesson, Inc., Alpharetta, GA). This comprehensive database provides information on date, nature of visit, diagnosis codes, transcribed history and physical examinations, discharge summaries, procedure notes, and progress notes, as well as laboratory values and radiologic interpretations from any visit to an ED, physician office, or clinic owned by CHS in Charlotte. A separate database allowed viewing of optical scans of handwritten face sheets and nursing notes from ED visits. This system lacks the ability to show written progress notes from hospitalized patients.

Reviewers examined all records generated from the time of enrollment up until the day of review. The reviewer extracted data to a standardized form⁶ including the date(s) and location(s) of return visit, past medical history recorded, type of testing done, the results, and any diagnoses or treatments. When a physician or physician extender authored a history and physical examination from days 45–90 for the ACS study and days 90–180 for the PE study, we considered this document sufficient to permit disease classification.

Reviewers classified disease status as follows: Any documented visit during the active follow-up period that disclosed data required for the explicit definitions of PE or ACS constituted a hard endpoint for disease-positive classification. If one or more documented history and physical examinations occurred after the active follow-up period, and if these examinations and other data made no mention of PE or ACS, this was considered a hard endpoint for disease-negative classification. If the patient had no return visit for any reason, we queried the Social Security Death Index (SSDI).¹¹ If the patient died, this was also considered a hard endpoint; the date, location, and cause of death (either from the death certificate or from perimortem medical records) were recorded. If the SSDI search was negative, the patient was assumed to be disease-negative (a soft endpoint).

For telephone follow-up, callers were told which patients were known to be dead, but callers were

otherwise blinded to medical record review. For compassionate reasons, callers were instructed to avoid telephoning families of patients known to be dead. Callers dialed non-disconnected telephone numbers on at least five different days, at differing times of the day. If the caller encountered an answering device, the caller left a return telephone number for the respondent to call. For disconnected or incorrect numbers or numbers with no answer, a second number, if provided by the patient, was dialed at least five times. If this failed, we dialed any other telephone number contained in the hospital medical record, or any apparently relevant number obtained from public telephone listings at least five times. When no contact occurred after this sequence, patients were considered “lost to telephone follow-up.” If telephone contact was made, the caller asked to speak to the patient, if possible, or the next of kin who could best proxy for the patient. Callers read from scripts depicted in Appendixes B and C (available as an online Data Supplement at <http://www.aemj.org/cgi/content/full/j.aem.2005.04.012/DC2>). A physician who is bilingual in English and Spanish conducted follow-ups in Spanish-speaking households. Answers to questions were written directly on the data-collection sheets. The explicit criteria for the presence or absence of disease was based on the respondents’ answers to the questions 4–6 in the ACS follow-up script (Appendix B), and question 6 in the PE follow-up script (Appendix C). However, the caller used the responses to all questions in the follow-up scripts to formulate the overall opinion as to whether the patient had been diagnosed as having ACS or PE since study enrollment.

Data Analysis. We used 2×2 tables to compare the diagnostic assignments of the “tests” that were telephone follow-up and electronic medical record follow-up versus the results of adjudication, which was considered the criterion standard. The primary outcome variables of interest were the numbers of false negatives and false positives assigned by each test.

RESULTS

Table 1 summarizes the demographic and clinical characteristics of the patients enrolled in both the PE study and the ACS study. Both studies had a female predominance, and the majority of patients were African American.

PE Study. **Table 2** compares the diagnostic indexes of the two methods of follow-up for the PE study for 1,380 living subjects who did not have PE after discharge. These 1,380 patients were derived from 1,488 enrolled patients, minus 80 who were diagnosed as having PE at enrollment, and minus 28 more, found

TABLE 1. Clinical and Demographic Data

	PE Study	ACS Study
Age—mean $\pm$ SD	45 $\pm$ 15.6 yr	49 $\pm$ 10.2 yr
Gender—female	74%	58%
Race		
African American	56%	55%
White	40%	43%
Hispanic	3%	1%
Payer status		
Self-pay	24%	25%
Medicaid	21%	9%
Medicare	16%	13%
Private insurance	29%	49%
Other	10%	4%
Chief complaint		
Chest pain	51%	79%
Dyspnea/respiratory distress	33%	3%
Other	13%	18%

PE = pulmonary embolism; ACS = acute coronary syndrome.

to be deceased at the 90-day postenrollment time point.

Of the 1,380 patients, 94.0% indicated they would return to a CHS hospital if their condition worsened. Medical record review disclosed that 586 patients did return to a CHS ED, and 128 others returned to a clinic or to their doctor's office between 90 and 180 days postenrollment. Thus, electronic medical record review or SSDI review at 180 days found that 742 of 1,408 (53%) of all PE patients had a hard endpoint of a death certificate or a physician's history and physical examination done between 90 and 180 days after enrollment that could be examined for documentation of the development of PE since enrollment. This disclosed 12 patients who were treated for image-proven thromboembolism (four with PE and eight with DVT). None of these 12 were among the 28 who died. All 12 patients had answered yes to the question as to whether they used CHS primarily and would return to an affiliated facility for medical care as needed.

The primary telephone number led to successful contact in 938 of 1,380 (68%) of the PE study patients; the second telephone number resulted in successful contact with a knowledgeable proxy or the patient in another 124 of 1,380 (9%) instances. Thus, from the initial 1,380 cases, outcome could be determined from telephone conversation in 1,062 (77%), leaving 318 (23%) lost to follow-up. Of the 1,062 successful

telephone contacts, callers discovered 14 patients or proxies who answered questions that made the caller believe that a new diagnosis of PE occurred within 90 days of discharge. Telephone follow-up also discovered six patients who were deceased but not known to be dead from medical record and SSDI review, increasing the total number of decedents to 34. All patients who had a new diagnosis of PE or who died had answered yes to the question as to whether they used CHS primarily and would return to an affiliated facility for medical care as needed.

Summary of the PE Study. Table 2 shows that the two methods of follow-up had similar diagnostic sensitivities, but telephone follow-up yielded more false-positive designations compared with the criterion standard. Medical record review afforded a hard endpoint in 263 patients (82%) who were lost to telephone follow-up. The combination of telephone follow-up plus electronic medical record follow-up with a hard endpoint (death prior to 90 days or documented history and physical between 90 and 180 days after enrollment) included 1,325 (96.0%) of the 1,380 living patients requiring follow-up.

ACS Study. Table 3 compares the diagnostic indexes of the two methods of follow-up for the ACS study for 770 living subjects who did not have ACS after discharge. These 770 patients were derived from 784 enrolled patients minus 14 who were diagnosed as having ACS at enrollment; no ACS patient died within 45 days of enrollment.

Of the 770 patients, 95.1% indicated they would return to a CHS hospital if their condition worsened. Medical record review disclosed that 56 patients did return to a CHS ED, and 24 returned to a CHS clinic or their physician's office during the 45- to 90-day period after enrollment. Thus, electronic medical record review or SSDI review found that 80 of 770 ACS (10%) patients had a hard medical record endpoint after 45 days that could be examined for written evidence of the explicit criteria for ACS since enrollment. Reviewers had the opinion that none of these 80 patients had any criteria to meet the a priori definition of ACS within 45 days.

The primary telephone number given by the patient led to successful contact of 616 of 770 (80%) of the

TABLE 2. Diagnostic Accuracy of Each Method versus the Criterion Standard (PE Study*)

Method	Outcome	Criterion Standard†		True Positives	Sensitivity	False Positives	Specificity
		PE	No PE				
Medical record	PE	12	0	12/12	100%	0/12	100%
	No PE	0	1,366				
Telephone	PE	12	2	12/12	100%	2/14	99.9%
	No PE	0	1,364				

*N = 1,380 pulmonary embolism (PE) study patients; excludes 28 decedents, none of whom were adjudicated to the diagnosis of PE.

†From adjudicated review.

TABLE 3. Diagnostic Accuracy of Each Method versus the Criterion Standard (ACS Study*)

Method	Outcome	Criterion Standard†		True Positives	Sensitivity	False Positives	Specificity
		ACS	No ACS				
Medical record	ACS	0	0	0/1	0%	0/769	100%
	No ACS	1	769				
Telephone	ACS	1	1	1/1	100%	1/2	99.9%
	No ACS	0	768				

*N = 770 acute coronary syndrome (ACS) study patients.

†From adjudicated review.

ACS study patients; the secondary telephone number allowed successful follow-up in an additional 62 (8%) of cases. Thus, outcome could be determined from telephone conversation in 678 of 770 (88%), leaving 92 cases, or 12% lost to follow-up. Telephone calls revealed two cases in which the patient indicated an ACS-defining event had occurred since discharge. No patient was discovered to have died within 45 days.

Summary of the ACS Study. Table 3 shows that medical record review yielded one false-negative designation and telephone follow-up yielded one false-positive designation. Medical record review afforded a hard endpoint in 75 of 92 patients (81.5%) who were lost to telephone follow-up. The combination of telephone follow-up plus electronic medical record follow-up with a hard endpoint included 753 (97.8%) of the 770 ACS patients requiring follow-up.

False-positive and False-negative Cases. We performed a detailed investigation to attempt to discover the cause of apparent diagnostic error with each follow-up method. In the PE study, telephone follow-up designated two false-positive cases. In both false-positive cases, on the initial telephone call, a patient's family member clearly indicated the perception that the patient had a new diagnosis of PE after enrollment that prompted new anticoagulation. These two patients were both already receiving oral anticoagulation for previously diagnosed PE at the time of study enrollment. The diagnostic evaluation of both patients included pulmonary vascular and lower-extremity venous imaging, which was negative for recurrent PE.

In the ACS study, medical record review designated one false-negative case. This patient indicated during telephone interview that he had undergone a cardiac catheterization and had an intracoronary stent placed 57 days after enrollment. This patient was one of nine who caused discordant opinions between the first two reviewers, mandating a third opinion for adjudication. Secondary interview of the adjudicators by the authors disclosed that the two concordant adjudicators knew the ACS-defining event occurred outside the 45-day limit, but they believed the patient probably had an ACS-defining coronary lesion during the 45-day interval. Telephone follow-up designated another patient as false-positive for ACS. The pa-

tient's spouse indicated the patient had coronary artery bypass grafting within 45 days, causing the caller to deem ACS present. However, adjudicators deemed the patient as ACS-negative because medical record review provided information that the patient underwent coronary artery bypass grafting for aortic valve replacement, after a preoperative coronary angiogram that was normal.

DISCUSSION

We found that under clearly defined conditions, electronic medical record review could function as an accurate surrogate to telephone follow-up. At the same time, we found that telephone follow-up required a large work effort relative to the return value. The two studies combined had 2,150 living patients who needed postenrollment follow-up. Telephone calls allowed successful contact with 1,746 of 2,150 (81%) patients. Approximately two unsuccessful telephone calls were made for each call that led to successful contact. We therefore dialed approximately 5,200 phone numbers to yield one case in which adjudicators deemed the patient to have disease that was not discovered on medical record review (one patient with ACS). Further investigation then disclosed that this patient actually developed his disease-defining event later than the predefined time limit for follow-up. Telephone follow-up used in isolation would have led to false-positive interpretations of disease in three of 16 (19%) of cases. All three of these telephone calls were dialed by physician-researchers, making it less likely that the interpretation of what the patients said was the result of the caller's experience level. These data suggest vulnerability of telephone follow-up to false-positive determinations if used in isolation.

We believe that our methods of telephone follow-up were as rigorous as can be reasonably expected. For example, we asked patients for two phone numbers, and we dialed numbers at least five times on different days at different times. If neither of two recorded telephone numbers was valid, we consulted public phone records in an attempt to find an alternative number. Despite this persistence, we were unable to contact 19% of patients. For general comparison, the published rates of successful telephone follow-up reported for other ED-based studies range from 50%

to 99%.^{12–21} However, these follow-up rates were computed from information obtained from both telephone calls and varying degrees of incorporated medical record review.

The higher rate of successful telephone contact in the ACS study (88% versus 77%) than the PE study warrants comment. We believe this phenomenon might be explained by the fact that calls were made sooner, starting at 45 days for the ACS study, versus 90 days for the PE study. This finding suggests that telephone follow-up may be more fruitful if performed sooner than 90 days after the ED visit.²² Additionally, the PE study was conducted under waiver of written informed consent and waiver of authorization of release of medical records. The ACS study required both written informed consent and authorization of release—a process that required the patient to sign his or her name three times. This may have selected patients who were more likely to give accurate telephone numbers in the ACS study.

The much lower rate of a hard endpoint for medical record review among ACS patients (10%) versus PE patients (50%) is probably explained by two facts. First, the active follow-up interval was twice as long (between 90 and 180 days, versus between 45 and 90 days) for the PE study compared with the ACS study. Second, by way of protocol, clinicians selected the ACS patients as persons probably not needing hospital admission; the chest pain unit protocol is a streamlined process, designed solely to rule out ACS in patients without complex comorbidity. Only 5% of ACS patients were admitted after their chest pain unit protocol was completed. On the contrary, the PE rule-out was performed on many patients with complex medical problems; 41% of the PE patients were admitted on the same visit as enrollment.

This project extends our work on tools and methods to allow research data to be prospectively obtained in the ED under waiver of informed consent and waiver of authorization (“double waiver”).⁶ Although each IRB has a unique risk tolerance, it has been our experience that most IRBs require written informed consent to allow telephone follow-up to be performed, but are more likely to allow medical record follow-up to be performed under double waiver. Double waiver may reduce selection bias in diagnostic and observational studies. A substantial body of published evidence has shown that the step of obtaining written informed consent for a research study can bias against enrolling cognitively impaired patients, the very old, children, pregnant patients, the acutely ill, patients who do not speak English, and other vulnerable populations.^{2,3,23–28}

LIMITATIONS

We emphasize that our data do not prove that medical record review can be used broadly as a valid surrogate

to telephone follow-up. We speculate that several conditions must be met for our findings to be reproduced elsewhere. Comprehensive medical record review may be possible only for studies conducted at large urban academic hospitals with a network of clinics or affiliated hospitals that share the same information storage system. The hospital in which this research was conducted was part of a large system that owns four of six hospitals in the city, accounting for 70% of all ED patients in the city. All hospitals within our network shared the same information system (Physician Portal) for medical records. The question asked of each patient regarding intent to return to the site hospital or affiliated facility if needed after discharge may be a key to valid follow-up from medical record review. In our sample, 94.3% of patients said they would return to our system if needed, and all 13 patients adjudicated to disease-positive status returned to our hospital. These two findings may not translate to other hospitals. We recognize that in other EDs, this question may be more difficult to ask and answer than it was in our ED, and other IRBs may not allow this information to be collected under double waiver. Moreover, this step may have less utility in an ED frequented by vacationers.

CONCLUSIONS

In emergency department patients who indicated their intention to return only to the site hospital or affiliated facility after discharge, the accuracy of clinical follow-up derived solely from medical record review compared favorably with the accuracy of follow-up derived solely from telephone calls.

References

1. Wolfe TR, Hartsell SC. Pulmonary embolism: making sense of the diagnostic algorithm. *Ann Emerg Med.* 2001; 37:504–14.
2. Tu JV, Willison DJ, Silver SL, et al. Impracticability of informed consent in the registry of the Canadian Stroke Network. *N Eng J Med.* 2004; 350:1414–21.
3. Hartmann JJ, Prins MH, Buller HR, Banga JD, ANTELOPE Study Group. Acute pulmonary embolism: impact of selection bias in prospective diagnostic studies. *Thromb Haemost.* 2001; 85:604–8.
4. Boudreaux ED, Clark S, Camargo CA Jr. Telephone follow-up after the emergency department visit: experience with acute asthma. On behalf of the MARC Investigators. *Ann Emerg Med.* 2000; 35:555–63.
5. Gillam M, Rothenhaus T, Smith V, Kanhouwa M. Information technology principles for management, reporting, and research. *Acad Emerg Med.* 2004; 11:1155–61.
6. Kline JA, Johnson CL, Webb WB, Runyon MS. Prospective study of clinician-entered research data in the emergency department using an Internet-based system after the HIPAA Privacy Rule. *BMC Med Inform Decis Making.* 2004; 4(1):17.
7. Kline JA, Webb WB, Jones AE, Hernandez J. Impact of a rapid rule-out protocol for pulmonary embolism on the rate of screening, missed cases, and pulmonary vascular imaging in an urban U.S. emergency department. *Ann Emerg Med.* 2004; 44:490–503.

8. Mitchell AM, Garvey JL, Chandra A, Diercks DB, Pollack CV, Kline JA. Prospective study of quantitative pretest probability assessment for acute coronary syndromes in patients evaluated in emergency department chest pain units. *Ann Emerg Med*. In press.
9. Kline JA, Novobilski AJ, Kabrhel C, Richman PB, Courtney DM. Derivation and validation of a Bayesian network to predict pretest probability of venous thromboembolism. *Ann Emerg Med*. 2005; 45:282–90.
10. Alpert JS, Thygesen K, Antman E. Myocardial infarction redefinition: 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.
11. Schisterman EF, Whitcomb BW. Use of the Social Security Administration Death Master File for ascertainment of mortality status. *Popul Health Metrics*. 2004; 2(1):2.
12. Rey E, Roncero Garcia-Escribano O, Alvarez SA, Diaz-Rubio M. Long-term outcome of patients with non-cardiac chest pain. *Rev Esp Enferm Dig*. 2002; 94(1):25–33.
13. Emerman CL, Woodruff PG, Cydulka RK, Gibbs MA, Pollack CV Jr, Camargo CA Jr. Prospective multicenter study of relapse following treatment for acute asthma among adults presenting to the emergency department. MARC Investigators. Multicenter Asthma Research Collaboration. *Chest*. 1999; 115:919–27.
14. Walker NJ, Sites FD, Shofer FS, Hollander JE. Characteristics and outcomes of young adults who present to the emergency department with chest pain. *Acad Emerg Med*. 2001; 8: 703–8.
15. Henrikson CA, Howell EE, Bush DE, et al. Chest pain relief by nitroglycerin does not predict active coronary artery disease. *Ann Intern Med*. 2003; 139:979–86.
16. Buchsbaum M, Marshall E, Levine B, et al. Emergency department evaluation of chest pain using exercise stress echocardiography. *Acad Emerg Med*. 2001; 8:196–9.
17. Christenson J, Innes G, McKnight D, et al. Safety and efficiency of emergency department assessment of chest discomfort. *Can Med Assoc J*. 2004; 170:1803–7.
18. Lukens TW, Emerman C, Effron D. The natural history and clinical findings in undifferentiated abdominal pain. *Ann Emerg Med*. 1993; 22:690–6.
19. Fumeaux T, Cornuz J. The use of the rapid D-dimer test for the exclusion of acute venous thromboembolism in a regional hospital. *Swiss Med Wkly*. 2003; 133(11-12):178–83.
20. Wicki J, Perneger T, Junod A, Bounameaux H, Perrier A. Assessing clinical probability of pulmonary embolism in the emergency ward: a simple score. *Arch Intern Med*. 2001; 161:92–7.
21. Chagnon I, Bounameaux H, Aujesky D, et al. Comparison of two clinical prediction rules and implicit assessment among patients with suspected pulmonary embolism. *Am J Med*. 2002; 113:269–75.
22. Mikhail MG, Smith FA, Gray M, Britton C, Frederiksen SM. Cost—effectiveness of mandatory stress testing in chest pain center patients. *Ann Emerg Med*. 1997; 29:88–98.
23. Hollander JE, Schears RM, Shofer FS, Baren JM, Moretti LM, Datner EM. The effect of written informed consent on detection of violence in the home. *Acad Emerg Med*. 2001; 8:974–9.
24. Bjarnason NH, Kampmann JP. Selection bias introduced by the informed consent process [comment]. *Lancet*. 2006; 1990:361.
25. Caldwell PH, Murphy SB, Butow PN, Craig JC. Clinical trials in children. *Lancet*. 2004; 364:803–11.
26. Dunn KM, Jordan K, Lacey RJ, Shapley M, Jinks C. Patterns of consent in epidemiologic research: evidence from over 25,000 responders. *Am J Epidemiol*. 2004; 159:1087–94.
27. Lewis BS, Yuval R, Halon DA, Flugelman MY. Selection bias introduced by the informed consent process. *Lancet*. 2003; 361:1990–1.
28. Yawn BP, Yawn RA, Geier GR, Xia Z, Jacobsen SJ. The impact of requiring patient authorization for use of data in medical records research. *J Fam Pract*. 1998; 47:361–5.