Journal of HOSPITAL MEDICINE www.journalofhospitalmedicine.com

ORIGINAL RESEARCH

The Effect of Inpatient Stress Testing on Subsequent Emergency Department Visits, Readmissions, and Costs

Jaya Mallidi, MD, MHS[1,2]*, Srikanth Penumetsa, MD, MRCP[1,2], Jennifer L. Friderici, MS[2,3], Fadi Saab, MD[4], Michael B. Rothberg, MD, MPH[5]

[1]Division of Cardiology, Department of Medicine, Baystate Medical Center, Springfield, Massachusetts; [2]Department of Medicine, Tufts University School of Medicine, Boston, Massachusetts; [3]Division of Academic Affairs, Baystate Medical Center, Springfield, Massachusetts; [4]Division Of Cardiology, Department Of Medicine, Michigan State University School of Medicine, Wyoming, Michigan; [5]Department of Medicine, Medicine Institute, Cleveland Clinic, Cleveland, Ohio.

BACKGROUND: Patients with low-risk chest pain are frequently readmitted for evaluation of recurrent chest pain. It is unknown whether stress testing during the first admission for chest pain is a cost-effective means of reducing readmissions.

METHODS: Using a hospital administrative database, we conducted a retrospective cohort study of patients aged ≥18 years admitted under "observation status" to Baystate Medical Center between January 2007 and July 2009 for chest pain without acute coronary syndrome. We compared subsequent emergency department (ED) visits, readmissions, and costs within 1 year for patients who had a stress test at index admission to those who did not, adjusting for age, gender, race, insurance, and comorbidities.

RESULTS: The cohort included 3315 patients. Most (n = 2376, 71.7%) had a stress test during the index admission. Within 1 year, 256 (7.7%) patients returned to the ED at least once with chest pain. Of these, 112 (43.8%) were admitted during their first return visit. In the multivariable model, return visits for chest pain were negatively associated with previous stress testing (odds ratio [OR]: 0.6, 95% confidence interval [CI]: 0.5 to 0.9). Once in the ED, however, the risk of admission did not vary by stress test during index admission (OR: 0.8, 95% CI: 0.4 to 1.4). Overall costs, including index admission and follow-up visits for chest pain, were higher for patients with stress testing at index admission.

CONCLUSION: Inpatient stress testing reduced subsequent resource utilization in terms of ED visits and resultant readmissions, but the savings were not enough to offset the cost of initial testing. *Journal of Hospital Medicine* 2013;8:564–568. © 2013 Society of Hospital Medicine

More than 9 million people visit the emergency department (ED) annually for evaluation of acute chest pain.[1,2] Most of these patients are placed on observation status while being assessed for an acute coronary syndrome (ACS). Traditionally, serial cardiac enzymes and absence of changes suggestive of ischemia on electrocardiogram rule out ACS. Patients are then stratified based on their presentation and risk factors. However, healthcare providers are not comfortable discharging even low-risk patients without further testing.[3] Routine treadmill stress testing is usually performed, often complimented by an imaging modality. A negative stress test before discharge reassures both the physician and the patient that the chest pain is not caused by an obstructive coronary lesion.

Patients with chest pain who have been discharged from the ED after ruling out an ACS are frequently readmitted for chest pain within 1 year.[4] It is unclear whether stress testing can prevent these readmissions by preventing return to the ED or by influencing the decision of ED physicians to admit patients for observation.[5–7] Even if stress testing can reduce ED visits or readmissions, it is not known whether the savings from preventing these visits can offset the initial cost of stress testing. The purpose of this study was to examine the impact of stress testing on readmission for chest pain, and to determine whether stress testing can reduce overall costs.

METHODS

Study Population

The hospital's billing database was used to obtain the data. Inclusion criteria included age 18 years or older with index hospitalization between January 2007and July 2009 with International Classification of Diseases, 9th Revision admitting diagnoses of "chest pain" (786.5), "chest pain NOS–not otherwise specified" (786.50), "chest pain NEC–not elsewhere classified" (786.59) or "angina pectoris" (413.9). All eligible patients were admitted under "observation status." Although observation patients are technically outpatients, they are cared for by inpatient physicians on inpatient units and are otherwise indistinguishable from inpatients. Patients with a discharge diagnosis of "acute myocardial infarction" at index admission were excluded. Also, patients who had a chest pain admission or an outpatient stress test within the previous 12 months of index admission were excluded.

*Address for correspondence and reprint requests: Jaya Mallidi, MD, Division of Cardiovascular Medicine, Baystate Medical Center, 1759 Chestnut Street, Springfield, MA 01199; Telephone: 860-990-4500; Fax: 413-794-9294; E-mail: jaya.mallidi@bhs.org

Additional Supporting Information may be found in the online version of this article.

Received: May 5, 2013; **Revised:** July 17, 2013; **Accepted:** August 1, 2013
2013 Society of Hospital Medicine DOI 10.1002/jhm.2081
Published online in Wiley Online Library (Wileyonlinelibrary.com).

TABLE 1. Patient Characteristics Based on Stress Test at Index Admission

	Total, N = 3315	Stress Test Original Admission, N = 2376	No Stress Test, N = 939	*P* Value*
Age, y, mean/SD	57.5/13.9	57.2/12.8	58.2/16.2	0.10
Male, n (%)	1505 (45.4)	1080 (45.5)	425 (45.3)	0.94
Race, n (%)				<0.001
White	2082 (62.8)	1552 (65.3)	530 (56.4)	
Black	345 (10.4)	239 (10.1)	106 (11.3)	
Hispanic	585 (17.7)	381 (16.0)	204 (21.7)	
Other	303 (9.1)	204 (8.6)	99 (10.5)	
Private insurance, n (%)	1469 (44.3)	1176 (49.5)	293 (31.2)	<0.001
No. of cardiovascular comorbidities, mean/SD†	0.68/0.78	0.70/0.78	0.64/0.77	0.04
Smoker, n (%)	335 (10.1)	249 (10.5)	86 (9.2)	0.28
Return for chest pain, n (%)	256 (7.7)	148 (6.2)	108 (11.5)	<0.001
All cause return, n (%)	1279 (38.6)	819 (34.5)	460 (49.0)	<0.001
Median time to next chest pain visit, d (25th, 75th percentile)	69 (6, 180)	67 (5, 190)	71 (9, 172)	0.86
Median time to all cause return, d (25th, 75th percentile)	92 (27, 198)	108 (33, 207)	67 (20, 175)	<0.001
Admitted upon first return for chest pain, n (%)	112 (43.8)	62 (41.9)	50 (46.3)	0.53

NOTE: **Abbreviations:** SD, standard deviation.

*Independent samples *t* test with Satterthwaite's adjustment (Gaussian), Fisher exact test (categorical), Wilcoxon rank sum (non-Gaussian).

†Current smoker, congestive heart failure, valvular disease, pulmonary/circulatory disorders, peripheral vascular disease, obesity, diabetes mellitus, and hypertension.

Data Collection and Outcomes

All data were extracted electronically from the hospital's billing database. For each patient we noted age, sex, race, insurance status, and cardiovascular comorbidities (current smoker, congestive heart failure, valvular disease, pulmonary/circulatory disorders, peripheral vascular disease, obesity, diabetes mellitus, and hypertension). For each admission we ascertained whether or not any type of stress test was performed. We obtained ED and hospitalization costs for chest pain visits within 12 months of index admission from the hospital's cost accounting system. We also obtained corresponding physician charges as well as collection rate from the health system's clinical decision support system.

The primary outcome was the rate of ED visits and readmissions for chest pain within 1 year of the index visit. Secondary outcomes included total annual hospitalization and ED costs. Total annual costs were calculated by summing index costs and follow-up costs for subsequent ED visits and readmissions.

Statistical Analysis

Fisher exact (categorical) and unpaired *t* tests/Wilcoxon rank sum (continuous) tests were used to compare the baseline characteristics of patients who received a stress test at index admission to those who did not. To address possible confounding by indication (allocation bias), the association between stress testing and various outcomes was quantified using multivariable logistic (ED visits and readmissions) or linear regression (costs).[8,9] In addition, we developed a propensity model using conditional logistic regression and matched patients on propensity score using 1:1 greedy matching algorithm with a caliper tolerance of 0.05.[10,11] For cost analyses, the annual collection rate was applied to all physician charges, and these were added to hospital or ED costs to obtain the total cost of each visit. The average cost of ED visits or readmissions for each group was calculated by dividing the total ED or readmission cost by the number of ED visits and readmissions, respectively. Physician charges were unavailable for approximately one-third (1487/5163 or 29%) of all hospitalizations; missing charges were estimated using mean imputation, and sensitivity analyses were conducted to ensure consistency of inferences between full (imputed) and restricted models.[12–14] Stata/MP 12.1 for Windows (StataCorp, College Station, TX) was used for all analyses.

RESULTS

A total of 3315 patients admitted with chest pain during the study period met the inclusion criteria. Of these, 2376 (71.7%) had a stress test on index admission. Table 1 describes the baseline characteristics of the study population. Receipt of a stress test during index admission was positively associated with white race, private insurance, and number of cardiac comorbidities. The propensity model included these covariates as well as study year, age (80+ vs younger), sex, and smoking status. The C statistic, which quantifies the model's ability to discriminate subjects who received a stress test from those who did not, was 0.63 (95% confidence interval [CI]: 0.61 to 0.65). Of patients who returned to the ED, we were able to find propensity matches for 69% to create a matched sample of 1776 patients. Of patients who were readmitted, we were able to find matches for 83% to create a matched sample of 186 patients.

Subsequent ED Visits for Chest Pain

Within 1 year, 1279 (38.6%) of all patients returned to the ED, and 256 (7.7%) returned at least once for

TABLE 2. Multivariable Model Predicting Return Emergency Department Visit for Chest Pain

Variable	Odds Ratio	95% CI
Stress test	0.5	0.4 – 0.7
Age >80 years	1.0	0.6 – 1.6
Gender		
Female	1.0	
Male	1.0	0.8 – 1.3
Race/ethnicity		
White	1.0	
Hispanic	1.6	1.2 – 2.3
Black	1.6	1.1 – 2.4
Other	2.3	1.6 – 3.5
≥1 Cardiac comorbidity*	1.1	0.8 – 1.4
Medicare/Medicaid	1.5	1.1 – 2.0
Year of index admission		
2007	1.0	
2008	0.8	0.6 – 1.1
2009	0.5	0.4 – 0.7
Smoking	1.4	0.9 – 2.1

NOTE: **Abbreviations:** CI, confidence interval.

*Current smoker, congestive heart failure, valvular disease, pulmonary/circulatory disorders, peripheral vascular disease, obesity, diabetes mellitus, and hypertension.

TABLE 3. Multivariable Model Predicting Readmission After Returning to the Emergency Department for Chest Pain

Variable	Odds Ratio	95% CI
Stress test	0.8	0.5 – 1.4
Age >80 years	1.0	0.4 – 2.6
Gender		
Female	1.0	
Male	1.0	0.6 – 1.7
Race/ethnicity		
White	1.0	
Hispanic	1.3	0.6 – 2.5
Black	0.6	0.2 – 1.4
Other	4.5	1.9 – 10.6
≥1 Cardiac comorbidity*	1.8	1.0 – 3.4
Medicare/Medicaid	1.3	0.7 – 2.4
Year of index admission		
2007	1.0	
2008	0.6	0.4 – 1.2
2009	0.2	0.1 – 0.5
Smoker	0.3	0.1 – 0.8

NOTE: **Abbreviations:** CI, confidence interval.

*Current smoker, congestive heart failure, valvular disease, pulmonary/circulatory disorders, peripheral vascular disease, obesity, diabetes mellitus, and hypertension.

chest pain. Patients who had a stress test at index admission were less likely to return to ED for chest pain, compared to those who did not get a stress test at admission (6.2% vs 11.5%; $P < 0.001$). The median time to the first subsequent ED visit for any complaint was greater among patients who had a stress test at index admission (108 days vs 67 days, $P < 0.001$), but no effect was noted on time to return for chest complaint (67 days vs 71 days, $P = 0.86$).

In a multivariable model, return to the ED for chest pain was positively associated with self-reported nonwhite race, insurance with Medicare or Medicaid, and earlier year of index admission (Table 2). Return ED visit was negatively associated with stress testing at index admission (adjusted odds ratio [OR]: 0.5, 95% CI: 0.4 to 0.7; propensity-matched analysis OR: 0.6, 95% CI: 0.5 to 0.9).

Subsequent Readmissions for Chest Pain

Of the 256 patients who returned to the ED for chest pain, 112 (43.8%) were readmitted during the first return visit. There was no statistically significant difference in the proportion admitted from the ED by prior stress test status. In a multivariable model, readmission after returning to the ED for chest pain was positively associated with cardiac comorbidities and earlier year of index admission (Table 3). The decision to readmit was not significantly associated with prior stress testing (adjusted OR: 0.8, 95% CI: 0.5 to 1.4; propensity-matched analysis OR: 0.8, 95% CI: 0.4 to 1.4).

Cost Analysis

The average multivariable-adjusted cost (hospital- + physician costs) for a patient at index chest pain admission was $3462 if a stress test was performed compared to $2374 without a stress test (Δ+$1088, 95% CI: $972 to $1203). In the propensity-matched sample the difference was +$1211(95% CI: $1084 to $1338). There were 155 occasions on which a patient returned to the ED for chest pain but was not readmitted. The average per-visit cost did not differ based on prior stress test status in the overall sample ($763 if stress testing done previously vs $722 if not [Δ+$41, 95% CI: −$43 to + $125]) or in the propensity-matched sample ($787 if stress testing was done vs $744 if not [Δ$43, 95% CI: −$54 to +$140]). Because ED visits were less frequent among patients who had a stress test at index admission, the average annual cost of ED visits was significantly lower for this group ($32 vs $52; Δ−$20, 95% CI: −$36 to −$4) or ($42 vs $54; Δ −$12 (95% CI: −$32 to +$8) in the propensity-matched sample. For the 117 occasions on which a patient returned with chest pain and was readmitted, the average cost per readmission also did not differ based on whether a stress test was performed at index admission or not ($2912 vs $2806, $P = 0.85$). Again, because readmissions were less common after stress testing, the average cost of readmissions was lower for patients with stress tests than for those without ($88 vs $180; Δ −$92, 95% CI: −$176 to −$8) or $137 vs $194 (Δ −$57, 95% CI: −$161 to $47) in the propensity-matched sample. The total cost of all visits (index, ED, and readmissions) was higher for patients who had a stress test at index admission than for those who did not ($3582 vs $2606; Δ+$975, 95% CI: $829 to $1122) or ($3833 vs $2690; Δ+$1142, 95% CI: $970, $1315) in the propensity-matched sample.

DISCUSSION

In this retrospective cohort study of patients admitted with low-risk chest pain, we found that a majority (>70%) underwent stress testing prior to discharge. Within 1 year approximately 8% returned to the ED with chest pain. Stress testing at index admission was associated with 40% reduction in the odds of subsequent ED visits for chest pain; however, once in the ED, having a previous stress test did not significantly affect the decision to admit. Despite the reduction in readmission rates, the overall hospital costs—including cost of index admission, subsequent ED visits, and readmissions—were higher for patients who had a stress test at index admission.

Two other studies have evaluated the impact of stress testing on return ED visits.[5,6] In a cohort of 1195 low-risk chest pain patients at a tertiary center in New York, patients who underwent stress testing were less likely to return to the ED for chest pain within 3 months compared to those who did not get a stress test (10% vs 15%, $P < 0.001$).[5] In contrast, another prospective study of 692 low-risk chest pain patients found no difference in return ED visits between patients who were evaluated versus those who were not evaluated for underlying coronary artery disease at index admission by stress testing or cardiac catheterization (39% vs 40%; $P = 0.85$).[6] In this study, the lack of difference may have been due to the population sampled, which had high rates of return in both groups. In our study, we also found that having a previous stress test does not significantly impact the decision to admit the patient. This was consistent with the results of another prospective cohort study of low-risk chest pain patients presenting to the ED.[7]

Previous studies offer conflicting interpretations of the cost implications of stress testing in this population. Based on studies conducted in the 1990s that showed that mandatory stress testing in the ED was cost-effective compared to hospital admission,[15,16] the most recent scientific statement by the American Heart Association recommends stress testing for all low-risk chest pain patients.[17] However, more recent studies have questioned the value of diagnostic testing beyond serial electrocardiograms and cardiac enzymes in low-risk patients.[18–22] In a study done at our institution among patients admitted with low-risk chest pain, the rate of positive stress tests was noted to be extremely low, and patients had a benign course; at 30 days the rates of major cardiovascular events was as low as 0.3%.[19] Other studies also showed no difference in outcomes among patients who received inpatient, outpatient, or no stress testing.[21,22]

These studies have generally been limited to the initial hospitalization period. Our study extends these findings in terms of resource utilization to the year following hospitalization. This is important because physicians might order stress tests to reassure patients or themselves that the pain is noncardiac, with the hope that this will decrease subsequent ED visits or readmissions. In our study, stress tests did reduce both ED visits and readmissions, but the index cost of hospitalization was so much higher with stress testing that the reduced readmissions did not offset the initial costs. Because stress tests have not been shown to change cardiovascular outcomes but did increase costs, it may be time to reevaluate the need for any kind of inpatient stress testing in these patients.

Our study has several limitations. The retrospective nature of the study subjects it to confounding. We adjusted for demographics, insurance, and comorbidities, but other unmeasured elements of the patients' presentation might have affected stress test ordering and subsequent return to the ED. In addition, we relied on administrative data, and comorbidities may not have been documented completely. During the follow-up period, we did not take into account patients who presented to the EDs of other hospitals or those who might have died. Because there is only one other hospital in our city, and it does not perform angioplasties, it is unlikely that we missed many infarctions this way, but we may not have included all ED visits. Similarly, we included only costs accrued within our healthcare system. If patients presented to outside facilities for testing or treatment, we were unable to capture it. It is possible that patients who did not undergo initial stress testing may have been more likely to have subsequent testing at outside facilities, which would have reduced the difference in cost that we observed. However, given the magnitude of this difference, it is unlikely that including outside costs would have completely eliminated the difference. The data in our study were collected over a 3-year period. Secular trends in the healthcare system over that time could potentially have affected our results. To reduce this bias, we included the year of the study in the propensity model. Also, the study was performed at a single hospital, and the results might not be generalizable to other institutions. Ours is a large independent academic medical center serving both a tertiary and a community role. Therefore, the population it serves would appear to be representative of the general population having chest pain without ACS.

Finally, we did not collect data on the results of stress tests. It is probable that the decision to admit a patient is modified by the results of a previous test, and this was not explored in our analysis. Presumably, patients with positive tests would be more likely, and those with negative tests less likely, to be admitted than patients who had no previous test. Previous studies have shown that among low-risk chest pain patients, the rate of abnormal stress tests is <15%, and among these only a minority (0.6%–0.7%) can benefit from revascularization.[19,20] Therefore, testing should result in a lower rate of readmissions overall, which is what we observed in this study. Once

patients reached the ED, however, the decision to admit was not associated with having a previous stress test. This could be due to a high rate of positive tests among patients who came to the ED, or a lack of discrimination by ED physicians. Although our study design could not distinguish between these 2 possibilities, studies have shown that fear of litigation and aversion to risk play an important role in this decision,[23,24] and it is possible that these considerations override the results of previous stress tests, which cannot categorically rule out current ischemia.

In an era of rising healthcare costs and limited resources, the care of low-risk chest pain is an attractive target for cost-reduction strategies. Low-risk chest pain accounts for 1.8 % of all admissions, at an average annual cost of $3.4 billion in the United States,[25] so figuring out how to prevent such admissions has important economic implications. Although stress testing did keep patients from returning to the ED, it did not affect the ED physicians' decisions to admit. We found that stress testing does decrease subsequent resource utilization, but not enough to offset the initial cost of testing. Thus, stress testing does not appear to be a cost-effective means to reduce readmissions.

Disclosures: Jaya Mallidi and Michael Rothberg had full access to all of the data in the study and take full responsibility for the integrity of the data and accuracy of the analysis. The authors report no conflicts of interest.

References

1. Bhuiya FA, Pitts SR, McCaig LF. Emergency room visits for chest pain and abdominal pain: United States, 1999–2008. Hyattsville, MD: National Center for Health Statistics; 2010.
2. Pitts SR, Niska RW, Xu J, Burt CW. National Hospital Ambulatory Medical Care Survey: 2006 emergency department summary. *Natl Health Stat Report*. 2008;7:1–38.
3. Pines JM, Szyld D. Risk tolerance for the exclusion of potentially life-threatening diseases in the ED. *Am J Emerg Med*. 2007;25:540–544.
4. Herlitz J, Karlson BW, Sjolin M. Re-admissions among patients with acute chest pain who were discharged from the emergency department. *Eur J Emerg Med*. 1996;3(1):31–35.
5. Shoyeb A, Bokhari S, Sullivan J, et al. Value of definitive diagnostic testing in the evaluation of patients presenting to ED with chest pain. *Am J Cardiology*. 2003;91(12):1410–1414.
6. Shaver KJ, Marsan RJ Jr, Sease KL, Shofer FS, Sites FD, Hollander JE. Impact of negative evaluation for underlying coronary artery disease on one year resource utilization for patients admitted with potential acute coronary syndrome. *Acad Emerg Med*. 2004;11:1272–1277.
7. Nerenberg RH, Shofer FS, Robery JL, Brown AM, Hollander JE. Impact of a negative prior stress test on emergency physician disposition decision in ED patients with chest pain. *Am J Emerg Med*. 2007;25:39–44.
8. LA, Wu C, Xue X, Hafner JP. Estimating the relative risk in cohort studies and clinical trials of common outcomes. *Am J Epidemiol*. 2003;157(10):940–943.
9. Zou G. A modified Poisson regression approach to prospective studies with binary data. *Am J Epidemiol*. 2004;159:702–706.
10. D'Agostino RB Jr. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. *Stat Med*. 1998;17(19):2265–2281.
11. Leuven E, Sianesi B. PSMATCH2: Stata module to perform full Mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing. 2003. Available at: http://ideas.repec.org/c/boc/bocode/s432001.html, 1) Version 4.0.6, 17 May 2012. E. Leuven, B. Sianesi. Accessed date July 1st, 2013.
12. Detsky AS, Naglie G. A clinician's guide to cost-effectiveness analysis. *Ann of Intern Med*. 1990;113:147–154.
13. Berk RA. A primer on robust regression. In: Fox J, Long JS, eds. Modern Methods of Data Analysis. Newbury Park, CA: Sage; 1990:292–324.
14. Goodall C. M-estimators of location: an outline of the theory. In: Hoaglin DC, Mostellar F, Tukey JW, eds. Understanding Robust and Exploratory Data Analysis. New York, NY: Wiley; 1983:339–431.
15. 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(1):88–98.
16. Kirk JD, Turnipseed S, Lewis WR, Amsterdam EA. Evaluation of chest pain in low-risk patients presenting to the emergency department: the role of immediate exercise testing. *Ann Emerg Med*. 1998;32(1):1–7.
17. Amsterdam EA, Kirk JD, Bluemke DA, et al.; American Heart Association Exercise, Cardiac Rehabilitation; Prevention Committee of the Council on Clinical Cardiology, Council on Cardiovascular Nursing, and Interdisciplinary Council on Quality of Care and Outcomes Research. Testing of low-risk patients presenting to the emergency department with chest pain: a scientific statement from the American Heart Association. *Circulation*. 2010;122(17):1756–1776.
18. Zalenski RJ, Selker HP, Cannon CP, et al. National Heart Attack Alert Program position paper: chest pain centers and programs for the evaluation of acute cardiac ischemia. *Ann Emerg Med*. 2000;35(5):462–447.
19. Penumetsa SC, Mallidi J, Friderici J, Hiser W, Rothberg M. Outcomes of patients admitted for Observation of Chest pain. *Arch Intern Med*. 2012;172(11):873–877.
20. Herman LK, Newman DH, Pleasant WA, et al. Yield of routine provocative cardiac testing among patients in an emergency department-based chest pain unit. *JAMA Intern Med*. 2013;173(12):1128–1133.
21. Than M, Cullen L, Reid CM, et al. A 2-h diagnostic protocol to assess patients with chest pain symptoms in the Asia-Pacific region (ASPECT): a prospective observational validation study. *Lancet*. 2011;377(9771):1077–1084.
22. Chan GW, Sites FD, Shofer FS, Hollander JE. Impact of stress testing on 30-day cardiovascular outcomes for low-risk patients with chest pain admitted to floor telemetry beds. *Am J Emerg Med*. 2003;21(4):282–287.
23. Katz DA, Williams GC, Brown RL, et al. Emergency physicians' fear of malpractice- tice in evaluating patients with possible acute cardiac ischemia. *Ann Emerg Med*. 2005;46(6):525–533.
24. Pines JM, Isserman JA, Szyld D, Dean AJ, McCusker CM, Hollander JE. The effect of physician risk tolerance and the presence of an observation unit on decision making for ED patients with chest pain. *Am J Emerg Med*. 2010;28(7):771–779.
25. HCUP Tools and Software. Health Care Cost & Utilization Project (HCUP). Agency for Healthcare Research and Quality, Rockville, MD. Available at: https://www.hcup-us.ahrq.gov/tools_software.jsp. Accessed July 2, 2012.