Weekend and Holiday Exercise Testing in Patients with Chest Pain

Richard A. Krasuski, MD, L. Howard Hartley, MD, Thomas H. Lee, MD, MSc,
Carisi A. Polanczyk, MD, MSc, Kirsten E. Fleischmann, MD, MPH

OBJECTIVE: To determine the outcome, safety, and possible cost savings of patients undergoing weekend or holiday exercise treadmill testing.

DESIGN: Medical records of all 195 patients scheduled for weekend and holiday exercise testing were reviewed, and 77.9% of patients were contacted by telephone to ascertain medical outcomes and need for further emergency department or inpatient care. Costs were calculated from estimates of days of hospitalization saved and incremental costs incurred in conjunction with weekend or holiday testing.

SETTING: Urban tertiary care academic medical center.

PATIENTS: A total of 195 patients were scheduled for testing, and 181 tests were performed. Over three quarters (75.1%) of patients underwent testing for assessment of chest pain. Other indications included risk stratification after myocardial infarction or coronary angioplasty or prior to noncardiac surgery, or evaluation for arrhythmias, dyspnea, or syncope.

MEASUREMENTS AND MAIN RESULTS: Outcomes included results and complications of testing, hospital course after testing, subsequent emergency department visits and readmissions, myocardial infarction, need for cardiac catheterization or revascularization, and mortality. No complications were noted during testing. In 136 patients tested for the indication of chest pain, 90 (66.2%) had negative tests, 39 (28.7%) were intermediate, and 6 (4.4%) were positive for ischemia. Same day discharge occurred in 115 (84.6%) of the patients, saving an estimated 185 days of hospitalization (\$316.83 per patient tested). Event rates over the 6 months following discharge were low.

CONCLUSIONS: Weekend and holiday exercise testing is a safe and effective means of risk stratification prior to hospital discharge for patients with chest pain. It also reduces length of stay and is cost saving.

KEY WORDS: exercise testing; prognosis; cost-benefit analysis; chest pain.

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Received from the Cardiovascular Division (LHH, THL, CAP, KEF) and the Section of Clinical Epidemiology (THL), Department of Medicine (RAK), Brigham and Women's Hospital and Harvard Medical School, Boston, Mass.

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Address correspondence and reprint requests to Dr. Fleischmann: Cardiology Division, UCSF Medical Center, 505 Parnassus Ave., San Francisco, CA 94143-0214.

The efficacy and safety of exercise treadmill testing (ETT) as a tool for risk stratification in patients with chest pain is well established.^{1,2} Despite widespread availability of exercise laboratories, testing is usually limited to weekday hours when hospital facilities are fully staffed. Unfortunately, this often necessitates hospitalization of a patient admitted for evaluation of chest pain until further diagnostic testing can be performed. Brigham and Women's Hospital in Boston, Massachusetts, recently began a trial of exercise testing on weekends and holidays. To evaluate the safety, efficacy, and potential cost savings of weekend and holiday exercise testing in patients admitted for the evaluation of chest pain, we reviewed the records of the 195 patients scheduled for testing during the first year, the majority of whom were tested for the indication of chest pain.

METHODS

Patient Population and Procedures

Medical staff at Brigham and Women's Hospital were informed of the availability of exercise testing during a defined 4-hour period on each weekend day and holiday. Of 111 additional days of testing offered, 82 were utilized. A total of 195 tests were scheduled; 14 were canceled for medical reasons. Patients exercised using the standard and modified Bruce protocols. The laboratory was staffed by a cardiovascular technician, a cardiology fellow and/or a cardiology attending. Prior to testing, fellows were asked to fill out a questionnaire concerning the perceived necessity of testing individual patients before discharge.

Data Collection

We reviewed the medical records of patients scheduled for weekend and holiday exercise tests over the first year of testing (November 1994 to November 1995). Demographic information including age, gender, and the indication for testing was collected. Results of ETT were extracted. Tests were considered negative if the patient reached a sufficient workload (heart rate $\geq$ 85% of predicted) or completed the protocol without significant symptoms or electrocardiographic evidence of ischemia. Tests were considered intermediate for ischemia if electrocardiographic changes consistent with but not diagnostic of ischemia (e.g., 1 mm horizontal or downsloping ST depression) or typical chest pain occurred during exercise, or if the patient was unable to attain an adequate workload to exclude ischemia. Positive tests included those highly predictive of significant coronary artery disease or

strongly positive tests suggesting multivessel or left main artery disease. Tests were defined as highly predictive if at least 2 mm horizontal or downsloping ST depression was seen or if the patient developed a 1-mm ST depression in conjunction with typical chest pain. Strongly positive tests required a fall in blood pressure with exercise, marked ST changes in multiple leads, or prolonged, persistent ST changes in recovery.

The posttest hospital course was examined for evidence of adjustment in cardiac medications or other cardiovascular testing and intervention prior to discharge, as well as for return visits and hospitalizations after discharge. A substantial portion of the patient population belonged to a large health maintenance organization, Harvard Community Health Care Plan (now known as Harvard Pilgrim Health Care). Permission was obtained to review the records of patients belonging to this organization for evidence of further hospitalization following discharge. Finally, efforts were made to reach each patient by telephone. Verbal consent was obtained from each patient prior to asking a standard set of questions regarding the need for medical attention, hospitalization, or further cardiac intervention following ETT.

Follow-up was divided into 30-day and 6-month periods. End points at 30 days included the need for emergency department visits and hospitalization. End points of myocardial infarction, cardiac catheterization, percutaneous transluminal coronary angioplasty (PTCA), coronary artery bypass grafting (CABG), and survival were collected for the 6-month period.

Hospital Days Saved

We assumed that if testing were not available on weekends and holidays, patients would have been hospitalized until the following weekday for testing. For patients tested for preoperative risk stratification, the assumption was made that a single day of hospitalization was saved if the patient was able to go to the operating room on the next weekday morning.

Follow-Up Characteristics

The average length of follow-up $\pm$ SD was 481.4 ± 165.1 days. Of the 195 patients initially scheduled for test-

ing, 187 (95.9%) had survival confirmed 6 months following discharge. Of the five deaths identified, none was within 6 months of hospital discharge. The modes of follow-up utilized are listed in Table 1. Of 195 patients, 77.9% were successfully contacted by telephone, and at least one form of follow-up was available for 95.9%.

RESULTS

Mean age $\pm$ SD for the exercised cohort was 59.3 ± 13.5 years (range 25–90 years), and 55.8% were male (Table 2). Fifty-three percent of patients belonged to HMOs, with Medicare (18.2%) and Blue Cross/Commercial insurance (11.6%) less common. Over three quarters (75.1%) of patients had ETT for the indication of chest pain. Other indications included risk stratification after myocardial infarction or coronary angioplasty (13.3%) and evaluation for arrhythmias (5.5%), dyspnea (3.3%), and syncope (1.7%). Two patients (1.1%) were tested to provide risk stratification prior to noncardiac surgery.

Demographic data are also given for a control group of 182 patients, on whom we have reported previously.³ These patients presented with chest pain during an overlapping period (November 1994 to June 1995), were felt to be at low risk or very low risk of cardiac events as defined by Goldman et al.,⁴ and underwent ETT on weekdays within 48 hours of presentation. The demographic information for these patients was very similar to that for the cohort studied (Table 2).

Before ETT was performed, fellows were asked to review each case individually and grade the perceived necessity of testing, also commenting on whether it required an inpatient setting. Of the 181 questionnaires, 133 were completed. One hundred five (78.9%) of the 133 patients were felt to have a clear indication for testing prior to discharge. Twenty-five patients (18.8%) were felt to be appropriate for testing, although testing could safely await an outpatient appointment. Three tests (2.3%) were not felt to be clinically indicated.

Table 2. Baseline Characteristics of the Weekend and Holiday Exercised Cohort and Weekday Control Group

Characteristic	Exercised Cohort (n = 181)	Control Group* (n = 182)
Age, years		
Range	25–90	32–89
Mean $\pm$ SD	59 ± 14	55 ± 13
Insurance, n (%)		
Commercial/Blue Cross	21 (12)	28 (15)
HMO	96 (53)	89 (49)
Medicare	33 (18)	23 (13)
Medicaid/Welfare/ free care/self-pay	31 (17)	42 (23)

*A cohort of low-risk patients presenting with acute chest pain who underwent exercise treadmill testing within 48 hours of presentation on weekdays (see text for details).

Table 1. Modes of Six-Month Follow-Up

Mode	Eligible Patients (n = 195)		Exercised Patients (n = 181)	
	n	%	n	%
Chart and computerized record	100	51.3	92	50.8
HPHC computerized record*	83	42.6	77	42.5
Phone call	152	77.9	142	78.5
Any form	187	95.9	173	95.6

*HPHC indicates Harvard Pilgrim Health Care.

Table 3. In-Hospital Outcomes

Outcomes	Chest Pain Cohort* (n = 136), n (%)	Exercised Cohort† (n = 181), n (%)	Control Group‡ (n = 182), n (%)
Same-day discharge	115 (84.6)	143 (79.0)	147 (80.8)
Cardiac catheterization	6 (4.4)	9 (5.0)	10 (5.5)
Percutaneous transluminal coronary angioplasty	3 (2.2)	5 (2.8)	1 (0.5)
Coronary artery bypass grafting	2 (1.5)	3 (1.7)	0 (0.0)

*Patients exercised holidays and weekends for the indication of chest pain.

†All patients exercised on holidays and weekends regardless of indication.

‡A cohort of low-risk patients presenting with acute chest pain who underwent exercise treadmill testing within 48 hours of presentation on weekdays (see text for details).

In the 136 patients tested for the indication of chest pain, 90 (66.2%) had negative tests, 39 (28.7%) were intermediate, and 6 (4.4%) were positive for ischemia. A total of 115 patients (84.6%) were discharged on the day of testing, a similar proportion to the chest pain patients exercised on weekdays (Table 3). Of 90 patients with negative exercise tests, 88 were discharged home the same day. In addition, 9 of 11 patients without symptoms or electrocardiographic changes at low workloads were discharged the same day. Of 28 patients whose tests were consistent with but not diagnostic of ischemia, 17 were discharged the same day, 7 underwent further adjustment of their medication regimen, and 2 went on to cardiac catheterization and CABG. One was able to have previously scheduled noncardiac surgery. Of six patients with positive or strongly positive tests, two had their medications adjusted and four underwent cardiac catheterization, with subsequent PTCA in three patients.

Within 30 days of discharge 13 (9.6%) of the 136 patients returned to the emergency department; 5 of these visits were for assessment of chest pain (Table 4). One visit was by a patient with a negative previous exercise test, the other four were by patients with tests intermediate for ischemia. Of nine patients (6.6%) hospitalized over this period, four were hospitalized for chest pain. Of the four patients, three had exercise tests during the previous admission that were intermediate for ischemia and one

had a negative test. Event rates over the 6 months following discharge were low (Table 4) and comparable to those in chest pain patients tested on weekdays. No patient died within the 6-month window.

In the 45 patients exercised for indications other than chest pain, 27 (60.0%) had negative tests, 2 (4.4%) had tests negative for evidence of ischemia but with significant arrhythmia, 11 (24.4%) had tests intermediate for ischemia, and 5 (11.1%) had positive tests. Of 27 patients with negative results, 22 were discharged the same day, and 1 was able to proceed with noncardiac surgery. The two patients with arrhythmia during the test had their medications adjusted. Of 11 patients with intermediate tests, 5 were discharged the day of testing, 3 had their cardiac medications adjusted, and 1 went on to cardiac catheterization. Two were exercise tested again prior to discharge.

Over the ensuing 30 days, three patients presented to the emergency department and were readmitted, in one instance for chest pain (previous exercise test negative). Six-month revascularization rates remained low (Table 4), and no patient died.

Using the assumptions outlined above, weekend and holiday exercise testing saved a total of 185 hospital days in patients with chest pain, an average of 1.4 days per patient. The incremental expenditures required to operate the exercise laboratory on weekends included the fees for

Table 4. Thirty-Day and Six-Month Outcomes

Outcome	Chest Pain Cohort (n = 136), n (%)	Total Cohort (n = 181), n (%)	Control Group (n = 182), n (%)
Within 30 days			
Emergency dept. visit	13 (9.6)	16 (8.8)	—
Emergency dept. visit for chest pain	5 (3.7)	6 (3.3)	—
Hospitalization	9 (6.6)	12 (6.6)	—
Hospitalization for chest pain	4 (2.9)	5 (2.8)	—
Within 6 months			
Myocardial infarction	1 (0.7)	1 (0.6)	4 (2.2)
Cardiac catheterization	3 (2.2)	7 (3.9)	9 (4.9)
Percutaneous transluminal coronary angioplasty	2 (1.5)	5 (2.8)	5 (2.7)
Coronary artery bypass grafting	0 (0.0)	0 (0.0)	3 (1.6)
Death	0 (0.0)	0 (0.0)	0 (0.0)

technical personnel (a yearly total of \$5,121.52) and the professional coverage fee of \$40 per test (total of \$5,440), for a sum of \$10,561.52. We based the cost of hospitalization solely on the cost of occupying a routine medical bed (\$290) at the Brigham and Women's Hospital. Multiplying this total by the 185 days of hospitalization saved, testing prevented \$53,650.00 of hospitalization costs for a net savings of \$43,088.48. This amounted to a savings of \$316.83 per patient tested.

For the cohort overall, 238 days of hospitalization were saved during the first year, an average of 1.3 days per test performed. Thus, testing prevented at least \$69,020 of hospitalization costs for a net savings of \$56,658.48, or \$313.03 per patient tested.

DISCUSSION

The current analysis assesses the feasibility, safety, and outcomes, including the cost implications, of a weekend and holiday ETT program. The results demonstrate that such a program is logistically feasible and that patients tested are comparable in demographics and outcomes to patients tested on weekdays, implying that the program neither paradoxically increases utilization nor significantly changes the population being tested. These data are increasingly important as hospitals are pressured to provide efficient diagnosis and treatment with a full range of services on weekends and weekdays alike. Our data also suggest that weekend and holiday testing is cost saving under a wide range of assumptions.

The safety and efficacy of ETT has been well established in the 28 years since the landmark survey of Rochmis and Blackburn on the techniques, safety, and litigation experience of 170,000 exercise tests in 73 medical centers.⁵ Early reports were unfortunately limited by discrepancies in technique from the institutions participating in the large surveys.^{6,7} The examination of large single-center cohorts has indicated a low and rapidly declining incidence of complications (less than a single cardiovascular complication per 10,000 tests).^{8,9} It was therefore expected but reassuring that no complications occurred in our exercised cohort.

Our study also lends insight into the in-hospital and postdischarge course of patients undergoing weekend and holiday ETT for stratification of chest pain. The proportion of patients discharged on the day of testing with a low event rate over the following 6 months was significant. For patients subsequently seeking medical attention in emergency departments, most visits were not related to chest pain. The absence of deaths in the 6-month follow-up period is consistent with a properly stratified, low-risk population.

A concern with any newly developed technology or technique is overuse. Weekend ETT is technically identical to weekday testing, making this less of an issue. To exclude the possibility that unnecessary testing accounted

for a significant proportion of our cohort, we conducted a candid survey of the physicians administering the test after they had an opportunity to review the patient's chart and before the test was performed. The results demonstrate that the vast majority were felt to be necessary prior to the time of discharge. Moreover, the demographic data and outcomes of a group of patients with chest pain exercised on weekdays were similar to those of the cohort exercised on weekends and holidays, supporting the idea that test-selection criteria were similar on weekends and weekdays.

Another consideration is the cost associated with the procedure itself. Proper testing requires dedicated staffing of exercise facilities by qualified medical personnel. Although the financial burden of operating an exercise laboratory on weekends and holidays is significant, our results demonstrate this is small compared with the cost of additional hospitalization.

This study complements and extends the body of literature available concerning immediate exercise testing of patients who come to the emergency department, typically without a full prior diagnostic evaluation to exclude myocardial infarction.¹⁰⁻¹² Although some overlap between these populations and the patients in the current report appears likely, the current program is not limited to patients at such low risk that formal exclusion of myocardial infarction is considered unnecessary. Moreover, availability of exercise testing on weekends and holidays may make immediate testing of chest pain patients deemed at sufficiently low risk more feasible, a concept incorporated into the critical pathway for low-risk patients with chest pain currently in use at Brigham and Women's Hospital.¹³

These findings must be considered in light of study design features that could affect the results. Although every attempt was made to obtain complete medical records and to contact each patient in the cohort, some outcomes may have been missed. In addition, this report represents the experience at a single urban tertiary care center, and the populations at other types of institutions may vary. Similarly, our estimates of the cost implications of weekend and holiday exercise testing are at least partially driven by the number of tests ordered and performed at our center, and do not represent a formal cost-effectiveness analysis. The costs of staffing and providing medical supervision for such a program may vary from institution to institution, but our data indicate that such a program will most likely save costs under a wide range of cost assumptions. Moreover, the estimates of cost savings were based solely on the costs of room and board associated with additional hospitalization, without adjustment for professional fees or additional testing such as blood work or procedures often performed in an inpatient setting, and thus are likely to be conservative.

Our findings demonstrate that weekend and holiday exercise testing is safe, effective, and cost saving, and is a practice that deserves further consideration as we strive

to provide less expensive medical care without compromising outcome.

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