Incidence of Abnormal Electrocardiograms Which Affected the Changes of Exercise Programs at Outpatient Cardiac Rehabilitation Clinic

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ABSTRACT

Objective: The primary purpose of the study was to determine the incidence of abnormal electrocardiograms (ECGs) which affected the changes of exercise programs. The secondary purpose was to study types of ECG abnormality and the time of detecting the abnormality.

Methods: The study was retrospective design. The studied population was selected from the followed up patients at our outpatient cardiac rehabilitation clinic from October 1, 2008 to May 31, 2009. The inclusion criteria were patients who had to follow up at our outpatient cardiac rehabilitation clinic and were monitored for ECG telemetry. The medical and ECG telemetry records of the patients were reviewed. The incidence of abnormal ECGs was reported as the percentage of patients with abnormal ECGs. The patients with abnormal ECGs were classified as the ECG changing group and those without abnormal ECGs were classified as the non-ECG changing group. The comparison of both groups was performed by Chi-square test for categorical data and the independent samples t-test for the quantitative data. The median survival time was carefully estimated by Kaplan-Meier method of Survival Analysis. The factors associated with time of detecting abnormal ECGs were analyzed by using Cox proportional hazards model. The data analysis was performed with statistical significant difference of the p-value < 0.05.

Results: Five hundred and forty patients, 378 males and 162 females, were enrolled. There were 151 from 540 patients (28%) in the ECG changing group and 389 patients (72%) in the non-ECG changing group. The comparison between two groups indicated that there were no significant differences regarding gender, age, body mass index, diseases and co-morbidities (such as coronary artery disease, cerebrovascular disease, diabetes mellitus, hypertension, dyslipidemia and chronic obstructive lung disease), left ventricular ejection fraction and status of cardiac surgery. The two most common types of ECG abnormality in the ECG changing group were tachyarrhythmia and bradyarrhythmia, respectively. The Cox proportional hazards model revealed that there was no factor associated with time of detecting abnormal ECGs. From the Kaplan-Meier method of Survival Analysis, the median survival time of detecting abnormal ECGs was 61 months (95% CI: 47.6, 74.9).

Conclusion: The incidence of abnormal ECGs which affected the changes of exercise programs in our outpatient cardiac rehabilitation clinic was 28%. The most common type of abnormality was tachyarrhythmia. The median survival time for detecting abnormal ECGs was 61 months after cardiac hospital discharge. There was no associated factor with the time of detecting abnormal ECGs.

Keywords: Incidence, abnormal electrocardiogram, exercise program, cardiac rehabilitation

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Our cardiac rehabilitation program has been categorized as inpatient and outpatient phases. The principles of cardiac rehabilitation program in both phases are exercise prescription and risk factors modification. Before hospital discharge, the patients are prescribed outpatient exercise programs which are viewed more as a continuation from early outpatient to long-term maintenance and are individually determined from an objective evaluation of patients response to exercise, including observations of heart rate, blood pressure and electrocardiograms. The patients with some abnormal ECGs such as ventricular tachycardia, multifocal premature ventricular contraction (PVC), triplets of PVC, paired PVC, third degree atrio-ventricular (A-V) block, bradyarrhythmia, or significant ST-T displacement are recommended either to terminate or change the exercise programs.[1-3]

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Although the American Heart Association (AHA), American College of Sports Medicine (ACSM) and Canadian Association of Cardiac Rehabilitation (CACR) have mentioned the benefits of ECG telemetry such as evaluating the results after hospital discharge, detecting abnormal ECGs and guiding exercise programs, the use of ECG telemetry monitoring for cardiac patients in the outpatient phase is still unclear.[4-6]

In Siriraj Hospital, all patients who have been followed up at the outpatient cardiac rehabilitation clinic are monitored with ECG telemetry. However, the abnormal ECGs that affect the changes of exercise programs in these patients have never been studied. Furthermore, ECG telemetry is not available for all cardiac rehabilitation clinics and is also costly and labor-intensive.[7] Therefore, the primary purpose of this study was to determine the incidence of abnormal ECGs which affected the changes of exercise programs. The secondary purpose was to study the types of ECG abnormality and time of detecting abnormal ECGs.

MATERIALS AND METHODS

The present study was designed to be retrospective and was conducted after approval of Siriraj Hospitals Ethics Committee (Si. 661/2008). The studied population was selected from the followed up patients at our outpatient cardiac rehabilitation clinic from October 1, 2008 to May 31, 2009. The inclusion criteria were the patients had to follow up at outpatient cardiac rehabilitation clinic and to have ECG telemetry monitoring. The sample size was 540 patients, given that the estimated incidence of abnormal ECGs was 3.2%. From the recorded number of patients coming to the outpatient cardiac rehabilitation clinic, a retrospective 8 months review would provide the total number of the sample size.

The medical and ECG telemetry records of the patients were reviewed and kept in the record forms that consisted of two parts. The first part concerned patient characteristics (e.g. age, gender and body mass index), diseases and co-morbidities (e.g. coronary artery disease, cerebrovascular disease, hypertension, diabetes, dyslipidemia, and chronic obstructive pulmonary disease), left ventricular ejection fraction and status of cardiac surgery. The second part concerned the aspects relating the ECG telemetry records such as types of the ECG abnormality and time of detecting abnormal ECGs that were recorded by the physiatrist specialized in cardiac rehabilitation.

Abnormal ECGs were defined as the first time abnormal ECGs which affected the changes of exercise programs observed at the cardiac rehabilitation clinic. The time of detecting abnormal ECGs was defined as the duration from the date of hospital discharge to the date of having the abnormal ECGs. The median survival time of detecting abnormal ECGs was defined as the time at which 50% of the patients in the ECG changing group developed abnormal ECGs. The incidence of abnormal ECGs was reported as percentage of patients with the abnormal ECGs. The patients with abnormal ECGs were classified as the ECG changing group and those without abnormal ECGs were classified as the non-ECG changing group. The comparison of both groups was performed by chi-square test for categorical data and the independent samples t-test for the quantitative data. The median survival time was carefully estimated by the Kaplan-Meier method of Survival Analysis. The factors associated with the time of detecting abnormal ECGs were analyzed by using the Cox proportional hazards model. The data analysis was performed with statistical significant difference of the p-value < 0.05.

RESULTS

Five hundred and forty patients who followed up at the outpatient cardiac rehabilitation clinic were included. There were 378 (70%) males and 162 (30%) females. Just over a half of the 540 patients (53.3%) were more than 65 year-old. Almost 60% of all patients had a body mass index (BMI) higher than 23 kg/m^2, whereas just over 30% had a BMI between 18 and 23 kg/m^2. More than three-quarters of the patients had coronary artery disease and over 60% of them had hypertension and dyslipidemia. Less than 10% had cerebrovascular disease and approximately 2% had chronic obstructive pulmonary disease. The patients with Ejection fraction (EFs) more than fifty percent were 391 (72.4%). Most of the patients (97.8%) underwent cardiac surgery such as coronary artery bypass graft (CABG) and valve surgery (Table 1).

There were 151 from 540 patients (28%) in the ECG changing group and 389 patients (72%) in the non-ECG changing group. Comparison between these two groups indicated that there were no significant differences regarding gender, age, body mass index, diseases and comorbidities (such as coronary artery disease, cerebrovascular disease, diabetes mellitus, hypertension, dyslipidemia and chronic obstructive lung disease), left ventricular ejection fraction and status of cardiac surgery (Table 1).

Related to the ECG changing group, 151 patients were recommended to change their exercise programs. There were 27 of 151 patients referred to cardiologists for further investigation and management and one of 27 patients was admitted to the intensive care unit (Table 2).

Regarding the types of abnormal ECGs, 151 patients had 165 abnormal ECGs and 14 patients had more than one type of abnormality. The two most common types of ECG abnormality in ECG group were sinus tachycardia and sinus bradycardia, respectively. The most frequently found ECGs of the patients who were referred to cardiologist was atrial fibrillation with rapid ventricular rate. In addition, the abnormal ECG of the patient admitted to the intensive care unit was sinus tachycardia (Table 3).

The Cox proportional hazards model revealed that there was no factor associated with the time of detecting abnormal ECGs. From the Kaplan-Meier method of Survival Analysis, the median survival time of detecting abnormal ECGs was 61 months (95% CI: 47.6, 74.9) (Fig 1).

DISCUSSION

In this study, bradyarrhythmia was sinus node or non-sinus node initiated heart rate less than 60 beats per minute (bpm.) before, during or post exercise whereas tachyarrhythmia was sinus node or non-sinus node initiated heart rate higher than 100 bpm. before or post exercise. Complex ventricular ectopy included paired premature ventricular contraction (PVC), triplet of PVC, frequent or increasing ventricular bigeminy or trigeminy and multifocal PVC before, during and post exercise. In addition, the significant ST-T displacement had to be more than 2 millimeters (compared with resting ECG configuration). Relating ECG telemetry in the study, the 12-lead ECG was obtained by EASI method which indicated that it was

TABLE 1. The demographic data and comparison between non-ECG changing and ECG changing groups.

Variables	Total (N=540)	Non-ECG changing group (N=389)	ECG changing group (N=151)	P-value
Sex				0.94
Male	378 (70.00)	270 (69.41)	108 (71.52)	
Age (years)				0.88
≥ 65	288 (53.33)	206 (52.96)	82 (54.30)	
BMI (kg/m^2)				0.26
<18	23 (4.26)	14 (3.60)	9 (5.97)	
18-23	169 (31.30)	125 (32.13)	44 (29.13)	
>23	321 (59.44)	236 (60.67)	85 (56.29)	
NA	27 (5.00)	14 (3.60)	13 (8.61)	
Disease				
CAD	421 (77.96)	310 (79.70)	111 (73.5)	0.91
CVD	47 (8.70)	35 (9.00)	12 (7.95)	0.58
DM	202 (37.41)	151 (38.82)	51 (33.75)	0.22
HT	375 (69.44)	280 (71.98)	95 (62.91)	0.98
DLP	356 (65.93)	263 (67.61)	93 (61.59)	0.32
COPD	10 (1.85)	9 (2.31)	1 (0.66)	0.31
Smoking	116 (21.48)	84 (21.59)	32 (21.19)	0.98
EF (%)				0.38
<30	30 (5.55)	20 (5.14)	10 (6.62)	
30-50	98 (18.15)	66 (16.97)	32 (21.19)	
≥ 50	391 (72.41)	285 (73.26)	106 (70.20)	
NA	21 (3.89)	18 (4.63)	3 (1.99)	
Surgical status				0.10
Yes	528 (97.78)	383 (98.5)	145 (96.6)	
	12 (2.22)	6 (4.00)	6 (4.00)	

Note: NA = Not available, CAD = Coronary artery disease, CVD = Cerebrovascular disease, DM = Diabetes mellitus, HT = Hypertension, DLP = Dyslipidemia, COPD = Chronic obstructive pulmonary disease

TABLE 2. Management in non-ECG changing and ECG changing groups.

Management	Number	%
Non-ECG changing group		
Not to change exercise program	389	72
ECG changing group		
To change exercise program	151	28
To change exercise program and refer to cardiologist	27	5
To change exercise program but not refer to cardiologist	124	23
Total	540	100

TABLE 3. Types of abnormal ECGs.

Types of abnormal ECGs	To change exercise program but not refer to cardiologist Number (%)	To change exercise program and refer to cardiologist Number (%)	Total Number (%)
Bradyarrhythmia	37 (27.01)	9 (32.14)	46 (27.89)
Sinus bradycardia	37 (27.01)	8 (28.57)	45 (27.27)
Junctional bradycardia	0 (0.00)	1 (3.57)	1 (0.61)
Tachyarrhythmia	58 (42.34)	14 (50)	72 (43.63)
Sinus tachycardia	44 (32.12)	1 (3.57)	45 (27.27)
Atrial fibrillation	12 (8.76)	11 (39.29)	23 (13.94)
Atrial flutter	2 (1.46)	1 (3.57)	3 (1.82)
Ventricular tachycardia	0 (0.00)	1 (3.57)	1 (0.61)
Ventricular ectopy	28 (20.43)	4 (14.29)	32 (19.39)
Bigeminy	9 (6.57)	3 (10.72)	12 (7.27)
Trigeminy	6 (4.37)	0 (0.00)	6 (3.64)
Multifocal PVC	10 (7.30)	1 (3.57)	11 (6.67)
Paired PVC	2 (1.46)	0 (0.00)	2 (1.21)
Triplet	1 (0.73)	0 (0.00)	1 (0.61)
ST-T displacement	14 (10.22)	1 (3.57)	15 (9.09)
Total	137 (100)	28 (100)	165 (100)

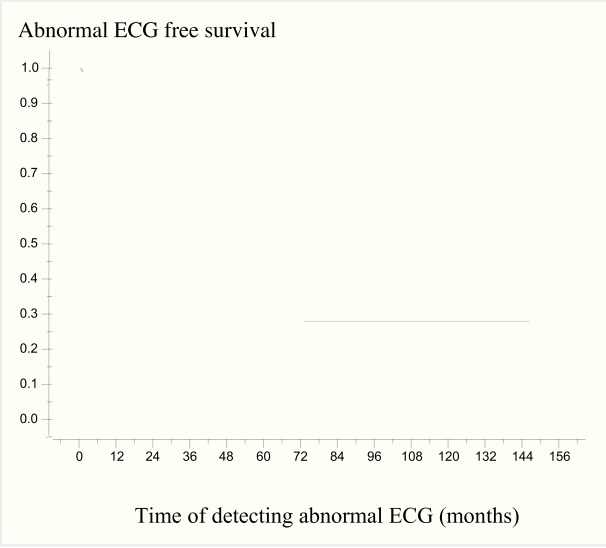

Fig 1. Time of detecting abnormal ECG

comparable to the standard 12-lead ECG for detection of arrhythmia and ischemia.[8-12]

The study showed that the incidence of abnormal ECGs which affected the changes of exercise programs among the patients in outpatient cardiac rehabilitation was 28%. However, physiatrists who were specialized in cardiac rehabilitation referred the patients just 5% to cardiologists for further management and investigation. The patients, who were referred to cardiologists, had either symptoms related to the abnormal ECGs or significant cardiac arrhythmia even though they had no symptom (such as ventricular tachycardia or bradycardia less than 40 bpm.).

Actually, the exercise programs themselves could induce changes in ECGs such as minor changes in P wave morphology, increases in T wave amplitude, depression of the J point and increases in heart rate during exercise. In addition, some changes in ECG wave morphology might occur from underlying pathology. For example, QRS duration might increase during exercise in patients with left ventricular dysfunction. The presence of left ventricular hypertrophy might result from valvular heart disease or hypertension, as well as conduction disturbances.[5,13] However, these changes were the normal ECG responses to exercise and did not affect the change of exercise program. In addition, resting ECG abnormalities might compromise the diagnostic accuracy of the exercise ECG.[13]

The authors found that there was no factor associated with the time of detecting abnormal ECGs even the left ventricular ejection fraction, despite the fact that it was the significant factor which classified the patients into mild, moderate or severe groups.[5] However, this study was a retrospective review and the information could not be completely recorded.

In Siriraj Hospital, the patients at the outpatient cardiac rehabilitation clinic would be followed up two to four weeks after their hospital discharges at the first time, and then followed up every three month in the first year. They would be followed up every six months in the second and third years, and once a year afterwards. Related to median survival time, it was 61 months or about 5 years after hospital discharge that fifty percent of the patients in the ECG changing group developed the abnormal ECGs which affected the changes of exercise programs. Therefore, ECG telemetry monitoring for this period would still detect abnormal ECGs. However, the appropriate duration of ECG telemetry monitoring for the patients in each outpatient cardiac rehabilitation clinic should depend on other factors such as the availability of the resources. A prospective study for confirmation of our results would be desirable.

CONCLUSION

The incidence of abnormal ECGs which affected the changes of exercise programs in outpatient cardiac rehabilitation clinic was 28%. The most common type of abnormality was tachyarrthymia. The median survival time of detecting abnormal ECGs was 61 months after cardiac hospital discharge. There was no associated factor with time of detecting abnormal ECGs.

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REFERENCES

1. Fletcher GF, Balady G, Froelicher VF, Hartley LH, Haskell WL, Pollock ML. Exercise standards: a statement for healthcare professionals from the American Heart Association Writing Group. Circulation. 1995 Jan 15;91 (2):580-615.
2. Curry JP, Hanson CW, Russell MW, Hanna C, Devine G, Ochroch A. The use and effectiveness of electrocardiographic telemetry monitoring in a community hospital general care setting. Anesth Analg. 2003 Nov;97 (5):1483-7.
3. Fletcher GF, Balady GJ, Amsterdam EA, Chaitman B, Eckel R, Fleg J, et al. Exercise standards for testing and training: a statement for healthcare professionals from the American heart association. Circulation. 2001 Oct 2;104(14):1694-740.
4. American College of Cardiology/American Heart Association. ACC/AHA 2002 guideline update for exercise testing. J Am Coll Cardiol. 2002;40: 1531.
5. American College of Sports Medicine. ACSMs guidelines for exercise testing and prescription. 7th ed. Baltimore (MD): Lippincott Williams & Wilkins; 2006.
6. Kavanagh T. Cardiac rehabilitation: Canada. In: Perk J, Mathes P, Gohlke H, Monpere C, Hellemans I, McGee H, Sellier P, Saner H, editors. Cardiovascular prevention and rehabilitation. London: Springer; 2007. p. 37-40.
7. Henriques MN, Ivonye CC, Jamched U, Kamuguisha LK, Olejeme KA, Onwuanyi AE. Is telemetry overused? Is it as helpful as though? Cleve Clin J Med. 2009 Jun;76(6):368-72.
8. Drew BJ, Scheinman MM, Evans GT Jr. Comparison of a vectrocardiographically derived 12-lead electrocardiogram with the conventional electrocardiogram during wide QRS complex tachycardia and its potential application for continuous bedside monitoring. Am J Cardiol. 1992 Mar 1;69(6):612-8.
9. Denes P. The importance of derived 12-lead electrocardiography in the interpretation of arrhythmias detected by Holter recording. Am Heart J. 1992 Oct;124(4):905-11.
10. Drew BJ, Adams MG, Pelter MM, Wung SF. ST-segment monitoring with a derived 12-lead electrocardiogram is superior to routine CCU monitoring. Am J Crit Care. 1996 May;5(3):198-206.
11. Drew BJ, Adams MG, Pelter MM, Wung SF, Caldwell MA. Comparison of standard and derived 12-lead electrocardiograms for diagnosis of coronary angioplasty induced myocardial ischemia. Am J Cardiol. 1997 Mar 1;79(5):639-44.
12. Drew BJ, Pelter MM, Wung SF, Adams MG, Taylor C, Evans GT, et al. Accuracy of the EASI 12-lead electrocardiogram compared to the standard 12-lead electrocardiogram for diagnosing multiple cardiac abnormalities. J Electrocardiol. 1999;32 Suppl:38-47.
13. Adamopoulos S, Fountoulaki K, Parissis J. Exercise testing in coronary heart disease. In: Perk J, Mathes P, Gohlke H, Monpere C, Hellemans I, McGee H, Sellier P, Saner H, editors. Cardiovascular prevention and rehabilitation. London: Springer; 2007. p. 88-98.