Internacional Journal of Cardiovascular Sciences. 2015;28(1):70-77

ORIGINAL MANUSCRIPT

Safety of the Six-Minute Walk Test in Hospitalized Cardiac Patients

Pryscilla Alves Ferreira[1], Palmireno Pinheiro Ferreira[1], Anne Karine Menezes Santos Batista[2], Fernanda Warken Rosa[3]

[1]*Universidade Federal da Bahia - Hospital Universitário Professor Edgard Santos - Serviço de Fisioterapia - Salvador, BA - Brazil*
[2]*Secretaria de Saúde do Estado da Bahia - Programa de Residência em Fisioterapia Hospitalar - Salvador, BA - Brazil*
[3]*Universidade do Estado da Bahia - Departamento de Ciências da Vida - Salvador, BA - Brazil*

Abstract

Background: There is no evidence in the literature to attest the safety of the six-minute walk test (6MWT) in hospitalized cardiac patients.
Objective: To identify adverse events during the course of the 6MWT in hospitalized cardiac patients.
Methods: This is an observational, cross-sectional, conducted in 30 patients with heart disease who were hospitalized. Two 6MWT practices were carried along a 20-meter corridor. The distance traveled, the cardiorespiratory parameters and signs of intolerance to physical exertion were collected. The adverse effects identified in both practices were classified as non-cardiopulmonary and cardiopulmonary, and in the latter group, divided into non-serious and serious.
Results: Adverse effects were observed in both 6MWT practices in 15 (50.0%) patients, and the following were identified: lower limb (LL) arthralgia, palpitation, dyspnea, desaturation, dizziness, nausea, hypotension, bradycardia, and numbness in the left arm. Of the 30 patients, 4 (13.3%) patients presented severely adverse effects. All of the 4 (100%) patients had hypertension (SAH) and 3 (75%) were diagnosed with coronary artery disease (ICO) and dyslipidemia (DLP).
Conclusion: In the 6MWT, a low frequency of serious adverse events was found in cardiac patients hospitalized two days after admission.

Keywords: Patient safety; Heart diseases; Walking

Introduction

Walk tests have been widely used since 1960[1]. A number of these are found in the literature. The six-minute walk test (6MWT) is considered the best-tolerated one and the one that best represents daily activities because it characterizes submaximal stress[2,3].

Completion of the 6MWT may be associated with several objectives, namely: assessing response to therapeutic procedures; obtaining an indicator of functional capacity; and predicting morbidity and mortality in patients with respiratory and cardiovascular diseases[1]. With these purposes, the 6MWT has been widely researched in cardiac patients in the outpatient setting, especially in patients with chronic heart failure (CHF)[4].

However, there are few reports in the literature on the safety of performing the 6MWT, especially in hospitalized patients. Gerson et al.[5] evaluated the safety of the 6MWT in 20 patients followed in the outpatient care diagnosed with refractory CHF and indication of elective cardiac transplantation. They observed the occurrence of pain in the lower limbs (LL), dyspnea, chest pain, palpitations and dizziness. A study by Nogueira et al.[6] evaluated the safety of 6MWT in patients with acute myocardial

Mailing address: Pryscilla Alves Ferreira
Rua Augusto Viana, s/nº - Canela - 40110-060 - Salvador, BA - Brazil
E-mail: pryscillaferreira@yahoo.com.br

DOI: 10.5935/2359-4802.20150010

Manuscript received on August 2, 2014; approved on January 28, 2015; revised on February 11, 2015.

infarction (AMI) and observed complaints of chest pain among the patients assessed.

Hospitalized patients often experience bed rest and, mobilization, at first, may be associated with postural hypotension [7]. Dias et al.[7] found this adverse event when they evaluated patients hospitalized for acute coronary syndrome (ACS). However, this assessment did not use 6MWT, but it was done through a walk limited by a 50-minute distance. In addition, the cause of hospitalization in a cardiology unit, for example, for decompensated CHF, surgery, chest pain or other reasons, may make patients more susceptible to risks associated with mobilization.

The 6MWT has few reports describing its adverse effects, especially when applied to hospitalized patients diagnosed with heart disease. More specific scientific knowledge about the safety of 6MWT in patients with heart disease could minimize the appearance of adverse clinical responses.

Thus, the objective of this study was to identify adverse events during the course of the 6MWT in hospitalized patients diagnosed with heart disease and present the clinical characteristics of these patients.

Methods

This is an observational cross-sectional study held in the cardiology ward of a federal university hospital in Salvador, BA, between December 2011 and February 2012.

The study was approved by the Research Ethics Committee from Hospital Universitário Professor Edgard Santos under no. 66/2011 and all participants signed an Informed Consent Form.

Consecutive convenience sampling included patients aged ≥18 years, with heart disease confirmed in medical records, clinically authorized to perform the 6MWT and oriented in time and space. The study excluded those with musculoskeletal abnormalities that prevented the walk, those under continuous oxygen therapy and those who were hospitalized for any periods shorter than the period required to complete the evaluation.

Once medical authorization to walk was obtained, clinical data were collected (diagnosis of admission, comorbidities, height, weight, medications taken, among others) from the patients' records. Then, the 6MWT was performed through two practices: the first one was intended to make the patient familiar with the technique and, after a 15-minute break and/or recovery of baseline physiological parameters, the second practice was initiated.

Before each 6MWT, the patient remained seated for at least five minutes while receiving the instructions for the test. Then, in the standing position, the following were measured: systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), peripheral oxygen saturation (SpO_2) and subjective perception of respiratory effort and LL. Once the 6MWT started, HR, SpO_2 and signs of intolerance to exercise were recorded minute by minute such as pain, dizziness, paleness, palpitations, dyspnea, etc. These variables were also evaluated if the patient stopped walking. Immediately after completion or interruption of the 6MWT and after two minutes of recovery, the pre-test variables were measured again.

If the patient had any symptoms or severe event such as severe dizziness, bradycardia, symptomatic hypotension, chest pain, among others, that could put him/her at risk, immediate interruption, referral of the patient to the bed, communication of the event to the medical and nursing staff and completion of the procedures necessary to stabilize the conditions were planned.

The distance covered was obtained at the end of the 6MWT. During the test, the patient walked for six minutes along a 20-meter corridor, flat and straight, in the ward, under standardized verbal stimuli every minute. The patient was instructed to walk as fast as he/she could and could not run, with the possibility of stopping to rest without any interruption of the test[3].

The identification of adverse effects was carried out from a subjective assessment based on signs and symptoms; and an objective assessment based on cardiorespiratory monitoring. The adverse effects related to the completion of the 6MWT included: chest pain, decreased HR,

ABBREVIATIONS AND ACRONYMS

- *DLP – dyslipidemia*
- *AF – atrial fibrillation*
- *HR – heart rate*
- *PAH – pulmonary arterial hypertension*
- *CHF – chronic heart failure*
- *CAD – coronary artery disease*
- *LL – lower limbs*
- *DBP – diastolic blood pressure*
- *SBP – systolic blood pressure*
- *SpO_2 – peripheral oxygen saturation*
- *6MWT – six-minute walk test*

increased DBP, increased DBP > 120 mmHg in normotensive patients or > 140 mmHg in hypertensive patients, sustained decline of symptomatic SBP, increased SBP > 200 mmHg, decreased SpO_2 < 90%, dizziness, pallor, nausea, sweating, palpitations, pre-syncope, dyspnea, loss of invasive devices, fall, pain, among others that occurred at any time during the two 6MWT practices[8].

The adverse effects identified in the 6MWT were classified according to their origin into no cardiopulmonary and cardiopulmonary. In the latter group, adverse events were grouped into non-severe and severe, that is, those that required rest or immediate therapeutic measures.

For monitoring the subjective perception of respiratory effort and LL fatigue, the Borg scale was used[9]. The measurement of SBP and DBP was performed with digital sphygmomanometer (G-TECH®, Plymouth — USA), using the guidelines contained in its manual. HR and SpO^2 were obtained by pulse oximetry (Nonin®, Providence — USA). The duration of the walk was measured using a digital stopwatch.

Data were analyzed using the statistic software SPSS version 17. Categorical variables were expressed as absolute values and in percentages and the continuous variables were expressed in measurements of central trend and dispersion.

Results

Initially, the study included 49 patients and excluded the following: 10 patients for inability to walk, 5 for being discharged before the test, 3 for refusal and 1 for using continuous oxygen therapy. Hence, the analysis included 30 patients: 9 men and 21 women.

Table 1 presents the clinical characteristics of the patients with heart disease.

Table 2 presents the following variables: body mass index (BMI), medical diagnosis on admission, definition of treatment, comorbidities, functional class of CHF and medicines used.

Table 1
Clinical characteristics of the patients studied

Variables	Mean±SD	Min	Max	Median
Age (years)	58.5±13.4	23	84	57
BMI (kg/m²)	25.1±4.6	17	35	24
Ejection fraction (%)*	58.8±13.8	29	77	63
Time between admission and completion of the 1st 6MWT (days)	2.9±3.0	1	14	2
Distance covered in the 1st 6MWT (m)	295.9±81.6	160	454	293
Distance covered in the 2nd 6MWT (m) †	322.8±80.4	200	473	315

BMI - body mass index; 6MWT - six-minute walk test; SD - standard deviation; Min - minimum value; Max - maximum value
(*) echocardiography held over the last six months was considered; data concerning 20 patients; (†) Data concerning 26 patients.

Table 2
Clinical variables of the population studied (n=30)

Variables		n	%
Diagnosis on admission	CHF	20	66.7
	CAD	6	20.0
	CHB*	4	13.3
Comorbidities	SAH	21	70.0
	DLP	12	40.0
	Exposure to smoking†	12	40.0
	DM	9	30.0
	PAH	9	30.0
	Alcoholism	8	27.0
	Osteoarticular disorder	6	20.0
	AF	6	20.0
	CRD	3	10.0
Functional Class — NYHA ‡	I	9	34.6
	II	12	46.2
	III	5	19.2
Medicines	Diuretics	20	66.7
	ACEI	13	43.3
	Beta-blocker	13	43.3
	Anticoagulant	11	36.7
	Antiplatelet agent	11	36.7
	Calcium channel blockers	9	30.0
	Vasodilator	8	26.7
	BRA	8	26.7
	Antiarrhythmic drug	7	23.3
	Alpha-agonist	2	6.7

CHF - chronic heart failure; CAD - coronary artery disease; CHB - complete heart block; SAH - systemic arterial hypertension; DLP - dyslipidemia; DM - diabetes mellitus; PAH - pulmonary arterial hypertension; AF - atrial fibrillation; CRD - chronic renal disease; NYHA - New York Heart Association; ACEI - angiotensin-converting enzyme; ARB - angiotensin receptor blocker
(*) Have undergone surgical correction with permanent pacemaker implantation; (†) Active exposure at any time of life (past or present); (‡) Except for patients with CHB

Table 3 presents the hemodynamic variables related to the second practice of the 6MWT.

From the population studied, 15 (50.0%) patients had adverse effects in either of the two practices of 6MWT. Five (16.6%) presented adverse effects only in the first practice of the 6MWT, 2 (6.6%) presented adverse effects only in the second one and 8 (26.6%) patients in both practices. In Table 4, of the 30 patients analyzed, it was found that 5 (16.7%) patients had adverse effect of

cardiopulmonary type; 11 (36.7%) had non-severe cardiopulmonary effect; and 4 (13.3%) patients had severe cardiopulmonary effect. Regarding the 15 patients who had adverse effects, the following have been identified: LL arthralgia (33.3%), palpitation (26.7%), dyspnea (26.7%), desaturation (13.3%), dizziness and nausea (6.7%), hypotension (13.3%), bradycardia (6.7%) and numbness in the left arm (6.7%). The characteristics of patients with these adverse effects are presented in Table 4.

Table 5 presents the distribution of adverse events according to the co-morbidities found in the patients.

Table 3
Hemodynamic variables for the second 6MWT in the population studied

Variables	Pre	Post	Recovery	Δ Pre and Post	Δ Post and Recovery
	Mean±SD	Mean±SD	Mean±SD	Median	Median
SBP (mmHg)	114.2±20.1	128.2±27.6	11.6±23.5	14.0	-11.6
DBP (mmHg)	71.3±14.2	75.6±14.2	72.5±15.1	4.2	-3.0
HR (bpm)	73.0±15.2	85.7±24.2	73.5±15.2	12.6	-12.2
SD (mmHg.bpm)	8342.9±2212.9	11023.0±3804.6	8569.8±2411.0	2680.1	-2453.0
Borg R	6.3±0.6	7.9±3.6	6.4±1.2	1.6	-1.5
Borg LL	6.5±1.6	8.0±3.4	6.7±1.6	1.4	-1.2
SPO_2 (%)	97.8±0.9	97.0±3.3	97.8±1.0	-0.8	0.8

6MWT - six-minute walk test; SBP - systolic blood pressure; DBP - diastolic blood pressure; HR - heart rate; DP - double product; SpO_2 - peripheral oxygen saturation
(*) Analysis of 26 patients because four were excluded for not having carried out the second practice of the 6MWT due to severely adverse event in the first practice.

Table 4
Adverse effects observed during the 6MWT

Effects	n	%	Patients' characteristics
Non-cardiopulmonary	5	16.7†	
LL arthralgia	5	33.3*	3 with osteoarticular disease
Cardiopulmonary			
Non-severe	11	36.7†	
Palpitation	4	26.7*	3 with chronic AF
Dyspnea	4	26.7*	2 with PAH
Desaturation	2	13.3*	2 with CHF and reported smoking
Dizziness + nausea	1	6.7*	with PAH
Severe	4	13.3†	
Symptomatic hypotension	2	13.3*	1 with CAD, DLP and SAH and 1 with CHF and SAH
Bradycardia	1	6.7*	with CAD, DLP and SAH
Left arm numbness	1	6.7*	with CAD, DLP and SAH

6MWT - six minute walk test; LL - lower limbs; AF - atrial fibrillation; PAH - pulmonary arterial hypertension; CAD - coronary artery disease; DLP - dyslipidemia; SAH - systemic arterial hypertension; CHF - chronic heart failure; LA - left arm
(*) frequency regarding the 15 patients who had adverse effects; (†) frequency regarding the 30 patients who underwent the 6MWT

Table 5
Distribution of adverse effects according to the comorbidities found in the patients studied

	SAH (n=21)	DLP (n=12)	Exposure to smoking* (n=12)	PAH (n=9)	AF (n=6)	Osteoarticular disorder (n=6)
Arthralgia	4	2	-	2	1	3
Adverse cardiopulmonary effects						
Non-severe						
Palpitation	2	1	1	1	3	2
Dyspnea	-	-	1	2	1	1
Desaturation	2	2	2	-	-	-
Dizziness + nausea	-	-	-	1	-	-
Severe						
Symptomatic hypotension	2	1	-	1	1	-
Bradycardia	1	1	1	-	1	-
Left arm numbness	1	1	-	1	-	-

SAH - systemic arterial hypertension; DLP - dyslipidemia; PAH - pulmonary arterial hypertension; AF - atrial fibrillation; LA - left arm
(*) Active exposure at any time of life (past or present)

No adverse effects were found in the patients with complete heart block (CHB) using pacemakers.

Discussion

The 6MWT proved to be a safe instrument for evaluating hospitalized patients diagnosed with heart diseases. Although there was an adverse effect in half of the patients included in the study, note that each one of them completed two practices of 6MWT. In addition, only the events in four individuals were considered severe and in all signs observed there was full remission only with the rest, with no need for medical intervention.

In this study, we found 21 individuals with SAH and 20 with CHF. In addition, an average ejection fraction of 58.8% and a median of 63.0% was found among patients. These data demonstrate the low severity of the patients studied and the presence of CHF with preserved systolic function among participants[10].

The time between hospital admission and completion of the first 6MWT was 2.9 days on average and median of two days, demonstrating the early evaluation of the walk. In this study, the variability of time between admission and completion of the 6MWT was due to the need for medical permission to complete the test, which was the case when the patient presented functional class ≤ III based on the New York Heart Association[11]. Therefore, in some patients, it was necessary to wait for the CHF and then perform the 6MWT, preventing the test application soon after admission.

Regarding the time to initiation of cardiac rehabilitation, the Sociedade Brasileira de Cardiologia recommends that it should occur during hospitalization and that it be linked to a functional assessment of the patient, where the 6MWT is considered a valuable tool[11-13]. Corroborating the results of this study and reaffirming the importance of early functional measurement, Dias et al.[7] assessed patients with ACS about two days after admission to the intensive care unit. However, this assessment was held through a limited test by the 50-meter distance[7]. The 6MWT, as used in this study, is limited by time. The distance traveled by the individual varies according to their capacity and it can be used as a prognostic value[14].

The 6MWT is widely used in the scientific community and in healthcare. However, its safe application was poorly understood, particularly in relation to hospitalized

patients and those more vulnerable to adverse events than individuals in outpatient care. Of the 30 participants of this study, which were asymptomatic before the evaluation, 15 (50.0%) had adverse effects in either of the two 6MWT practices. This data does not impair the completion of 6MWT in clinical practice, since most of the adverse effects identified were not considered serious and all of them were spontaneously reversible upon rest. Still, the life-sustaining resources recommended by the American Thoracic Society during the course of that test is of utmost importance[3].

Among the adverse effects identified in this study, the most frequent ones were LL arthralgia, palpitations and dyspnea. The findings of this study are consistent with those found by Gerson et al.[5] the evaluation of which was directed to patients with refractory CHF and indication for elective cardiac transplantation[5]; with that of Nogueira et al.[6] that evaluated 25 patients approximately one week after AMI; with the evaluation of approximately 2,300 patients performed by Enright et al.[15]. However, unlike the present study, these studies did not describe any possible explanations for their findings.

Of the 30 patients studied, 4 (13.3%) had events classified as severe (symptomatic hypotension in 2, bradycardia in one and LL numbness in another). All of them were diagnosed with SAH and 3 (75.0 %) were diagnosed with CHD and DLP.

We call attention to these three clinical conditions. Firstly, it is important to note that SAH and DLP are important risk factors for CHD. The predilection of the adverse effects on the patients diagnosed with coronary artery disease may have occurred because of the pathophysiology of this disease. CHD is characterized by an imbalance between oxygen supply and consumption by the heart due to changes at any point of the coronary circulation. Upon situations of increased demand, there will be focal ischemia and, in the long-term, gradual loss of heart muscle efficiency[16]. In situations of greater physical stress, inefficient heart is not able to meet the need for increased cardiac output and can produce such symptoms. Thus, it is believed that patients with CHD deserve special attention and stricter criteria for discontinuing the 6MWT.

This study also showed that 6 (66.7%) out of 9 patients with some degree of PAH had symptoms related to low cardiac output, such as dizziness, nausea, symptomatic hypotension and numbness in the left arm (LA). Low cardiac output could lead to syncope and fall from height, although this adverse event was not observed in this study. It is known that PHA can settle quietly as a result of heart diseases[17]. Its most common symptom is exercise intolerance due to low cardiac output, whose characteristic is its progressive nature, thus suggesting secondary right ventricular dysfunction[17]. Syncope and presyncope may also be present[17]. In addition to these signs and symptoms, patients may have chest pain, which is usually a sign of subendocardial right ventricular ischemia due to reduced flow and coronary perfusion pressure[17]. Thus, it is believed that patients with PAH also deserve special attention during the 6MWT and more stringent criteria for discontinuation.

As the regulation of cardiac output upon physical effort occurs from mechanisms that allow inotropic and chronotropic adaptation[18], in this study, the researchers believed in the possibility of hypertensive peaks during the effort of some patients with pacemakers. However, no adverse event of this nature was observed in patients using this device.

Gerson et al.[5], in assessing the safety of 6MWT in patients with heart transplant indication, used electrocardiographic evaluation in their volunteers during the test. Considering that this study confirmed the 6MWT as a safe assessment from an electrocardiographic point of view, it was decided not to use this type of monitoring in patients in order to reproduce the 6MWT with cardiorespiratory assessment tools commonly used in clinic routine.

The limited number of patients admitted to the ward where the research was conducted during the study period did not allow an inferential analysis. While this unit has 15 beds, there is a low turnover of patients. It is suggested to conduct further research with larger samples to statistically test the hypotheses presented here.

Widely discussed and a constant concern in hospital accreditation processes, patient safety is a comprehensive issue and involves many aspects of an institution. This is because therapeutic care is often associated with secondary damage, so it is essential to recognize, minimize or eliminate the risks to which patients are exposed[19].

Thus, the results presented here allow physical therapists to identify the group of individuals that is most susceptible to adverse events and to support their evaluation in a safer way. Note that a basic condition for completion of the 6MWT in hospitalized individuals is the permission by the physician in charge, and the evaluation and proper execution of the test by the physiotherapist.

Conclusion

In the 6MWT, a low frequency of serious adverse events was found in patients hospitalized due to heart disease two days after their admission.

Potential Conflicts of Interest

No relevant potential conflicts of interest.

Sources of Funding

This study had no external funding sources.

Academic Association

This study represents the final paper of Pryscilla Alves Ferreira, in Multiprofessional Hospital Residency at Hospital Universitário Professor Edgard Santos from Universidade Federal da Bahia.

References

1. Enright PL. The six-minute walk test. Respir Care. 2003;48(8):783-5.
2. Solway S, Brooks D, Lacasse Y, Thomas S. A qualitative systematic overview of the measurement properties of functional walk tests used in the cardiorespiratory domain. Chest. 2001;119(1):256-70.
3. ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories. ATS statement: guidelines for the six-minute walk test. Am J Respir Crit Care Med. 2002;166(1):111-7.
4. Rasekaba T, Lee AL, Naughton MT, Williams TJ, Holland AE. The six-minute walk test: a useful metric for the cardiopulmonary patient. Intern Med J. 2009;39(8):495-501.
5. Gerson C Jr, Bernardelli GF, Arena R, Oliveira LV, Valdez F, Branco JN. Cardio-respiratory responses of the 6-minute walk test in patients with refractory heart failure during the preoperative period for heart transplant surgery. Monaldi Arch Chest Dis. 2010;74(2):64-9.
6. Nogueira PA, Leal AC, Pulz C, Nogueira ID, Filho JA. Clinical reliability of the 6 minute corridor walk test performed within a week of a myocardial infarction. Int Heart J. 2006;47(4):533-40.
7. Dias CM, Maiato AC, Baqueiro KM, Figueredo AM, Rosa FW, Pitanga JO, et al. Resposta circulatória à caminhada de 50 m na unidade coronariana, na síndrome coronariana aguda. Arq Bras Cardiol. 2009;92(2):135-42.
8. Conselho Nacional de Ergometria. Consenso Nacional de Ergometria. Arq Bras Cardiol. 1995;65(2):191-211.
9. Borg GA. Perceived exertion. Exerc Sport Sci Rev. 1974;2:131-53.
10. Mesquita ET, Socrates J, Rassi S, Villacorta H, Mady C. Insuficiência cardíaca com função sistólica preservada. Arq Bras Cardiol. 2004;82(5):494-500.
11. Bocchi EA, Braga FG, Ferreira SM, Rohde LE, Oliveira WA, Almeida DR, et al; Sociedade Brasileira de Cardiologia. III Diretriz brasileira de insuficiência cardíaca crônica. Arq Bras Cardiol. 2009;93(1 supl. 1):3-70.
12. Cortez AA, Ferraz A, Nóbrega ACL, Brunetto AF, Herdy AH, Hossri CAC, et al; Sociedade Brasileira de Cardiologia. Diretriz de reabilitação cardiopulmonar e metabólica: aspectos práticos e responsabilidades. Arq Bras Cardiol. 2006;86(1):74-82.
13. Bocchi EA, Marcondes-Braga FG, Bacal F, Ferraz AS, Albuquerque D, Rodrigues D, et al; Sociedade Brasileira de Cardiologia. Atualização da Diretriz brasileira de insuficiência cardíaca crônica - 2012. Arq Bras Cardiol. 2012;98(1 supl. 1):1-33.
14. Rubim VSM, Drumond Neto C, Romeo JLM, Montera MW. Valor prognóstico do teste de caminhada de seis minutos na insuficiência cardíaca. Arq Bras Cardiol. 2006;86(2):120-5.
15. Enright PL, McBurnie MA, Bittner V, Tracy RP, McNamara R, Arnold A, et al; Cardiovascular Health Study. The 6-min walk test: a quick measure of functional status in elderly adults. Chest. 2003;123(2):387-98.
16. Feitosa GS, Feitosa Filho GS, Carvalho EN. Alterações cardiovasculares da hipertensão arterial: hipertrofia ventricular esquerda, doença arterial coronária e insuficiência cardíaca. Rev Bras Hipertens. 2002;9(3):280-7.
17. Guimarães JI, Lopes AA, Aiello VD, Carvalho ACC, Almeida Dr, et al; Sociedade Brasileira de Cardiologia. Diagnóstico, avaliação e terapêutica da hipertensão pulmonar. Arq Bras Cardiol. 2005;84(supl. 1):1-189.
18. Greco OT, Ardito RV, Souza DR, Schaldach M. Marcapasso com sensor de contratilidade regulado pelas variações do sistema nervoso autônomo na miocardiopatia chagásica crônica. Arq Bras Cardiol. 1998;71(6):751-61.
19. Gouvêa CS, Travassos C. Indicadores de segurança do paciente para hospitais de pacientes agudos: revisão sistemática. Cad Saude Publica. 2010;26(6):1061-78.