


ORIGINAL ARTICLE

# Impact of bedrest on cardiovascular events and complications associated with temporary pacemakers in patients waiting for permanent pacemaker implantation

Tomoaki Hama MD<sup>1</sup>  | Norishige Morita MD, PhD<sup>1</sup> | Akiko Ushijima MD, PhD<sup>1</sup> | Akira Ueno MD, PhD<sup>1</sup> | Takayuki Iida MD<sup>1</sup> | Yuji Ikari MD, PhD<sup>2</sup> | Yoshinori Kobayashi MD, PhD<sup>1</sup>

<sup>1</sup>The Division of Cardiology, Department of Medicine, Tokai University Hachioji Hospital, Hachioji, Japan

<sup>2</sup>The Division of Cardiology, Department of Medicine, Tokai University Hospital, Isehara, Japan

## Correspondence

Tomoaki Hama, Research associate, The Division of Cardiology, Department of Medicine, Tokai University Hachioji Hospital, 1838 Ishikawa-machi, Hachioji-shi, Tokyo, Japan.

Email: thama@tsc.u-tokai.ac.jp

## Abstract

**Background:** Patients with a temporary pacemaker (TPM) for bradycardias are required to maintain bedrest until permanent pacemakers (PPMs) are implanted because of the development of Adams–Stokes syndrome, worsening heart failure, or complications associated with TPMs is anticipated. However, bedrest may be detrimental in patients because it leads to disuse syndrome. This study examined whether bedrest could decrease the incidence of cardiovascular events or complications associated with TPMs in patients waiting for PPM implantation.

**Methods:** We conducted a retrospective cohort study on 88 patients who had emergency hospitalization for the treatment of bradycardias, and a TPM was inserted during the waiting period before PPM implantation. We divided patients into two groups according to whether they underwent bedrest (Bedrest Group) or not (Ambulation Group) during the period that patients were supported with TPM. We evaluated whether bedrest was a predictor of adverse events using a logistic regression analysis.

**Results:** Adverse events occurred in 31 patients (35%). In the univariate analysis, there was no significant difference in the incidence of adverse events between the Bedrest and Ambulation Groups (39% vs. 29%). In the logistic regression analysis, bedrest was not a predictor of adverse events (odds ratio, 1.40; 95% confidence interval, 0.53–3.68,  $P = .497$ ).

**Conclusions:** In patients with TPMs for bradyarrhythmias during the waiting period for PPM implantations, bedrest might not prevent adverse events, such as cardiovascular events and complications associated with TPMs.

## KEYWORDS

bed rest, cardiovascular event, complication associated with temporary pacemaker, permanent pacemaker implantation, temporary pacemaker

These authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2021 The Authors. *Journal of Arrhythmia* published by John Wiley & Sons Australia, Ltd on behalf of the Japanese Heart Rhythm Society.

## 1 | INTRODUCTION

Bradycardia can cause syncope and decompensated heart failure; therefore, we often implant permanent pacemakers (PPMs) in patients with bradycardia.<sup>1,2</sup> While patients with bradyarrhythmias with a temporary pacemaker (TPM) are waiting for PPM implantations, we often order patients to maintain bedrest because of the development of Adams–Stokes syndrome, decompensated heart failure, and complications associated with TPMs, such as a cardiac perforation, TPM-associated infections, and pacing failure, is anticipated.<sup>3,4</sup> In contrast, bedrest is known to cause disuse changes, such as a reduction in muscle strength and exercise capacity, and worsening prognosis in patients.<sup>5–7</sup> Therefore, it deems favorable for patients to be released from bedrest. However, it remains controversial as to whether bedrest can help avoid cardiovascular events and complications associated with TPMs during the waiting period for PPM implantation.

Consequently, the present study aimed to evaluate whether bedrest could influence the incidence of cardiovascular events and complications associated with TPMs while patients with a TPM for bradyarrhythmias are waiting for PPM implantations.

## 2 | METHODS

### 2.1 | Study design and population

We performed a retrospective cohort study to confirm whether bedrest could prevent adverse events in patients with a TPM for bradyarrhythmias during the waiting period for PPM implantation. This study consisted of 88 patients who had drug-refractory symptomatic bradyarrhythmias and/or heart failure and emergency admission in our hospital for PPM implantation in patients from April 2011 to May 2020. All patients had a TPM inserted during the waiting period for PPM implantation. We divided (retrospective study) patients into two groups: (1) patients who underwent bedrest during the period that the patients were supported with a TPM (Bedrest Group) and (2) patients who stood or walked during the period that the patients were supported with a TPM (Ambulation Group). It depended on the attending physicians' decision whether patients were kept on bedrest or not during the period. We checked for all adverse events that occurred during the period that the patients were supported with a TPM. This study was performed in accordance with the Declaration of Helsinki and approved by the research ethics committee of Tokai University (20R-304).

### 2.2 | Adverse events and complications

In this study, adverse events were defined as death, decompensated heart failure, and complications associated with TPMs, such as a cardiac perforation, pacing failure, and TPM-associated infections. The criteria for TPM-associated infections were as follows: (1) There was

at least one finding of an infection among the following situations in which fever (body temperature  $>38.3^{\circ}\text{C}$ ), leukocytosis (white blood cell count  $>12000/\mu\text{L}$ ), increased plasma C-reactive protein (CRP) level ( $>2$  standard deviation above the normal value), or positive blood culture were observed in their examinations. (2) There were no findings of other infections, except for TPM-associated infections. (3) The attending physicians suspected the development of TPM-associated infections in the patients and performed interventions, such as removal of the catheter, exchange to a new catheter, change of antibiotics, or postponement of PPM implantation.<sup>8</sup> Patients' medical records were retrospectively reviewed, and the investigational items were collected, including age, sex, body mass index (BMI), types of arrhythmias (atrioventricular block [AVB], sick sinus syndrome [SSS], and bradycardic atrial fibrillation [AF]), symptoms of bradyarrhythmias (syncope and heart failure), the insertion sites of TPMs, minimal heart rate, pacing threshold, sensing threshold, and time of TPM insertion. In this study, heart failure was defined as a brain natriuretic peptide (BNP) level  $\geq 80$  pg/mL or presence of symptoms caused by heart failure.<sup>9</sup> We also checked the coronary risk factors (smoking, hypertension, diabetes mellitus, and dyslipidemia), medications (diuretics, antiarrhythmic drugs, beta-blockers, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, and calcium channel blockers), blood tests (BNP, hemoglobin [Hb], estimated glomerular filtration rate, CRP, HbA1c, LDL-cholesterol, HDL-cholesterol, and triglycerides), echocardiography (left ventricular diastolic diameter [LVDd] and left ventricular ejection fraction [LVEF]) during hospitalization, duration from the hospitalization to the device implantation, and whether patients underwent bedrest. We also determined all adverse events and details in patients during the period that patients were supported with a TPM from their medical records (deaths, cardiovascular events, and complications associated with TPMs).

### 2.3 | Statistical analysis

Data are presented as mean  $\pm$  standard deviation or number (%). We used an unpaired t-test for comparisons of continuous variables and a chi-square test for comparisons of nominal variables between the two groups. We estimated the 95% confidence intervals for the main results. All tests were assessed at a significance level of a  $P$ -value  $<.05$ . Statistical analyses were performed using SPSS version 16.0 software (SPSS Inc).

First, we compared the Bedrest and Ambulation Groups in terms of adverse events and baseline characteristics with the abovementioned statistical analyses. Next, to select the covariates for the logistic regression analysis, we divided the patients into two groups according to whether they had an adverse event or not (Event (+) Group and Event (–) Group). We also compared the two groups with the abovementioned statistical analyses and selected the items in which there were significant differences between the two groups to use as covariates. With the covariates and whether they underwent bedrest or not, we performed the logistic regression analysis.

**TABLE 1** The characteristics and results of the 88 patients enrolled in the study

	Total (n = 88)	Bedrest Group (n = 54)	Ambulation Group (n = 34)	P value
Age (y.o.)	80 ± 10	81 ± 9	77 ± 10	.046
Sex(M/F), n (%)	43 (49)	25 (46)	18 (53)	.544
BMI	22.2 ± 4.1	21.6 ± 4.4	23.3 ± 3.1	.050
<b>Arrhythmia</b>				
Atrioventricular block, n (%)	61 (69)	38 (70)	23 (68)	.787
Sick sinus syndrome, n (%)	25 (28)	16 (30)	9 (26)	.749
Bradycardic Af, n (%)	3 (3)	1 (2)	2 (6)	.331
<b>Symptoms due to bradyarrhythmias</b>				
Syncope, n (%)	55 (63)	35 (65)	20 (59)	.572
Heart failure, n (%)	81 (92)	51 (94)	30 (88)	.256
<b>TPM insertion</b>				
Jugular vein approach, n (%)	83 (94)	49 (91)	34 (100)	.081
Femoral vein approach, n (%)	5 (6)	5 (9)	0 (0)	.081
Minimal heart rate (/min)	61 ± 10	62 ± 11	59 ± 8	.246
TPM pacing threshold (V)	1.5 ± 0.4	1.5 ± 0.5	1.5 ± 0.2	.862
TPM sensing threshold (mV)	0.9 ± 0.3	0.9 ± 0.3	0.9 ± 0.3	.524
Time of TPM insertion (days)	8 ± 8	9 ± 8	7 ± 6	.470
<b>Coronary risk factor</b>				
Smoking, n (%)	28 (32)	13 (24)	15 (44)	.049
Hypertension, n (%)	59 (67)	38 (70)	21 (62)	.403
Diabetes mellitus, n (%)	28 (32)	18 (33)	10 (29)	.701
Dyslipidemia, n (%)	24 (27)	14 (26)	10 (29)	.721
<b>Medications</b>				
Diuretics, n (%)	37 (42)	23 (43)	14 (41)	.896
Anti-arrhythmic drugs, n (%)	1 (1)	1 (2)	0 (0)	.614
Beta-blockers, n (%)	6 (7)	3 (6)	3 (9)	.427
ACE-Is, n (%)	5 (6)	3 (6)	2 (6)	.645
ARBs, n (%)	36 (41)	21 (39)	15 (44)	.627
CCBs, n (%)	38 (43)	27 (50)	11 (32)	.104
<b>Blood exam</b>				
BNP (pg/mL)	601 ± 1001	734 ± 1220	390 ± 394	.119
Hemoglobin (g/dL)	12.7 ± 2.0	12.6 ± 1.8	13.0 ± 2.2	.347
eGFR (mL/min/1.73m <sup>2</sup> )	44.2 ± 20.4	42.2 ± 17.6	47.3 ± 23.8	.261
CRP (mg/dL)	0.901 ± 1.693	0.815 ± 1.452	1.038 ± 2.011	.553
HbA1c (%)	6.1 ± 0.9	6.0 ± 0.9	6.3 ± 1.0	.240
LDL-cholesterol (mg/dL)	107 ± 29	105 ± 27	109 ± 31	.517
HDL-cholesterol (mg/dL)	52 ± 13	52 ± 13	51 ± 12	.634
Triglyceride (casual) (mg/dL)	118 ± 79	115 ± 81	123 ± 75	.670
<b>Echocardiography</b>				
LVDd (mm)	46 ± 6	45 ± 6	47 ± 7	.173
LVEF, n (%)	59 ± 12	59 ± 12	58 ± 10	.862
Time from the hospitalization to the implantation (days)	9 ± 8	9 ± 9	8 ± 6	.413
Adverse event, n (%)	31 (35)	21 (39)	10 (29)	.365

Note: Continuous values are reported as the mean ± SD.

Abbreviations: ACE-I, angiotensin-converting enzyme inhibitor; Af, atrial fibrillation; ARB, angiotensin receptor blocker; BMI, body mass index; BNP, brain natriuretic peptide; CCB, calcium channel blocker; CRP, C-reactive protein, LVDd, left ventricular diastolic diameter; eGFR, estimated glomerular filtration rate; LVEF, and left ventricular ejection fraction; TPM, temporary pacemaker.

### 3 | RESULTS

#### 3.1 | Clinical characteristics and results of the study patients

Table 1 shows the demographic and clinical data of the total study population. The mean age was  $80 \pm 10$  years, and 49% (43/88) of the patients were male. Moreover, 69% (61/88) of the patients had atrioventricular block. One patient had both AVB and SSS. Furthermore, 63% (55/88) of patients had syncope before admission. Almost all patients had a TPM inserted via the jugular vein. The average duration of the TPM insertion was  $8 \pm 8$  days. The TPM catheters were inserted on the right ventricular septal side, and antibiotics have been administered during the waiting period for PPM implantation in all patients. The majority of patients had mild renal dysfunction and preserved left ventricular systolic function. The average time from hospitalization to pacemaker implantation was  $9 \pm 8$  days. Adverse events occurred in 31 patients (31/88, 35%).

Fifty-four patients (54/88, 61%) underwent bedrest during the period that the patients were supported with a TPM. The average age in the Bedrest Group was older than that in the Ambulation Group. There were no significant differences in sex, BMI, type of arrhythmia, symptoms due to bradyarrhythmias, insertion site of the TPM, minimal heart rate, TPM pacing and setting thresholds, time of TPM insertion, coronary risk factors, medications, blood tests, LVDd, LVEF, and time from hospitalization to the implantation, except for age and smoking, between the Bedrest and Ambulation Groups. Adverse events occurred in 21 patients in the Bedrest Group (21/54, 39%) and ten patients in the Ambulation Group (10/34, 29%). There were no significant differences in the incidence of adverse events between the two groups.

#### 3.2 | Adverse events and complications

Table 2 shows the details of the adverse events (31/88, 35%) in the study patients. No patients died or had cardiac perforations during

**TABLE 2** The details of the adverse events in the 31 patients

		Total (n = 31)	Bedrest Group (n = 21)	Ambulation Group (n = 10)
Death	n	0	0	0
Decompensated heart failure	n	3	2	1
Complications associated with TPM	n	28	19	9
Cardiac perforation	n	0	0	0
Pacing failure	n	16	9	7
TPM associated infection	n	12	10	2
Total	n	31	21	10

Abbreviation: TPM, temporary pacemaker.

the period that the patients were supported with a TPM. Moreover, 28 patients developed complications associated with TPM. Because of TPM-associated infections, PPM implantation was postponed in five patients. The incidence of complications associated with TPM in the Bedrest Group was higher than that in the Ambulation Group (35%, 19/54, vs. 26%, 9/34). However, there was no significant statistical difference between the two groups.

#### 3.3 | Predictors of adverse events

We evaluated whether bedrest was a predictive factor of adverse events in study patients with a logistic regression analysis. To determine the covariates for the analysis to determine whether patients would undergo bedrest or not, we compared the differences between the two groups divided by the presence or absence of adverse events (Table 3). Accordingly, we added (1) the time of TPM insertion and (2) diabetes mellitus as covariates into the analysis because the two items significantly differed between the two groups. Table 4 shows the results of the logistic regression analysis of the predictors of the onset of adverse events. In the results, bedrest was not an independent predictor of the occurrence of adverse events during the waiting period for PPM implantation (odds ratio, 1.40; 95% confidence interval, 0.53-3.68;  $P = .497$ ).

### 4 | DISCUSSION

The major findings of this study were as follows. There was no significant difference in the occurrence of adverse events between the Bedrest and Ambulation Groups. Moreover, bedrest was not a predictor of the occurrence of adverse events in the logistic regression analysis. These findings suggested that bedrest may not prevent adverse events in patients who have bradyarrhythmias with a TPM while they are waiting for PPM implantation.

PPM implantations are greatly useful for patients with unstable arrhythmias. Cardiac syncope with Adams–Stokes syndrome has a poorer prognosis than syncope due to other causes and has a high mortality of approximately 20%–30%.<sup>2</sup> It is recommended in the Japan Circulation Society (JCS) guidelines on nonpharmacological treatment of arrhythmias to implant a PPM for AVB, bi- or trifascicular block, SSS, bradycardic AF causing syncope, or heart failure.<sup>10</sup> In addition, TPM insertion has also been shown to be favorable in that it provides temporary heart rate support in patients with syncope, heart failure, and risk of cardiac death until a PPM is implanted.<sup>11</sup> In contrast, a previous study showed that the complication rate associated with a TPM was 36.7%. The details were that pacing failure occurred in 9.5% of patients, infections in 4.8%, and cardiac perforations in 1.6%.<sup>3</sup> Even worse, cardiac perforations caused by a device can affect mortality and extension of hospitalization.<sup>12,13</sup> In this study, complications associated with a TPM was the most frequent adverse event during the period that the patients were supported with a TPM (Table 2). Because the development of cardiac syncope,

**TABLE 3** Comparison of the two groups divided by the presence or absence of adverse events to select the covariates for the logistic regression analysis

	Total (n = 88)	Event (+) Group (n = 31)	Event (-) Group (n = 57)	P value
Age (y.o.)	80 ± 10	80 ± 11	80 ± 9	.725
Sex (M/F), n (%)	43 (49)	16 (52)	27 (47)	.704
BMI	22.2 ± 4.1	22.0 ± 4.9	22.3 ± 3.6	.730
<b>Arrhythmia</b>				
Atrioventricular block, n (%)	61 (69)	24 (77)	37 (65)	.224
Sick sinus syndrome, n (%)	25 (28)	6 (19)	19 (33)	.165
Bradycardic Af, n (%)	3 (3)	1 (3)	2 (4)	.718
<b>Symptoms due to bradyarrhythmias</b>				
Syncope, n (%)	55 (63)	22 (71)	33 (58)	.226
Heart failure, n (%)	81 (92)	30 (97)	51 (89)	.219
<b>TPM insertion</b>				
Jugular vein approach, n (%)	83 (94)	29 (94)	54 (95)	.581
Femoral vein approach, n (%)	5 (6)	2 (6)	3 (5)	.581
Minimal heart rate (/min)	61 ± 10	61 ± 10	61 ± 10	.971
TPM pacing threshold (V)	1.5 ± 0.4	1.6 ± 0.4	1.5 ± 0.4	.449
TPM sensing threshold (mV)	0.9 ± 0.3	0.9 ± 0.3	0.9 ± 0.3	.836
Time of TPM insertion (days)	8 ± 8	10 ± 9	7 ± 6	.032
<b>Coronary risk factor</b>				
Smoking, n (%)	28 (32)	7 (23)	21 (37)	.170
Hypertension, n (%)	59 (67)	20 (65)	39 (68)	.710
Diabetes mellitus, n (%)	28 (32)	14 (45)	14 (25)	.047
Dyslipidemia, n (%)	24 (27)	7 (23)	17 (30)	.466
<b>Medications</b>				
Diuretics, n (%)	37 (42)	16 (52)	21 (37)	.180
Anti-arrhythmic drugs, n (%)	1 (1)	0 (0)	1 (2)	.648
Beta-blockers, n (%)	6 (7)	1 (3)	5 (9)	.306
ACE-Is, n (%)	5 (6)	2 (6)	3 (5)	.581
ARBs, n (%)	36 (41)	14 (45)	22 (39)	.550
CCBs, n (%)	38 (43)	16 (52)	22 (39)	.239
<b>Blood exam</b>				
BNP (pg/mL)	601 ± 1001	582 ± 545	611 ± 1177	.899
Hemoglobin (g/dL)	12.7 ± 2.0	12.9 ± 1.8	12.6 ± 2.0	.586
eGFR (mL/min/1.73m <sup>2</sup> )	44.2 ± 20.4	42.6 ± 22.9	45.1 ± 18.9	.591
CRP (mg/dL)	0.901 ± 1.693	0.922 ± 1.488	0.889 ± 1.795	.933
HbA1c (%)	6.1 ± 0.9	6.3 ± 1.1	6.0 ± 0.8	.295
LDL-cholesterol (mg/dL)	107 ± 29	112 ± 30	104 ± 27	.224
HDL-cholesterol (mg/dL)	52 ± 13	48 ± 13	53 ± 13	.114
Triglyceride (casual) (mg/dL)	118 ± 79	142 ± 109	106 ± 53	.041
<b>Echocardiography</b>				
LVDd (mm)	46 ± 6	46 ± 5	46 ± 7	.679
LVEF, n (%)	59 ± 12	59 ± 12	58 ± 11	.907
Time from the hospitalization to the implantation (days)	9 ± 8	11 ± 9	8 ± 7	.046
Bedrest, n (%)	50 (57)	21 (68)	29 (51)	.365

Note: Continuous values are reported as the mean ± SD.

Abbreviations: ACE-I, angiotensin-converting enzyme inhibitor; Af, atrial fibrillation; ARB, angiotensin receptor blocker; BMI, body mass index; BNP, brain natriuretic peptide; CCB, calcium channel blocker; CRP, C-reactive protein, LVDd, left ventricular diastolic diameter; eGFR, estimated glomerular filtration rate; LVEF, and left ventricular ejection fraction; TPM, temporary pacemaker.

**TABLE 4** The analyses of the predictors of the onset of adverse events with a logistic regression analysis

Predictor	logistic regression analysis		
	OR	95% CI	P value
Bedrest	1.40	0.53-3.68	.497
Time of the temporary pacemaker insertion	1.07	1.00-1.15	.039
Diabetes mellitus	2.85	1.09-7.47	.033

Abbreviations: CI, confidential interval; OR, odds ratio.

decompensated heart failure, and various adverse events associated with TPMs, as mentioned above, is anticipated, we are apt to oblige patients to maintain bedrest until PPM implantation. However, our research results showed that bedrest did not influence the prevalence of adverse events.

In contrast, although bedrest might reduce the metabolic demand on the heart and prevent ischemia and arrhythmias during the acute phase, bedrest itself can cause many complications.<sup>14</sup> It leads patients to lose approximately 2%-3% of their muscle strength per day.<sup>5</sup> Moreover, disuse changes caused by bedrest include not only muscular weakness and joint contractures but also nerve disorders, such as orthostatic disturbances, sleep disruption, deep venous thrombosis, and decline in the exercise capacity. A previous study showed that, in healthy men who maintained bedrest for 20 days, their maximal oxygen consumption decreased from 3.3 to 2.4 L/min.<sup>6</sup> Regarding the physical work capacity, 3 weeks of bed rest was the same as 20 years of aging in the same man.<sup>15</sup> Another study has shown that, once patients acquire sarcopenia, which is a syndrome associated with a decline in the muscle mass and strength, it can especially increase the mortality risk due to cardiovascular disease.<sup>16-18</sup> To the best of our knowledge, there have been no studies that showed that bedrest can have a favorable effect on the clinical course of patients with regard to the prevention of adverse events during the waiting period for PPM implantation. On the contrary, bedrest has been shown to be harmful in patients with cardiovascular disease.<sup>15-18</sup>

In the JCS/Japan Heart Failure Society guidelines, as soon as the hemodynamics in patients with heart failure become stabilized, they should get out of bed and undergo cardiac rehabilitation.<sup>19</sup> The JCS guidelines also indicate that patients with various arrhythmias should receive medical treatment from the cardiovascular team, consisting of not only physicians but also nurses, physical therapists, and clinical engineers.<sup>10</sup> Under appropriate management of patients with a TPM for bradyarrhythmias, it might be unnecessary to make patients maintain bedrest during the waiting period for PPM implantation.

#### 4.1 | Limitations

There were a couple of limitations to the present study. First, this study did not have a large sample size, especially of patients who had

adverse events. Second, the details of the physical capacity, muscle strength, and activities of daily life, such as the Barthel index, in the study patients were not checked. Further, there was no description about the severity of heart failure, such as the NYHA classification, in the medical records.

## 5 | CONCLUSIONS

Bedrest might not prevent cardiovascular events or device complications in patients with a TPM for bradyarrhythmias during the waiting period for PPM implantation.

### ACKNOWLEDGMENT

The authors express their special gratitude to Mr John Martin and Enago ([www.enago.jp](http://www.enago.jp)) for the English language review.

### CONFLICT OF INTEREST

The authors declare no conflict of interest for this article.

### ORCID

Tomoaki Hama  <https://orcid.org/0000-0002-2958-3794>

### REFERENCES

- Sodeck GH, Domanovits H, Meron G, Rauscha F, Losert H, Thalmann M, et al. Compromising bradycardia: management in the emergency department. *Resuscitation*. 2007;73:96-102.
- Brignole M, Moya A, De Lange FJ, Deharo JC, Elliott PM, Fanciulli A, et al. ESC Guideline for the diagnosis and management of syncope. *Eur Heart J*. 2018;39:1883-948.
- Tjong FVY, De Ruijter UW, Beurskens NEG, Knops RE. A comprehensive scoping review on transvenous temporary pacing therapy. *Neth Heart J*. 2019;27:462-73.
- Lin J, Wang L, Zhao Y. Inadvertent left ventricular pacing and perforation by a temporary pacemaker. *J Electrocardiol*. 2017;50:686-9.
- Muller EA. Influence of training and of inactivity on muscle strength. *Arch Phys Med Rehabil*. 1970;51:449-62.
- Saltin B, Blomqvist G, Mitchell JH, Johnson RL Jr, Wildenthal K, Chapman CB. Response to exercise after bed rest and after training. *Circulation*. 1968;38:VII1-78.
- Ried-Larsen M, Aarts HM, Joyner MJ. Effects of strict prolonged bed rest on cardiorespiratory fitness: systematic review and meta-analysis. *J Appl Physiol*. 2017;123:790-9.
- Levy MM, Fink MP, Marshall JC, Abraham E, Angus D, Cook D, et al. 2001 SCCM/ESICM/ACCP/ATS/SIS international sepsis definitions conference. *Intensive Care Med*. 2003;29:530-8.
- De Lemos JA, Morrow DA, Bentley JH, Omland T, Sabatine MS, McCabe CH, et al. The prognostic value of B-type natriuretic peptide in patients with acute coronary syndromes. *NEJM*. 2001;345:1014-20.
- Okumura K, Aizawa Y, Aonuma K, Hagiwara N, Isobe F, Kato T, et al. Guidelines for non-pharmacotherapy of cardiac arrhythmias. *Circ J*. 2013;77:249-74.
- Sullivan BL, Bartels K, Hamilton N. Insertion and management of temporary pacemakers. *Semin Cardiothorac Vasc Anesth*. 2016;20:52-62.
- Hsu JC, Varosy PD, Bao H, Dewland TA, Curtis JP, Marcus GM. Cardiac perforation from implantable cardioverter-defibrillator lead placement insights from the national cardiovascular data registry. *Circ Cardiovasc Qual Outcomes*. 2013;6:582-90.

13. Harrigan RA, Chan TC, Moonblatt S, Vike GM, Ufberg JW. Temporary transvenous pacemaker placement in the emergency department. *J Emerg Med.* 2007;32:105–11.
14. Brower RG. Consequences of bed rest. *Crit Care Med.* 2009;37:S422–S428.
15. McGuire DK, Levine BD, Williamson JW, Snell PG, Blomqvist CG, Saltin B, et al. A 30-year follow-up of the Dallas bed rest and training study: I. Effect of age on the cardiovascular response to exercise. *Circulation.* 2001;104:1350–7.
16. Maeda K, Shamoto H, Wakabayashi H, Akagi J. Sarcopenia is high prevalent in older medical patients with mobility limitation: comparisons according to ambulatory status. *Nutr Clin Pract.* 2017;32:110–5.
17. Atkins JL, Whincup PH, Morris RW, Lennon LT, Papacosta O, Wannamethee SG. Sarcopenic obesity and risk of cardiovascular disease and mortality: a population-based cohort study of older men. *J Am Geriatr Soc.* 2014;62:253–60.
18. Dhillon RJS, Hasni S. Pathogenesis and management of sarcopenia. *Clin Geriatr Med.* 2017;33:17–26.
19. Tsutsui H, Isobe M, Ito H, Ito H, Okumura K, Ono M, et al. JCS2017/JHFS2017 guideline on diagnosis and treatment of acute and chronic heart failure. *Circ J.* 2019;2084–184.

**How to cite this article:** Hama T, Morita N, Ushijima A, et al. Impact of bedrest on cardiovascular events and complications associated with temporary pacemakers in patients waiting for permanent pacemaker implantation. *J Arrhythmia.* 2021;37:669–675. <https://doi.org/10.1002/joa3.12534>