Insights into heart failure, atrial fibrillation, hypertension, and pulse rate obtained from physiological data monitoring

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Abstract
Heart failure refers to a condition in which the heart's pumping function deteriorates, making it unable to send enough blood to the rest of the body. It is necessary to investigate the cause of this phenomenon. It is thought to occur as the final stage of many heart diseases. The following diseases are considered to be the cause, namely: ischemic heart disease (myocardial infarction and angina pectoris), hypertensive heart disease, valvular heart disease, cardiomyopathy, and arrhythmias (atrial fibrillation). The initial symptoms are shortness of breath and fatigue. As the symptom progresses, it may include difficulty breathing at rest, nighttime cough/shortness of breath, leg swelling, weight gain, loss of appetite, and fatigue. The diagnosis is basically determined by medical history/physical examination, chest X-ray (cardiomegaly), electrocardiogram, echocardiogram, and blood tests (BNP, NT-proBNP). BNP or NT-proBNP is used as a marker for heart failure. The subject in this study was elderly, had high blood pressure, and suffered from heart failure due to atrial fibrillation. Furthermore, the subject's atrial fibrillation symptoms worsened, with NT-proBNP levels exceeding 1200 pg/ml, which is approximately 10 times the borderline level of 125 pg/ml. The diagnosis would indicate that the heart failure is quite advanced, based on this information. However, the subject did not exhibit signs of heart failure, such as shortness of breath or chest tightness. Moreover, his pulse rate settled into the 70-80 range. This paper presents a single-case study summarizing findings on heart failure, atrial fibrillation, hypertension, and pulse rate, derived from approximately one year of monitored physiological data from a subject exhibiting atypical characteristics. It is believed this paper will be helpful to patients suffering from similar illnesses.

Key words
heart failure, atrial fibrillation, hypertension, pulse rate, weight

1. Introduction

Heart failure refers to a condition in which the heart's pumping function is impaired, making it unable to adequately supply the body and lungs with the blood needed. Alternatively, it refers to a condition where the heart is under excessive strain in order to supply the necessary blood. The symptom is not "a state where the heart stops." The disease chronically progresses and then stagnates. The five-year survival rate for heart failure patients is generally estimated to be around 50% according to data from organizations such as the Japanese Circulation Society and the Japanese Heart Failure Society, as well as general clinical statistics. It can be said to be a serious illness (Groenewegen, 2020; Pitt, 1999).

Heart failure often causes an increase in heart rate (tachycardia). The three main symptoms are as follows:

- The amount of blood pumped per stroke decreases
- The body tries to compensate by increasing the heart rate
- The sympathetic nervous system becomes activated, causing the pulse to quicken

These symptoms are a type of compensatory reaction. If the pulse remains too fast, the heart becomes even more exhausted, worsening heart failure and creating a vicious cycle. Many studies have shown that the higher the resting heart rate, the worse the prognosis for heart failure (hospitalization or death). The risk increases when the resting heart rate exceeds 70 beats per minute, as a general guideline. The prognosis becomes even worse when the rate exceeds 80 beats per minute. A heart rate that is too slow (bradycardia) is also a problem. The cardiac output will be insufficient, leading to dizziness, fainting, and worsening of heart failure when the heart rate is extremely low. This can also occur with conditions such as sick sinus syndrome, atrioventricular block, and the effects of beta-blockers. The proper control of heart rate is crucial in the treatment of heart failure. A typical example of such medication is beta-blockers, which lower the heart rate and reduce the burden on the heart. Ivabradine is used when the heart rate is high in sinus rhythm.

Here, the relationship between pulse rate and heart rate is explained. Pulse rate represents the number of times an arterial pulse can be felt per minute and is measured at the wrist or neck (beats/minute). Heart rate represents how many times the heart beats per minute and is measured using an electrocardiogram or heart sounds. Normally, pulse rate equals heart rate, but in cases of arrhythmia (atrial fibrillation), decreased cardiac function (heart failure), or peripheral circulatory failure, it becomes the condition of the pulse rate larger than the heart rate. The normal pulse rate for elderly people

at rest is around 70-80 beats per minute.

Here, the relationship between atrial fibrillation and heart rate is explained (Darae, 2025; Jordan, 2022). The pulse tends to be irregular and rapid in atrial fibrillation. This is an important feature. The reasons why the pulse becomes irregular in atrial fibrillation are as follows, namely the intervals between ventricular contractions become irregular, resulting in a completely irregular pulse. Next, the relationship between heart failure and atrial fibrillation is indicated. Heart failure makes humans more susceptible to atrial fibrillation. The reason for this is that the increased atrial pressure, atrial enlargement, and myocardial fibrosis make atrial fibrillation more likely to occur and persist in heart failure. Conversely, the effects of atrial fibrillation on heart failure include loss of atrial contraction, tachycardia and irregular heartbeat. As a result, the incidence, exacerbation, rehospitalization, and mortality rates of heart failure increase.

In the future, the heart failure pandemic will become a major concern. The heart failure pandemic refers to a situation in which the number of heart failure patients is increasing globally and explosively due to aging and the rise of lifestyle-related diseases, placing a serious burden on healthcare and society. Japan was one of the first countries in the world to face this pandemic, and it is estimated that it will exceed 1.3 million by 2030. Cardiac rehabilitation is being seen as a promising solution to this heart failure pandemic (Balady et al., 2007; Japanese Society of Cardiac Rehabilitation, 2021a; 2021b; Piepoli et al., 2016; Takahashi and Mase, 2020; Thomas et al., 2020).

This paper presents a single-case study in which a specific patient with heart failure was observed, summarizing findings on heart failure, atrial fibrillation, hypertension, and pulse rate based on approximately one year of physiological data monitoring.

2. Subject's medical condition and treatment

2.1 Medical condition

Only one subject (male, 74 years old) was adopted in this study. His medical condition was diagnosed as severe condition, with hypertension and chronic tachycardic atrial fibrillation. Tachycardia is defined as the heart rate of 100 beats per minute or more, but his heart rate has been recently staying within the 70s to 80s. Atrial fibrillation is a type of arrhythmia in which, when chronic, the atria are constantly spasming, resulting in an irregular pulse. There were times when the arrhythmia temporarily subsided while undergoing cardiac rehabilitation, but once he stopped the rehabilitation, the seizures became constant. This disease is a progressive illness that becomes more likely with age. It is also a difficult disease to cure. Heart failure is a condition in which the heart's pumping mechanism, which sends blood throughout the body, is weakened, making it unable to deliver a sufficient amount of blood to the rest of the body. Furthermore, it causes blood pools in organs such as the lungs and liver, causing various symptoms including difficulty breathing, swelling, palpitations, and fatigue. Heart failure is not the name of a single disease, but rather refers to a syndrome of weakened cardiac function caused by various underlying conditions. The subject currently has no palpitations or fatigue, but there is slight swelling in the heel of the left foot. The important point to note about atrial fibrillation is that blood clots (thrombi) that form inside the heart can block blood vessels in the brain or the periphery of the heart (stroke, myocardial infarction). This symptom becomes more likely with age. The impetus for this research was the fact that the heart failure marker levels of the subject were found to be significantly above the normal range during a routine health checkup on January 23, 2024. The changes in heart failure marker levels are shown in Table 1. Furthermore, a diagram of the table is also shown in Figure 1. There are two types of heart failure markers, namely BNP and

Table 1: Changes in the heart failure marker levels (BNP, NT-proBNP) of the subjects

2024/01/23	NT-proBNP:	817 pg/ml	(Converted to NT-proBNP: Approximately 525 pg/ml)
2024/05/18	NT-proBNP:	771 pg/ml	
2024/08/02	BNP:	137.7 pg/ml	
2024/09/07	NT-proBNP:	820 pg/ml	
2024/11/09	NT-proBNP:	1158 pg/ml	
2025/01/07	NT-proBNP:	1138 pg/ml	
2025/01/10	BNP:	205.9 pg/ml	(Converted to NT-proBNP: Approximately 927 pg/ml)
2025/04/05	NT-proBNP:	730 pg/ml	
2025/06/14	NT-proBNP:	871 pg/ml	
2025/10/04	NT-proBNP:	1266 pg/ml	
2025/12/20	NT-proBNP:	1263 pg/ml	
2026/02/21	NT-proBNP:	1019 pg/ml	

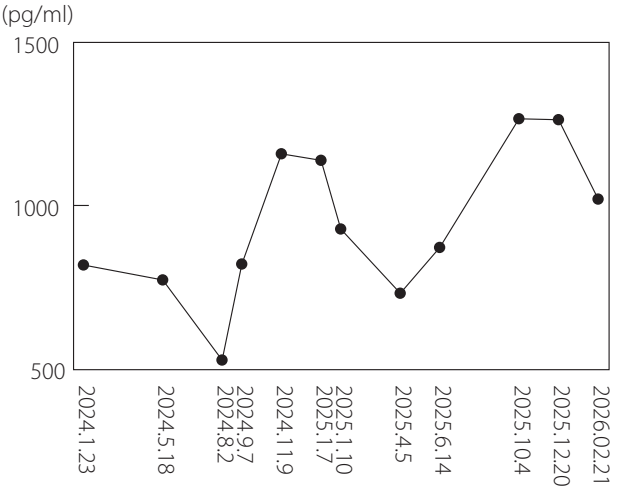

Figure 1: Changes in the heart failure marker levels (NT-proBNP)

NT-proBNP, with normal ranges of 18.4 pg/ml and 125 pg/ml, respectively. In this section, the interpretation of NT-proBNP is reinforced based on the literature (Anderson, 2025). NT-proBNP is identified as a highly sensitive rule-out biomarker, characterized by age dependency and a continuous nature, and should be interpreted in integration with clinical information.

2.2 Treatment

The current treatment is as follows:

- Medication and dietary therapy are provided for hypertension.
- Anticoagulant medication (Eliquis tablets) is prescribed for strokes and myocardial infarctions to mitigate the risk of thrombosis. Taking anticoagulant medications increases the risk of bleeding.
- The subject is taking an antiarrhythmic drug (Bisoprolol Fumarate Tablets 5 mg) for atrial fibrillation. There are limitations to the effectiveness of antiarrhythmic drugs. The subject no longer feels the effects of this medication. The catheter ablation treatment is usually performed in such cases. However, the specialist in charge says that there is a high possibility of recurrence, so the subject needs to be prepared to live with atrial fibrillation for the rest of his life.
- The subject had been performing a cardiac rehabilitation (Kouduki, 1994) for heart failure, developed at Tohoku University, from the end of March 2025 to the end of June 2025. Furthermore, the subject had decided to limit himself only to walking approximately 5,000 steps per day from April 2025 onwards.

2.3 Medication

The medication is as follows:

- Eliquis tablets (after breakfast, after dinner)
  Effects: To prevent blood from clotting and thus prevent blood clots
- Bisoprolol fumarate tablets 5 mg (after breakfast)
  Effects: To prevent angina attacks, lower blood pressure, regulate irregular heartbeats, help the heart function
  Note: dizziness and other symptoms may occur
- Lisinopril 10 mg tablets (after breakfast)
  Effects: To lower blood pressure, help the heart function
  Note: dizziness and other symptoms may occur
- Tsumura Goshajinkigan Extract Granules (107) (after each meal)
  Effects: To relieve swelling and itching, improve blurred vision, relieve symptoms such as pain, numbness, and coldness in the lower back and legs, improve symptoms such as difficulty urinating, frequent urination, and polyuria, compensate for the decline in physical function
- Methycobal tablets (after each meal)
  Effects: To relieve numbness
- Febuxostat 10 mg tablets (after dinner)
  Effects: To suppress uric acid synthesis
- Naftopidil 50 mg tablets (after breakfast)
  Effects: To relieve symptoms associated with benign prostatic hyperplasia
- Rize Tablets 5 mg (at bedtime)
  Effects: To make patient sleep soundly, relieve muscle stiffness, relieve anxiety and tension
- Adephos Kowa Granules 10 % (after each meal)
  Effects: To improve blood flow
- Tocopherol nicotinate capsules 100 mg (after each meal)
  Effects: To improve blood flow and blood lipid levels

3. Measurement Methods and Conditions

Monitoring was limited to a single, specific subject. The measured data included body weight, blood pressure, hypertension classification, heart rate, irregular pulse wave detection, and step count. Step count was recorded on a daily basis, while the other parameters were measured twice per day (upon waking and before going to bed). For all parameters except step count, the average of the two daily measurements was used.

The measurement devices employed were as follows:

- Weighing scale: TANITA, BC-760 (1), serial number 8220527
- Maximum capacity: 150 kg; body fat percentage measurement resolution: 0.1 %; minimum display: 100 g
- Blood pressure monitor: OMRON upper-arm blood pressure monitor, HCR-7107

4. Biometric data monitoring

- The weight measurements and cardiovascular examination results from the subject's past health checkups are shown in Table 2. The subject's height is 172.7 cm. This table shows that the hypertension develops gradually, and the ratio of body weight to height increases. At this time, the arrhythmias were not yet detected on the electrocardiogram. The abnormality was found in the electrocardiogram markers four months later.
- Data collection of the subject began on March 22, 2025. Weight was measured twice a day, once upon waking and once before going to bed, and the average value is derived. The value upon waking was taken before taking the medication. Systolic blood pressure, diastolic blood pressure, and pulse rate were also measured twice, once upon waking and once before going to sleep, and these average values were derived. The irregular pulse waves are treated as arrhythmias in this paper. The changes in weight and blood pressure are shown in Figure 2 to Figure 8. These trends show that, firstly, the changes in body weight be-

Table 2: Subject's past health checkup weight measurements and cardiovascular examination results

Check date	Weight (kg)	Blood pressure (systolic) (mmHg)	Blood pressure (diastolic) (mmHg)	Electrocardiogram (findings)
2018/08/20	73.5	123	81	normal range
2019/08/19	72.0	128	81	normal range
2020/09/23	73.0	137	82	range of hypertension
2021/09/22	73.0	144	86	range of hypertension
2023/09/21	71.5	145	91	range of hypertension

tween waking and going to sleep are very similar, with only a difference of about 1 kg at most. The changes in blood pressure between waking up and going to sleep are generally similar. The changes in systolic and diastolic blood pressure upon waking and before going to sleep are also quite similar. The weight is higher when going to sleep than when waking up. Both systolic and diastolic blood pressure are higher upon waking than before going to sleep. The diastolic blood pressure is high upon waking, indicating hypertension, but the blood pressure actually becomes low after breakfast. This is thought to be the effect of the medication. It is thought that losing weight would lower blood pressure, but it sometime increased. This phenomenon is shown in Figure 2 and Figure 4.

- The weight trends at waking and going to bed were very similar (similar relationship), with the weight at bedtime being about 1 kg heavier than at waking. This is thought to be due to the influence of metabolism. Under the conditions of this experiment, the difference between waking and going to bed decreased rapidly (May 24th to May 30th) when weight was rapidly reduced.
- The weekly changes in pulse rate in the morning and evening are shown in Figure 9 to Figure 12. The pulse rate trends are almost the same at waking and going to bed, with only slight variations during the summer months. The variation is at most about 10. In terms of seasonal variation, the pulse rates tend to be about 10 higher at both waking and going to bed during the summer months. Also, pulse rates tend to be higher at bedtime than at waking during the summer months.
- The weekly "percentage of patients without arrhythmias" are shown in Figure 13 to Figure 16. The cardiac rehabilita-

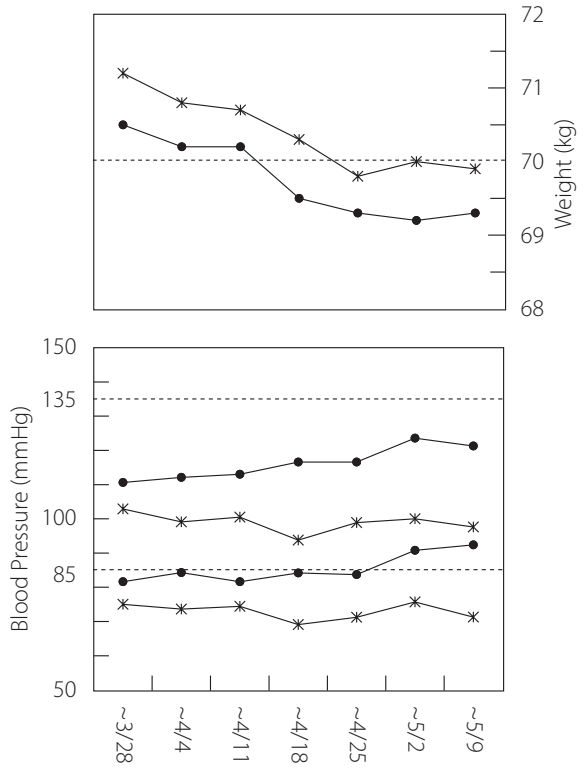

Figure 2: Weekly changes in weight and blood pressure (morning and evening) from March 22 to May 9, 2025
Note: ● indicates waking up and ✳ indicates going to bed.

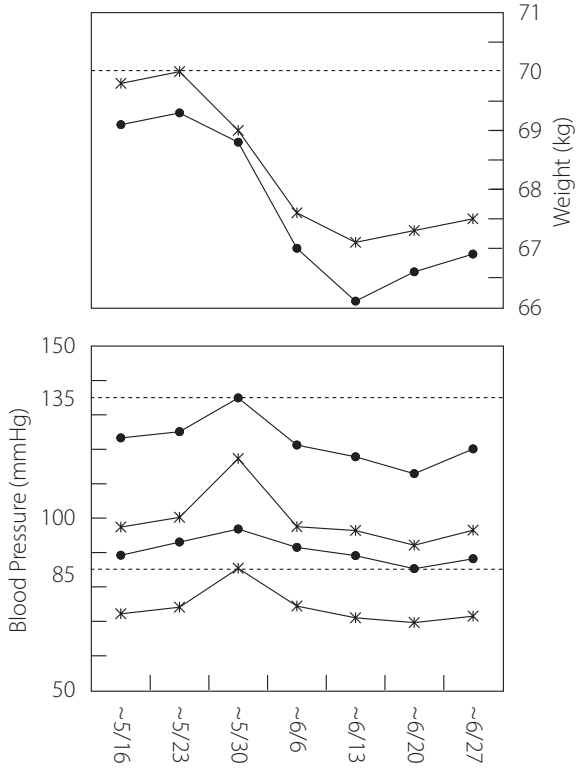

Figure 3: Weekly changes in weight and blood pressure (morning and evening) from May 10 to June 9, 2025
Note: ● indicates waking up and ✳ indicates going to bed.

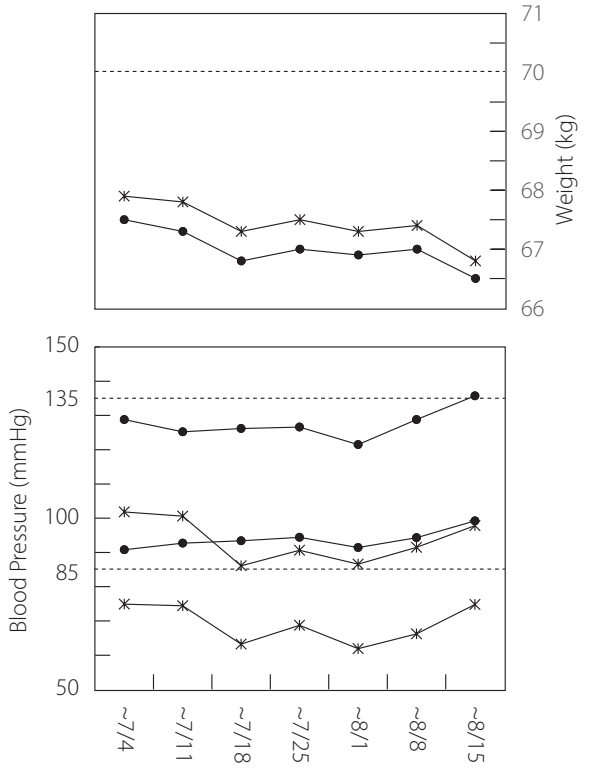

Figure 4: Weekly changes in weight and blood pressure (morning and evening) from June 28 to August 15, 2025
Note: ● indicates waking up and ✳ indicates going to bed.

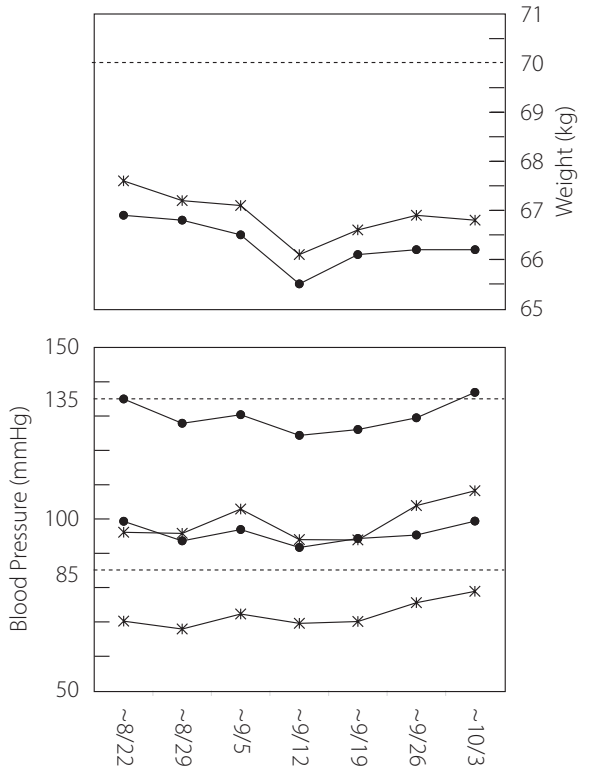

Figure 5: Weekly changes in weight and blood pressure (morning and evening) from August 16 to October 3, 2025
Note: ● indicates waking up and ✳ indicates going to bed.

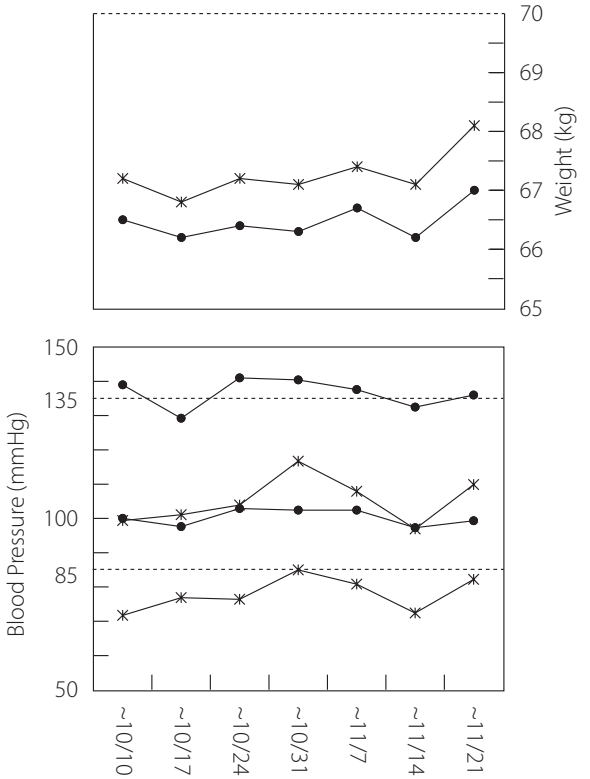

Figure 6: Weekly changes in weight and blood pressure (morning and evening) from October 4 to November 21, 2025
Note: ● indicates waking up and ✳ indicates going to bed.

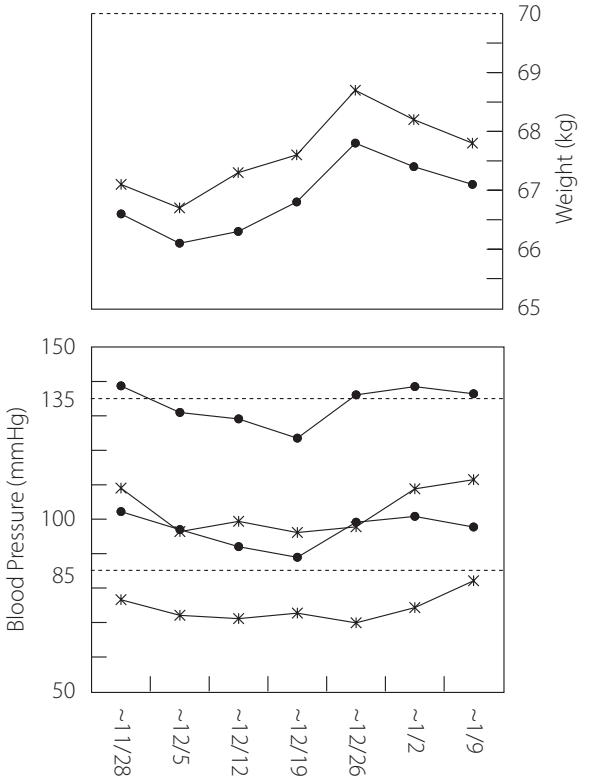

Figure 7: Weekly changes in weight and blood pressure (morning and evening) from November 22, 2025 to January 9, 2026
Note: ● indicates waking up and ✳ indicates going to bed.

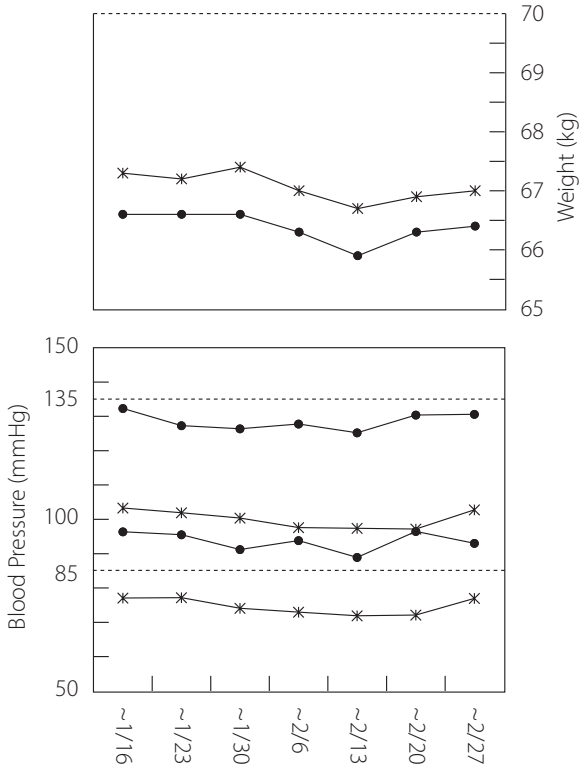

Figure 8: Weekly changes in weight and blood pressure (morning and evening) from January 10 to February 27, 2026
Note: ● indicates waking up and ✳ indicates going to bed.

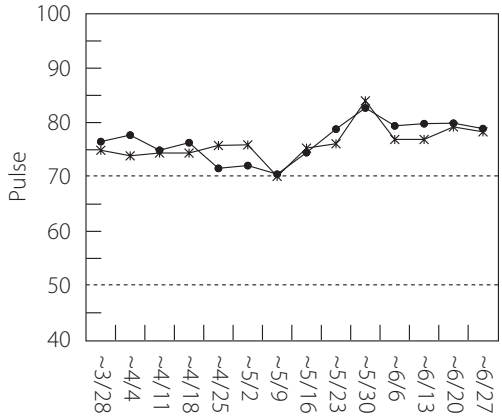

Figure 9: Weekly change in pulse rate (morning and evening) from March 22 to June 27, 2025
Note: ● indicates waking up and ✳ indicates going to bed.

tion developed at Tohoku University was implemented from February. 2025 to around the end of June 2025 (Kouduki, 1994). Although the rehabilitation period was short, the weekly "percentage of days without arrhythmia" gradually increased. He adopted to take approximately 5,000 steps per day for cardiac rehabilitation in July 2025, but his condition fluctuated between improving and worsening and gradually deteriorated over time. The weekly "non-arrhythmia ratio" is increasingly becoming zero.

- The average of two measurements is used for systolic blood pressure, diastolic blood pressure, and pulse rate in this paper. At that time, the difference between the two measurements of the subject's systolic and diastolic blood pressure was approximately 15 or less. Furthermore, there

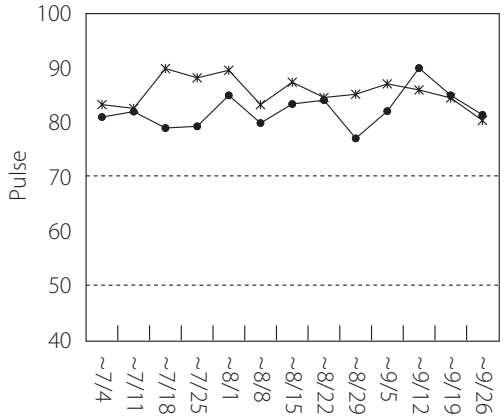

Figure 10: Weekly change in pulse rate (morning and evening) from June 28 to September 26, 2025
Note: ● indicates waking up and * indicates going to bed.

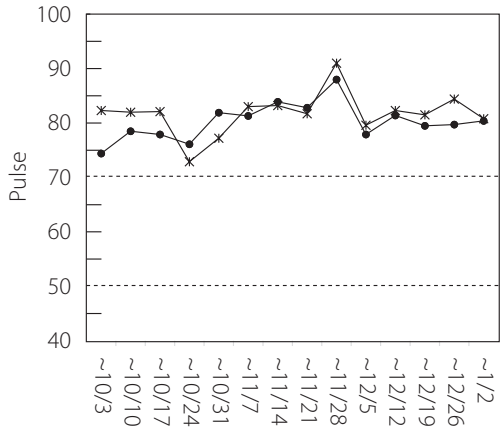

Figure 11: Weekly change in pulse rate (morning and evening) from September 27, 2025 to January 2, 2026
Note: ● indicates waking up and ✳ indicates going to bed.

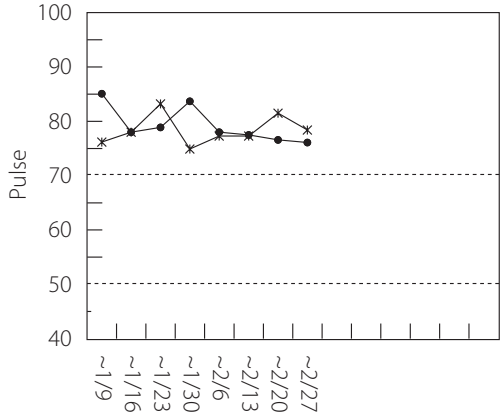

Figure 12: Weekly change in pulse rate (morning and evening) from January 3 to April 10, 2026
Note: ● indicates waking up and ✳ indicates going to bed.

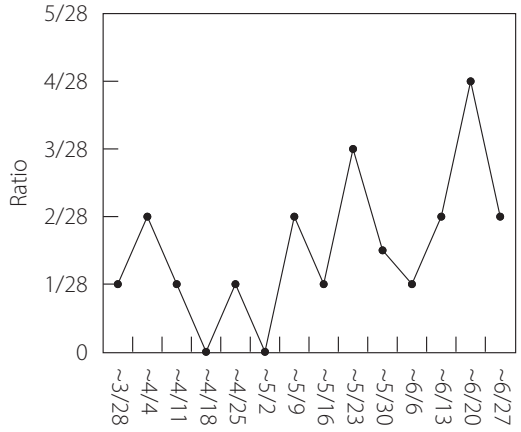

Figure 13: Weekly non-arrhythmia ratio from March 22 to June 27, 2025

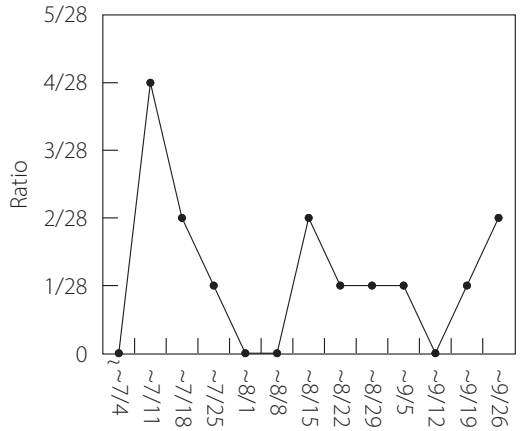

Figure 14: Weekly non-arrhythmia ratio from June 22 to September 26, 2025

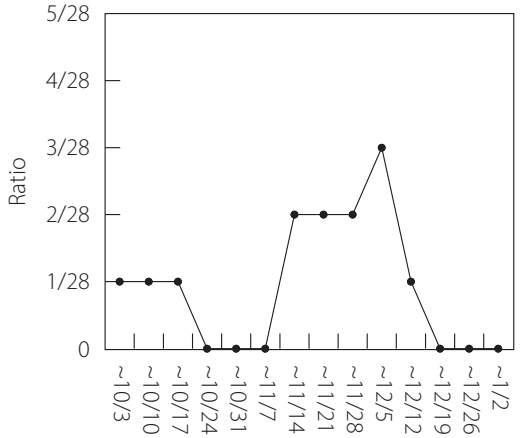

Figure 15: Weekly non-arrhythmia ratio from September 27, 2025 to January 2, 2026

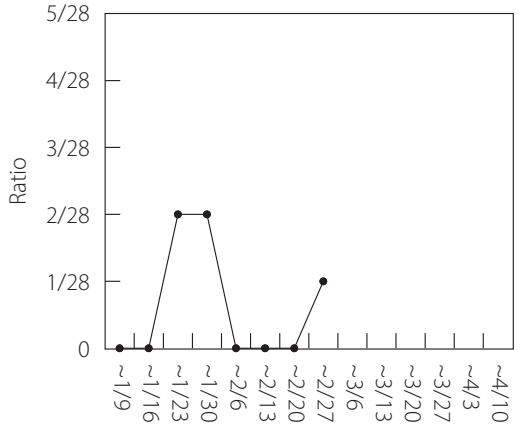

Figure 16: Weekly non-arrhythmia ratio from January 3 to April 10, 2026

was a tendency for the difference in systolic blood pressure to be larger. The measured pulse rate is approximately 80-100. The difference between the two measurements is approximately 20 or less. These trends remained unchanged except during the summer months. The data for the week from January 7 to January 13, 2026 are shown in Table 3 as a concrete example.

- The average values and average variability of systolic blood pressure, diastolic blood pressure and pulse rate obtained in Table 3 are shown in Table 4. The percentage-increase or decrease of the following measured values (second measurement value) is shown in Table 5. Both systolic and diastolic blood pressure, as well as pulse rate, are lower when sleeping than when awake. This factor is thought to be due to the bisoprolol fumarate tablets and lisinopril tablets that are taken every morning after breakfast. In the second measurement, the rate of increase or decrease (average value of variability/average value) showed that the variability for the pulse rate was much larger (about twice as large) while the one for blood pressure was about 5 % larger.
- The weight characteristics at waking and bedtime are very similar, with the weight at bedtime being about 1 kg heavier than the one at waking. This is thought to be due to the influence of metabolism. In this study, the rapid weight loss (Figure 3) resulted in a sharp decrease in the difference between waking and bedtime weight (May 24th to May 30th).
- The experimental data suggests that blood pressure tends to increase as the weight increases. However, it is unclear whether blood pressure decreases as the weight decreases.
- While worsening atrial fibrillation (increased frequency of arrhythmias) can lead to elevated heart failure markers, it does not necessarily mean that heart failure is severe. The reasoning behind this is that there may be no signs of heart failure such as shortness of breath or chest tightness even if the heart failure marker (NT-proBNP) is elevated. The subject in this study has also experienced this. Even though NT-proBNP levels exceeded 1200 pg/ml, which is 10 times the borderline level of 125 pg/ml, there were no signs of heart failure and the pulse rate remained in the 70-80 range. It could also be said conversely that the worsening of heart failure exacerbated the atrial fibrillation.

- The subject began to use the cardiac rehabilitation method developed by Tohoku University (Kouduki, 1994) around mid-February 2025. After that, he aimed for about 5,000 steps per day starting around the end of June, but his atrial fibrillation worsened. Specifically, the "percentage of non-arrhythmias" on a weekly basis became zero in many cases. However, his pulse rate remained in the 70-80 range.
- On Sunday, February 22, 2026, his pulse rate at bedtime

Table 3: Variations between two measurements taken over a one-week period from January 7 to January 13, 2026

Date	January 7th (Wed.)					
Measurement time	Waking up			Bedtime		
	1st time	2nd time	Variability	1st time	2nd time	Variability
Systolic blood pressure(mmHg)	142	131	11	112	113	1
Diastolic blood pressure(mmHg)	90	97	7	78	76	2
Pulse rate (time/min)	95	86	9	68	79	11
Date	January 8th (Thu.)					
Measurement time	Waking up			Bedtime		
	1st time	2nd time	Variability	1st time	2nd time	Variability
Systolic blood pressure (mmHg)	128	115	13	102	114	12
Diastolic blood pressure (mmHg)	88	92	4	70	80	10
Pulse rate (time/min)	104	82	22	65	82	17
Date	January 9th (Fri.)					
Measurement time	Waking up			Bedtime		
	1st time	2nd time	Variability	1st time	2nd time	Variability
Systolic blood pressure (mmHg)	124	131	7	101	114	13
Diastolic blood pressure (mmHg)	93	93	0	79	89	10
Pulse rate (time/min)	87	85	2	76	62	14
Date	January 10th (Sat.)					
Measurement time	Waking up			Bedtime		
	1st time	2nd time	Variability	1st time	2nd time	Variability
Systolic blood pressure (mmHg)	145	142	3	106	109	3
Diastolic blood pressure (mmHg)	97	93	4	84	78	6
Pulse rate (time/min)	70	82	12	68	75	7
Date	January 11th (Sun.)					
Measurement time	Waking up			Bedtime		
	1st time	2nd time	Variability	1st time	2nd time	Variability
Systolic blood pressure (mmHg)	139	127	12	108	110	2
Diastolic blood pressure (mmHg)	88	94	6	78	77	1
Pulse rate (time/min)	77	80	3	82	86	4
Date	January 12th (Mon.)					
Measurement time	Waking up			Bedtime		
	1st time	2nd time	Variability	1st time	2nd time	Variability
Systolic blood pressure (mmHg)	139	135	4	111	109	2
Diastolic blood pressure (mmHg)	93	103	10	80	79	1
Pulse rate (time/min)	87	85	2	80	75	5
Date	January 13th (Tue.)					
Measurement time	Waking up			Bedtime		
	1st time	2nd time	Variability	1st time	2nd time	Variability
Systolic blood pressure (mmHg)	129	131	2	94	91	3
Diastolic blood pressure (mmHg)	96	105	9	71	77	6
Pulse rate (time/min)	60	64	4	76	83	7

Table 4: Average values and the average variabilities of systolic blood pressure, diastolic blood pressure, and pulse rate

Measurement period	from January 7 (Wed.) to January 13 (Tue.)			
Measurement time	Waking up		Bedtime	
	Average	Dispersion of AVG.	Average	Dispersion of AVG.
Systolic blood pressure (mmHg)	132.7	7.4	106.7	5.1
Diastolic blood pressure (mmHg)	94.4	5.7	78.3	5.1
Pulse rate (time/min)	81.7	7.7	75.5	9.3

Table 5: Increase/decrease rate of the second measurement

Measurement period	from January 7 (Wed.) to January 13 (Tue.)	
Measurement time	Waking up	Bedtime
	Increase/decrease rate	Increase/decrease rate
Systolic blood pressure (mmHg)	5.6 %	4.8 %
Diastolic blood pressure (mmHg)	6.0 %	6.5 %
Pulse rate (time/min)	9.4 %	12.3 %

was 66 beats per minute, which is 10 beats less than the previous night. The arrhythmia did not occur at that time. His rate upon waking up that day was 78.0 beats per minute. And the blood pressure upon waking was 134.5 (systolic) and 101.5 (diastolic). The blood pressure at bedtime was 91.5 and diastolic blood pressure was 72.0.

- Both his systolic and diastolic blood pressure upon waking have increased compared to a year ago.
- The pressure is fluctuating slightly, and heart failure markers are gradually increasing. However, the pulse rate remains in the 70s to 80s, and there are almost no signs of heart failure.
- Since the AST (Aspartate Aminotransferase) level is within the normal range, it can be believed that there is no damage to the heart muscle. And the subject's LD/IFCC ratio was 242, which is above the normal range (124-222), indicating damage to cardiac cells and heart failure. Here, LD stands for Lactate Dehydrogenase, and IFCC means International Federation of Clinical Chemistry and Laboratory Medicine.
- Based on Figure 2, the correlation between body weight at waking and at bedtime was calculated, yielding a correlation coefficient of 0.97, indicating a strong correlation. Similarly, from the curves in the figure, it can be seen that there is also a correlation between blood pressure measurements at waking and at bedtime. Furthermore, the curves indicate a correlation between systolic and diastolic blood pressure values. However, when the correlation coefficient between body weight at waking and systolic blood pressure at waking was calculated, it was found to be −0.96, indicating a negative correlation.

5. Conclusion

Improvement through medication alone is rarely expected in the case of chronic heart failure. Recurrence is common even after catheter treatment in elderly patients. The cardiac rehabilitation is a scientifically proven and effective method for strengthening the heart, and its effectiveness cannot be denied. However, it cannot be expected to produce the same direct results as surgical procedures. The effects of rehabilitation are indirect, and the results vary from patient to patient. The dietary therapy has a very significant impact on the heart, blood vessels, and blood pressure. Therefore, the following comprehensive treatment is necessary, namely: "cardiac rehabilitation, " "diet therapy, " "taking medication," "catheter treatment," "patient medical knowledge," The authors hope that the knowledge gained from this study will be helpful to patients with similar conditions. Finally, the authors sincerely hope that this will give some patients a sense of purpose in life even if a complete cure is not possible.

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