stress has been shown to be associated with increased arterial stiffness and vascular endothelial dysfunction (9). In the present study, however, there were no significant differences in the baseline BP or the frequency of underlying DM between the two groups. Therefore, the observations in this study strongly suggest that the elevation of arterial stiffness observed in the hypotension group was induced by vascular endothelial dysfunction associated with the increased vascular oxidative stress. Because elevated arterial stiffness with vascular endothelial dysfunction indicates reduced vascular compliance, it is possible that vessels in the hypotension group no longer responded appropriately to the changes of the intravascular volume during HD, resulting in excessive fall of blood pressure.

In the present study, although a significant decrease of the SBP was observed during the HD in the hypotension group, no significant change of the HR associated with the hypotension was observed during the HD in this group. It is well documented that the HR increases, as a compensatory hemodynamic response, according to the intravascular volume removed or decrease of BP during HD. The present study also showed that the value of LF/HF during HD was significantly reduced in the hypotension group than in the non-hypotension group. The LF/HF is known to indicate the dominance of sympathetic nervous activity over parasympathetic one (13). Previous studies have demonstrated lower value a of LF/HF during HD in patients with HD-induced hypotension than in those without HD-induced hypotension, indicating that intradialytic hypotension may occur as a consequence of impaired sympathetic responses to progressive hypovolemia (4,5). Because the findings shown in the present study are consistent with the aforementioned findings, it is suggested that the excessive fall of blood pressure during HD is attributable to inadequate compensatory sympathetic nervous activity. In addition, we also demonstrated significant increase of the HF during HD along with elevated sympathetic nervous activity in the non-hypotension group in the present study. It is well known that the HF reflects the parasympathetic nervous activity and exhibits reciprocal fluctuations against the sympathetic nervous activity (13). Because we assessed the autonomic nervous activity using the average values of HF and LF/HF recorded during HD, total power spectra of HF and LF/HF are considered to increase during the HD to maintain the hemodynamically stable condition. Previous study has also demonstrated significant increase in HF cooperated with the elevation of LF/HF in some condition such as deep and slow breathing as a result of the modulation in autonomic nervous system (18). Furthermore, entropy was significantly increased during HD as compared with the baseline in the non-hypotension group, and also significantly higher in the non-hypotension group than in the hypotension group. Entropy is well-known as an indicator of the adequacy of cardiovascular control, and an increase of entropy has been demonstrated to reflect better autonomic balance (19). Therefore, these findings observed in this study seem to reflect the inadequate cardiovascular response associated with imbalance between the sympathetic and parasympathetic nervous activities in the hypotension group.

The present study demonstrated that the physical activity level, as assessed using an accelerometer, was significantly lower in the hypotension group than in the non-hypotension group. Many studies have demonstrated that regular exercise may have beneficial effects on health, such as reduction in the risk of cardiovascular diseases, improvement of the insulin sensitivity and better control of the BP (20). However, HD patients are extremely inactive because of the time constraint imposed by the regular HD sessions and various symptoms associated with HD (21). Reduced physical activity level may be one of the factors promoting the development of arteriosclerosis, and is recognized as a critical risk factor for the development of cardiovascular events (22). Because arterial stiffness is also known to be closely correlated with the prevalence of arteriosclerosis (23), the reduced physical activity level may have been responsible for the elevated arterial stiffness in the hypotension group observed in this study. The results of the present study are consistent with reports of the negative correlation of the arterial stiffness, as measured by the ba-PWV, with the physical activity level in elderly subjects, and of the lower ba-PWV value in regularly trained subjects than in age-matched sedentary subjects (24). Furthermore, it was also reported that the exercise training improved not only the physical functioning and QOL, but also reduced the arterial stiffness, a known risk factor for cardiovascular diseases, even in HD patients (25). Therefore, we believe that a regular exercise training program can be an effective intervention for improvement of potential vascular malfunction and the consequent reduction in the risk of HD-induced hypotension in CRF patients undergoing regular maintenance HD.

Unlike the previous reports, no significant difference in prevalence of diabetes was shown between the two groups in the present study, which may have resulted from small sample size of the study. Thus, further study will be needed to investigate the effect of diabetes on cardiovascular and autonomic nervous responses that are involved with inducing an intradialytic hypotension. Even though there is the limitation as written above, we consider that our results shown in the present study are useful for the clinical evaluation of intradialytic hypotension and could propose the following statements summarized in the conclusion.

CONCLUSION

We conclude that vascular malfunction and imbalance of autonomic nervous activity may be the major factors involved in the excessive fall of blood pressure during HD in some patients with CRF undergoing maintenance HD.

REFERENCES

1. Shoji T, Tsubakihara Y, Fujii M, Imai E. Hemodialysis-associated hypotension as an independent risk factor for two-year mortality in hemodialysis patients. *Kidney Int* 2004;66:1212–20.
2. Perazella M. Approach to patients with intradialytic hypotension: a focus on therapeutic options. *Semin Dial* 1999;12:175–18.
3. Daugirdas JT. Pathophysiology of dialysis hypotension: an update. *Am J Kidney Dis* 2001;38:S11–S17.
4. Pelosi G, Emdin M, Carpeggiani C et al. Impaired sympathetic response before intradialytic hypotension: a study based on spectral analysis of heart rate and pressure variability. *Clin Sci* 1999;96:23–31.
5. Cavalcanti S, Severi S, Chiari L et al. Autonomic nervous function during haemodialysis assessed by spectral analysis of heart-rate variability. *Clin Sci* 1997;92:351–9.
6. Yamanaka N, Aoyama T, Ikeda N, Higashihara M, Kamata K. Characteristics of heart rate variability entropy and blood pressure during hemodialysis in patients with end-stage renal disease. *Hemodial Int* 2005;9:303–8.
7. Rubinger D, Revis N, Pollak A, Luria MH, Sapoznikov D. Predictors of haemodynamic instability and heart rate variability during haemodialysis. *Nephrol Dial Transplant* 2004;19:2053–60.
8. Duman D, Demirtunc R, Erdogan B, Sahin GM, Karadag B. Dialysis-induced hypotension is associated with impaired aortic elasticity in patients undergoing chronic hemodialysis. *Blood Press Monit* 2008;13:73–8.
9. Cai H, Harrison DG. Endothelial dysfunction in cardiovascular diseases: the role of oxidant stress. *Circ Res* 2000;87:840–4.
10. Imai E, Fujii M, Kohno Y et al. Adenosine A1 receptor antagonist improves intradialytic hypotension. *Kidney Int* 2006;69:877–83.
11. Green J, Fukuhara S, Shinzato T et al. Translation, cultural adaptation, and initial reliability and multitrait testing if kidney disease quality of life instrument for use in Japan. *Qual Life Res* 2001;10:93–100.
12. Yamashina A, Tomiyama H, Takeda K et al. Validity, reproducibility, and clinical significance of noninvasive brachial-ankle pulse wave velocity measurement. *Hypertens Res* 2002;25:359–64.
13. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrocardiology. Heart rate variability: standards of measurement, physiological interpretation, and clinical use. *Circulation* 1996;93:1043–65.
14. Lipsitz LA. Age-related changes in the "complexity" of cardiovascular dynamics: a potential marker of vulnerability to disease. *Chaos* 1995;5:102–9.
15. Dworschak M, Lorenzl N, Rapp HJ. Diminished circadian rhythm of heart rate variability after aortic surgery appears to be independent of myocardial ischemia. *Jpn Heart J* 2003;44:645–54.
16. Kumahara H, Schutz Y, Ayabe M et al. The use of uniaxial accelerometry for the assessment of physical-activity-related energy expenditure: a validation study against whole-body indirect calorimetry. *Br J Nutr* 2004;91:235–43.
17. Blacher J, Guerin AP, Pannier B, Marchais SJ, Safar ME, London GM. Impact of aortic stiffness on survival in end-stage renal disease. *Circulation* 1999;99:2434–9.
18. Zamaklar-Trifunović D, Seferović PM, Petrović M et al. The influence of respiratory pattern on heart rate variability analysis in heart failure. *Serb Arc Med* 2007;135:135–42.
19. Khalfen ESH, Temkin BM. Clinical value of the study of cardiac rhythm entropy in patients with myocardial infarction. *Kardiologiia* 1983;23:37–41.
20. Sato Y, Nagasaki M, Nakai N, Fushimi T. Physical exercise improves glucose metabolism in lifestyle-related diseases. *Exp Biol Med* 2003;228:1208–12.
21. Johansen KL, Chertow GM, Ng AV et al. Physical activity levels in patients on hemodialysis and healthy sedentary controls. *Kidney Int* 2000;57:2564–70.
22. Blair SN, Kohl HW III, Barlow CE et al. Changes in physical fitness and all-cause mortality: a prospective study of healthy and unhealthy men. *JAMA* 1995;273:1093–8.
23. Popele NM, Grobbee DE, Bots ML et al. Association between arterial stiffness and atherosclerosis. The Rotterdam Study. *Stroke* 2001;32:454 -60.
24. Hirata T, Morita T, Souma H, Yoshida S, Kitani T. Relationship between habitual exercise and regional arterial stiffness in elderly subjects with lifestyle-related disease. *Jpn J Clin Sports Med* 2008;1:17–23.
25. Mustata S, Chan C, Lai V, Miller JA. Impact of an exercise program on arterial stiffness and insulin resistance in hemodialysis patients. *J Am Soc Nephrol* 2004;15:2713–8.

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Arterial pulsation on a human patient simulator improved students' pulse assessment

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ABSTRACT

Even with basic cardiovascular lectures, undergraduates do not usually experience the reality of palpation and, therefore, cannot integrate their physiological knowledge. We created a pulse training scenario of human patient simulators (HPS) to recognize and assess the normal and arrhythmic pulse of the radial artery. All 25 participants were recruited as volunteers to the study from the School of Allied Health Sciences, Kitasato University. Participants received training in radial palpation of arrhythmias on HPS. The test scenario included 10 arrhythmic pulses combined with normal pulses and weak pulses. The average examination scores significantly improved, from 23.8 ± 2.8 of the pretest to 72.9 ± 3.4 of the posttest (mean and SE, N = 25, p < 0.00001). A questionnaire and general written comments for the palpation training were positive. The palpation training improved the participants' assessment of radial pulses.

Keywords: Education; Physiology; Human Patient Simulator; Arrhythmic Pulse; Pulse Assessment

1. INTRODUCTION

Detailed physical examinations frequently provide important information needed to assess the cardiovascular system. The first step in evaluating patients with palpitations is to determine whether or not their symptoms are actually due to arrhythmias. Palpation of the carotid and radial arteries is simple and often an underutilized low-cost method [1]. Pulse characteristics must be assessed simultaneously and carefully for rate (tachycardic, normal, or bradycardic, or any irregularity), and volume. Irregular pulse can be regularly irregular e.g. bigeminy or irregularly irregular e.g. atria fibrillation [2]. Although arrhythmias are easily assessed with an electrocardiogram (ECG) and Holter monitoring to determine the type, precise palpation of the arterial pulse helps in diagnosing arrhythmias, even asymptomatic ones, and is also necessary to determine blood flow adequacy. Although it is simple for medical staff to understand the importance of palpation, many undergraduate students do not realize their arterial pulses as cardiovascular events and how they are related to their own physiology. There is likely dissociation between their knowledge and reality. Hands-on experience of their own normal pulse and pulses of arrhythmias, even with virtual reality devices, should deepen their understanding of cardiovascular physiology.

Development of human patient simulators (HPSs) began in the late 1960s and accelerated in the late 1980s and early 1990s [3]. HPSs are used at medical centers, universities, and colleges in the USA and throughout the world [3,4]. HPSs are also used in the education and training of healthcare professionals and undergraduates in scientific inquiry [3,5-7]. They are used to teach basic skills, such as respiratory physiology and cardiovascular hemodynamics, and advanced clinical skills, e.g. management of difficult airways, tension pneumothorax, pulmonary embolism, and shock [3]. However, we could not obtain an HPS scenario that focused on the palpation skill of arterial pulses and arrhythmias.

We created an original simple training scenario of arterial pulses and arrhythmias so that the students can realize the relationships between pulses and cardiovascular hemodynamics. The palpation training was evaluated by pre- and postexamination and a questionnaire. Ethical approval for this study was granted by the Kitasato University Medical Ethics Committee, 6 September 2011, Section B 11-76.

2. MATERIALS AND METHODS

2.1. Participants

All the participants, aged between 20 and 27 years, were recruited as volunteers to the study (21.5 ± 0.5 mean ± SE; 16 males, 9 females; clinical engineering course 23, occupational therapy course 2) from the School of Allied Health Sciences, Kitasato University. Certain participants had an explicit interest in emergency medicine and had experience of AED (automated external defibrillator) training. All of the participants had been lectured on cardiac physiology and cardiac diseases. This research ethics board approved the study and consent was obtained from all participants.

2.2. Procedure and Design

We created a palpation training scenario of HPS to recognize characteristics of pulse sequences related with arrhythmia. The scenario included six arrhythmias, normal sinus rate, bradycardia, tachycardia, atrial fibrillation (AF), ventricular premature contraction (bigeminy), and arrest. They were combined with normal pulse or weak pulse on the radial artery (**Figure 1**).

Participants were trained on arterial palpation of arrhythmias on HPSs in a mini lecture. They could palpate the pulse as many times as they wanted. The participants were asked to describe their assessment for each pulse examination before the mini lecture (pretest) and again after the mini lecture (posttest). In the examinations, 10 kinds of arrhythmias were sequentially presented by an instructor in each scenario. The ECG monitor was not presented merely to train the palpation techniques. Each participant was requested to palpate the HPS's radial artery and assess and write a diagnosis within 1 minute for each arrhythmia. The response form was not a multiple choice form to avoid guesses as answers. After the examinations, the participant was asked to answer the questionnaire to evaluate the training using a 4-point scale ranging from "agree strongly" to "disagree strongly" and to add comments on his or her impressions of the experience.

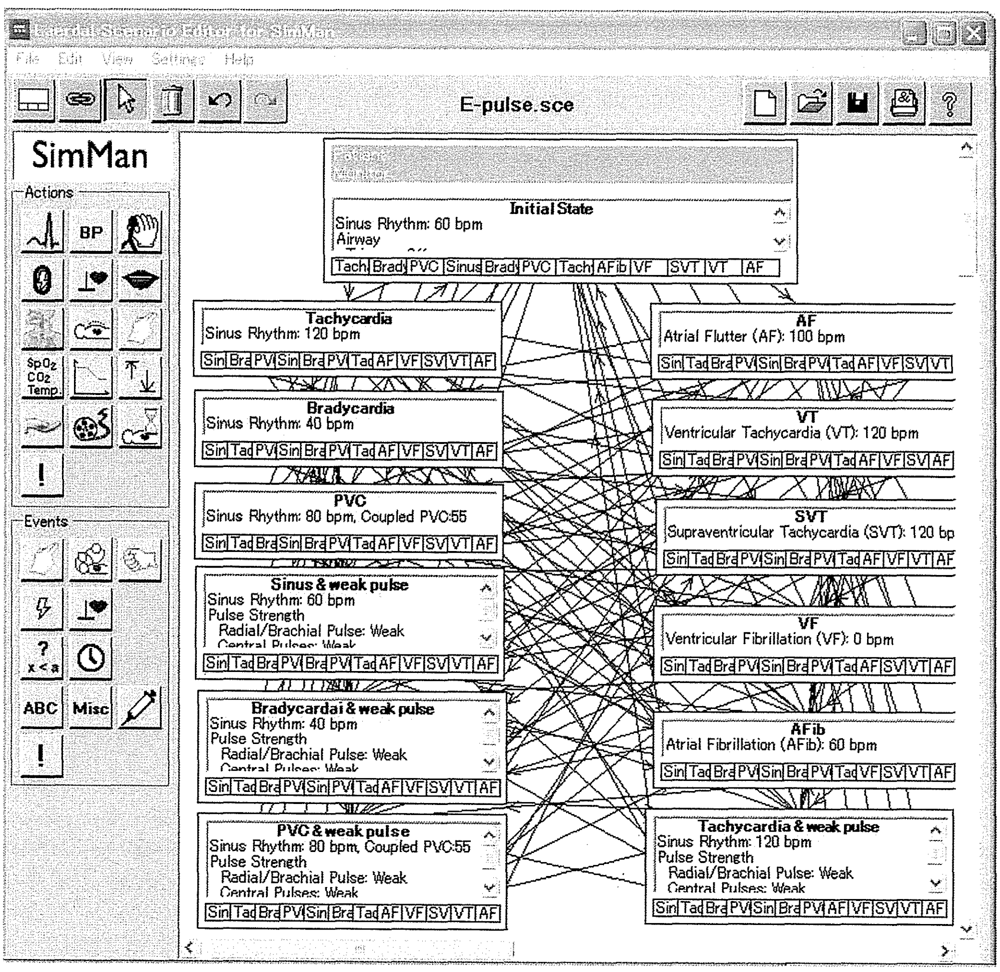

Figure 1. Creating the scenario of the palpitation training on a scenario editor in the HPS. Each box frame in the window includes a setting of pulse rhythm, pulse rate, and pulse strength on HPS. The complicated arrow lines between the frames indicate the next setting.

2.3. Statistical Analysis

Test scores were summarized for each student's pretest and posttest. The scores were summarized using descriptive statistics including means and standard errors (SEs). Comparison of the scores was accomplished using pared *t*-test analysis. The scores were considered significantly different at $p \leq 0.05$.

3. RESULTS

The training scenario including 10 arrhythmic pulses combined with normal pulses or weak pulses was manually created with the scenario editor of the HPS.

After the scenario was manually loaded and run, arrhythmia menu was listed in a control window (**Figure 2**). Requested arrhythmia pulses were presented on radial and cervical artery of the HSP. The mean of test scores was significantly improved from 23.8 ± 2.8 of pretest to 72.9 ± 3.4 of posttest (mean and SE, $N = 25$, $p < 0.00001$) (**Table 1**). Questionnaires and general written comments were very positive (e.g. "promotes critical thinking", "practice without risk", etc.) Ninety-six per cent of the students rated the simulator training as "excellent" or "very good".

4. DISCUSSION

HPS has various basic functions and a scenario constructor/editor to create a new training scenario of specific clinical cases. Many various scenarios were created and presented throughout the world. Most scenarios are focused on learning how to recognize and treat rare, complex, and clinical problems. However, to our knowledge, this study is the first in which an HPS scenario has been focused on palpation with arrhythmias, basic but important skills. Arterial pulse waveforms, such as normal, water-hammer pulse, bifid pulse, and pulsus alternans, are usually monitored on a polygraph screen in practice. The volume of the pulse is a subtle sign to recognize low and high volume pulse (increased, normal or reduced) [1]. This medical skill requires years of experience with many patients and many careful examinations [1,2]. The pulsation and arrhythmias could not be realized even with standardized patients (actors and actresses trained to portray patients with specific clinical symptoms and conditions). Although this study mainly intended to deepen the participants' knowledge and interest in cardiovascular physiology, not to increase their clinical skills, they will assess pulsation exactly on real patients in the clinical setting.

The contemporary HPS has palpable pulses, heart, breath, and bowel sounds and the arm for intravenous infusion [4]. However, time was required for faculty to become sufficient familiar with the technology to be able to use it effectively for student learning [6,8]. We also recognized the mechanical limitations of the HPSs with

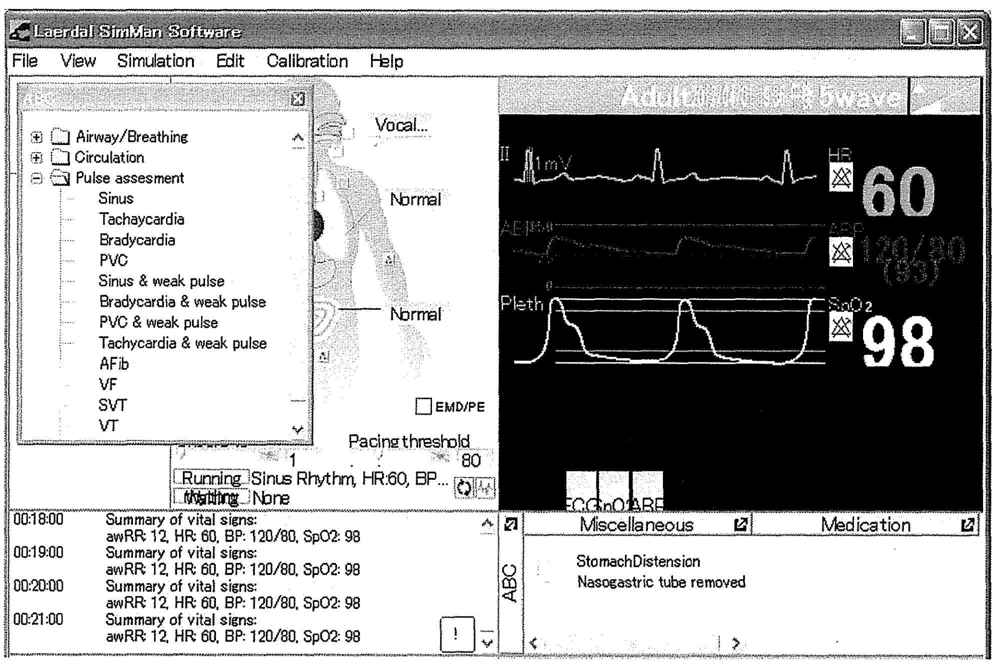

Figure 2. A control window on the main window of HPS. A list of training pulses is displayed in the control window. The ECG, arterial pulse and saturation of oxygen are sequentially drawn in a monitor panel on the main window. The two windows are only shown in operator's PC. The display is hidden to participants in training.

Table 1. Summary of test scores and questionnaire results.

Arrhythmia (pulse rate/min)	Pre-test	Post-test (corrected, N = 25)
Sinus (60)	18 (72%)	21 (84%)
Tachycardia (120)	14 (56%)	23 (92%)
Bradycardia (40)	15 (60%)	23 (92%)
Premature ventricular contraction (80)	2 (4%)	18 (72%)
Sinus (60 with weak pulse)	2 (4%)	11 (44%)
Bradycardia (40 with weak pulse)	3 (12%)	12 (44%)
PVC (80 with weak pulse)	2 (8%)	18 (72%)
Tachycardia (120 with weak pulse)	4 (16%)	25 (100%)
Atrial fibrillation (60)	1 (4%)	8 (32%)
Ventricular fibrillation (0)	0 (0%)	19 (76%)

Questionnaire for participants' knowledge about arrhythmias (N = 25)

Do you have any arrhythmias? Yes (often, sometimes) 3 No 22

Have you learned about arrhythmias in any lectures? Yes 21 No 4

How would you rate your understanding of arrhythmias?

None 0 Only names of some diagnoses 1 Know some diagnoses 20 Ability to read an ECG 4

Have you measured your own pulse of the radial artery correctly? Yes 12 No 13

Do you know there is a palpitation function on HPSs? Yes 7 No 18

Questionnaire for participants' impressions of the training

How would you rate your understanding of pulses of the radial artery?

Deepened 15 Better 10 Not improved 0 Confused 0

How well do you feel the training helped you understand arrhythmias?

Strongly 21 Fairly 3 Not well 0 Not effective 0

How well do you feel the training helped you understand cardiovascular physiology?

Strongly 11 Fairly 13 Not well 1 Not effective 0

How would you recommend this training to a colleague?

Strongly 15 Slightly 9 Not well 1 Not at all 0

How do you assess the training? (Comments)

- "Sensing pulses with my fingers is important for studying arrhythmias."
- "Sensing pulses deepens my understanding of medical knowledge with realism."
- "I received useful feedback from this training."
- "This training was a good use of my time."
- "This training should be a required component of medical education."
- "This training is relatively hard."
- "Increasing difficulty of the simulated pulses helps."
- "This training was fun." Etc.

making the scenarios. All mechanical parameters of the HPSs must completely be set in scenarios because the parameters are independent, not linked with other parameters, and constant. The used HPS can pulsate arteries as only normal, weak, or none, not perfectly replicate various pulse waveforms. In 1982, Kreitenberg *et al.* [1] created a simple teaching device for examination of the arterial and venous pulse that created palpable pulses with changing mechanical cams. The device exactly reproduced physiologic tracings of arterial pulsations, normal, bisferious, hyperkinetic, alternans, slow-rising, and anacrotic and dicrotic waves. For ECG, although the HPS simulates a fibrillated baseline of AF on a monitor screen, pulse volume on the artery is not changed without manual setting of arterial systolic and diastolic blood pressure in a scenario. RR intervals of AF are relatively constant, which may be misleading to understand real AF pulses. These results revealed inadequacies of current HPSs and suggest possible details and functions of the next generation of HPSs that would be more accurate and realistic. However, participants' evaluations revealed positive reviews of this palpation experience in HPS.

Confucius said, "I hear and I forget. I see and I remember. I do and I understand". Likewise, students' experience of palpation could indirectly deepen their understanding of arrhythmia and bridge the gaps between cardiovascular physiology and clinical phenomena.

5. CONCLUSION

We created an original palpation training scenario to detect pulses in the radial artery. The palpation training was evaluated with pre- and post-examination scores and positive comments. We also recognized the incompleteness of HPSs and that the details and functions of future HPSs can technically be improved.

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REFERENCES

[1] Kreitenberg, A., Karliner, J.S., Engler, R.L. and Marchand, E.R. (1982) A simple teaching device for examination of the arterial and venous pulse. *American Journal of Cardiology*, **50**, 1391-1393. doi:10.1016/0002-9149(82)90480-5

[2] Nair, B.K. (2011) The pulse. In: Nair, B.K., Ed. *Adult Physical Examination*. Accessed 22 August 2011. http://physicalexamination.org/?q=node/33

[3] Good, M.L. (2003) Patient simulation for training basic and advanced clinical skills. *Medical Education*, **37**, 14-21. doi:10.1046/j.1365-2923.37.s1.6.x

[4] Wilson, M., Shepherd, I., Kelly, C. and Pitzner, J. (2005) Assessment of a low-fidelity human patient simulator for the acquisition of nursing skills. *Nurse Education Today*, **25**, 56-67. doi:10.1016/j.nedt.2004.10.004

[5] Hyatt, J.P. and Hurst, S.A. (2010) Novel undergraduate physiology laboratory using a human patient simulator. *Medical Education*, **44**, 523. doi:10.1111/j.1365-2923.2010.03651.x

[6] McCausland, L.L., Curran, C.C. and Cataldi, P. (2004) Use of a human simulator for undergraduate nurse education. *International Journal of Nursing Education Scholarship*, **1**, 1-17. doi:10.2202/1548-923X.1035

[7] Wallin, C.J., Meurling, L., Hedman, L., Hedegård, J. and Felländer-Tsai, L. (2007) Target-focused medical emergency team training using a human patient simulator: Effects on behaviour and attitude. *Medical Education*, **41**, 173-180. doi:10.1111/j.1365-2929.2006.02670.x

[8] Brannan, J.D., White, A. and Bezanson, J.L. (2008) Simulator effects on cognitive skills and confidence levels. *Journal of Nursing Education*, **47**, 495-500. doi:10.3928/01484834-20081101-01

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Letters to the Editor

Effects of electrical muscle stimulation in a left ventricular assist device patient☆

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Implantation of left ventricular assist devices (LVAD) is increasingly used in patients with advanced chronic heart failure (CHF). Exercise capacity and quality of life in LVAD patients are reduced [1], and conventional rehabilitation procedures, such as endurance and resistance training, may not be feasible in this population. Neuromuscular electrical stimulation (NMES) has recently been proposed as a method for both endurance and strength training in patients with advanced CHF [2], but no data are available about the feasibility and efficacy of NMES in CHF patients implanted with LVAD.

A 51-year-old man (96.2 kg, 165 cm) with advanced CHF due to idiopathic dilated cardiomyopathy and recent LVAD (HeartMate II) implantation as bridge to transplantation was referred to our institute for rehabilitation. At admission, left ventricular ejection fraction was 25%; pro-brain natriuretic peptide, 2466 pg/ml; NYHA, class III; blood pressure, 85/60 mmHg; heart rate, 81 bpm (sinus rhythm); and transcutaneous hemoglobin saturation, 93%. NMES was started 33 days after LVAD implantation. Maximal quadriceps isometric strength (QIS) (hand-held dynamometer fixed on a rigid bar) expressed as mean of right and left leg peak values, chair stand test, short physical performance battery (SPPB) [3], one-leg standing time, functional reach test, 10-m comfortable walking speed, and step width were measured at protocol start, after 7 days, at protocol end (15 days), and 8 days after protocol end. Blood pressure, heart rate, Borg scale (0–10), and LVAD performance parameters (pump flow, pulsatility index, and pump power) were evaluated every 5 minutes during each NMES session. The LVAD pump speed was set at 9400 rpm. A portable battery-powered, programmable stimulator (ES-360; Ito; Tokyo, Japan) was used for NMES. Self-adhering electrodes (50×90 mm) were placed on the quadriceps (5 cm distal to the inguinal fold and 3 cm proximal to the patella upper border) and gastrocnemius (3 cm distal to the knee joint fold and close to the distal muscle ending) muscles. Alternating sinusoidal current (2.5 kHz) was delivered in bursts with a 50 Hz carrier frequency; impulse trains were delivered for 5 s and paused for 5 s. The current intensity was the highest tolerable up to 80 mA (mean value per session 75 ± 11 mA). The patient was treated twice a day (30-minute sessions—24 sessions over 15 days) in a semi-recumbent position, with knees flexed at 40° and ankles dorsi-flexed on a flat board. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki, and was approved by the Ethics Committee of Veruno Scientific Institute. Informed consent was obtained from this patient.

At baseline, maximal QIS (53% of predicted value), chair stand test time, SPPB score, and 10-m comfortable walking speed were severely reduced (Table 1). Over the NMES period, a progressive and marked improvement of these parameters (+26%, +44%, +71%, and +77%, respectively) was observed, which was maintained 8 days after protocol end (Table 1). Of note, repeated measures analysis of variance showed no significant changes in LVAD performance and hemodynamic parameters during NMES sessions over the whole treatment period (Fig. 1).

Table 1
Muscle strength, balance and walking performance at baseline, 7 and 15 days of NMES, and 8 days after NMES end.

	Baseline	7 days	15 days	8 days after NMES end
Maximal QIS (kg)	28.7	31.2	36.1	35.8
Chair stand test time (s)	19.6	15.5	10.9	10.1
SPPB score	7	10	12	12
One-leg standing time (s)	2.81	6.09	8.52	7.86
Functional reach (cm)	28.5	41.5	43.5	43.0
10-m comfortable walking speed (m/s)	0.71	1.14	1.25	1.23
Step width (m/step)	0.53	0.67	0.71	0.71

QIS, quadriceps isometric strength; SPPB, short physical performance battery; NMES, neuromuscular electrical stimulation.

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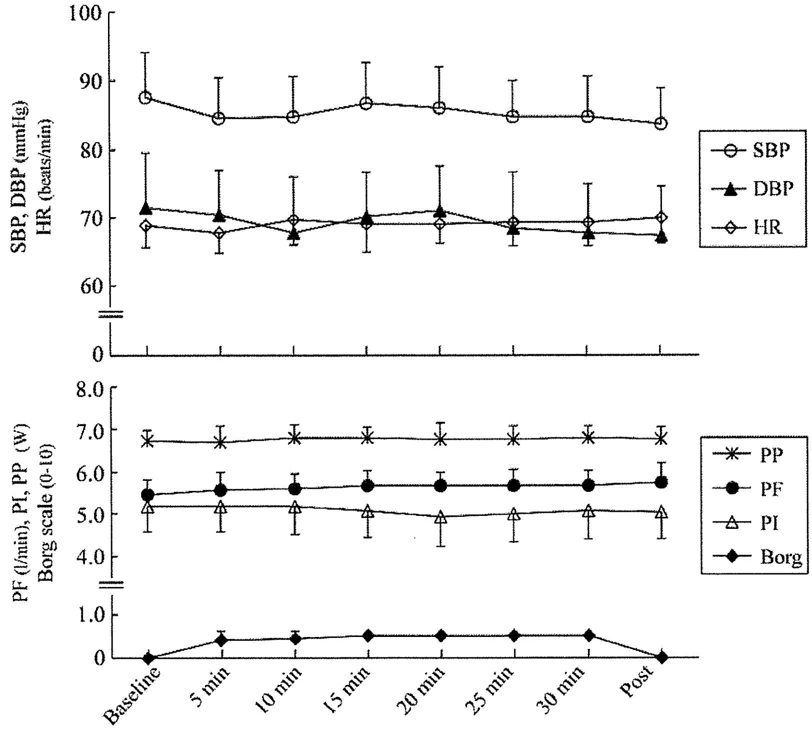

Fig. 1. Left ventricular assist device performance and hemodynamic parameters during neuromuscular electrical stimulation sessions. Data are presented as average of 24 sessions. SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate; PF, pump flow; PI, pulsatility index; PP, pump power.

This case report demonstrates a progressive and marked improvement of maximal QIS, chair stand test time, SPPB score, and 10-m comfortable walking speed over a 15-day NMES period in a LVAD patient. We used 2.5 kHz alternating current and 50 Hz carrier frequency, a stimulation modality not evaluated to date. The improvement in QIS was superior to that obtained in CHF using 10 to 25 Hz frequencies and similar to that reported using a 50 Hz frequency [2]. However, unlike our short-term protocol, the latter has been described after 6–8 weeks treatment periods. Interestingly, a recent study has demonstrated that NMES-induced muscle strength gain could be ascribed to adaptations occurring within the central nervous system [4]; moreover, activation of various brain areas has been observed during a single NMES session [5]. These mechanisms could account for the short-term improvement observed in this report. Additionally, no studies have addressed the effects of NMES on SPPB, balance function, and walking speed in patients with CHF. The observed increase in SPPB is noteworthy, as SPPB is known to be a strong predictor of functional disability and mortality in both healthy subjects and older patients with CHF [6]. Finally, the absence of changes in LVAD performance and hemodynamic parameters during NMES sessions is an important finding, testifying to quadriceps and gastrocnemius NMES safety and feasibility in this population.

In summary, this case report demonstrates that short-term NMES improved muscle strength, balance function, and walking speed in a LVAD-implanted CHF patient without affecting LVAD performance and hemodynamic parameters. Randomized clinical trials are needed to confirm these preliminary results.

The authors of this manuscript have certified that they comply with the Principles of Ethical Publishing in the International Journal of Cardiology (Shewan and Coats 2010; 144:1–2).

References

[1] Kugler C, Malehsa D, Tegtbur U, et al. Health-related quality of life and exercise tolerance in recipients of heart transplants and left ventricular assist devices: a prospective, comparative study. J Heart Lung Transplant 2011;30:204–10.

[2] Sbruzzi G, Ribeiro RA, Schaan BD, et al. Functional electrical stimulation in the treatment of patients with chronic heart failure: a meta-analysis of randomized controlled trials. Eur J Cardiovasc Prev Rehabil 2010;17:254–60.

[3] Guralnik JM, Simonsick EM, Ferrucci L, et al. A Short Physical Performance Battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol 1994;49:M85–94.

[4] Gondin J, Brocca L, Bellinzona E, et al. Neuromuscular electrical stimulation training induces atypical adaptations of the human skeletal muscle phenotype: a functional and proteomic analysis. J Appl Physiol 2011;110:433–50.

[5] Smith GV, Alon G, Roys SR, Gullapalli RP. Functional MRI determination of a dose-response relationship to lower extremity neuromuscular electrical stimulation in healthy subjects. Exp Brain Res 2003;150:33–9.

[6] Volpato S, Cavalieri M, Sioulis F, et al. Predictive value of the Short Physical Performance Battery following hospitalization in older patients. J Gerontol A Biol Sci Med Sci 2011;66A:89–96.

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Walking Speed in Patients With First Acute Myocardial Infarction Who Participated in a Supervised Cardiac Rehabilitation Program After Coronary Intervention

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SUMMARY

This study aimed to evaluate the degree of reduction in walking speed in patients with acute myocardial infarction (AMI) compared to age-matched community-dwelling people and identify factors associated with walking speed. The subjects were 210 middle-aged and 188 elderly patients with a first AMI (AMI group) and 198 age-matched community-dwelling people with no medical events (non-AMI group). We measured maximum walking speed in all subjects and collected clinical data, including that related to motor function, at the end of a supervised cardiac rehabilitation program in the AMI group. Data were analyzed based on age and sex. Walking speed in men and women in the middle-aged AMI subgroup decreased to 77.9% and 75.7% relative to that of the non-AMI subgroup matched by sex, respectively; walking speed in men and women in the elderly AMI subgroup decreased to 78.7% and 74.2% relative to that of the non-AMI subgroup matched by sex, respectively. Moreover, 6.4% of men and 23.8% of women in the middle-aged AMI subgroup, and 28.8% of men and 43.5% of women in the elderly AMI subgroup, had a slower walking speed compared to their respective non-AMI groups, which may contribute to an increased risk for cardiovascular mortality. Stepwise multiple regression analysis for motor function revealed that only leg strength in the middle-aged AMI subgroup, and both leg strength and standing balance in the elderly AMI subgroup, were associated with walking speed, regardless of sex after adjusting for clinical characteristics. These results suggest that evaluation and management of walking speed are necessary in implementing effective disease management for patients with first AMI. (Int Heart J 2012; 53: 347-352)

Key words: Standing balance, Leg strength

Walking speed, or gait speed, is a parameter of growing interest for the clinical evaluation of prognosis after adverse health-related events such as falls, hospital admission, and difficulty performing physical activities of daily living (ADL) among community-dwelling people.[1-5] A recent prospective cohort study reported that a slower walking speed was strongly associated with cardiovascular mortality in a population of well-functioning elderly people.[5] The Heart Failure and A Controlled Trial Investigating Outcomes of Exercise TraiNing (HF-ACTION) showed that greater clinical benefits, such as reduced mortality or hospitalization, were observed among patients with heart failure who adhered to a higher volume of exercise, which was calculated by multiplying exercise intensity by the time spent exercising.[6,7] Patients with chronic heart failure in this trial participated in supervised exercise training, followed by a 3-month home-based exercise program. Walking speed, an indicator of exercise intensity, was closely related to the volume of exercise in HF-ACTION, as walking was the preferred physical activity at home that required no special exercise equipment. Furthermore, many studies have shown that walking ability, as reflected by maximum walking speed, is strongly associated with the total volume of physical ADL in community-dwelling people.[8,9] Accordingly, evaluation and management of walking speed may be necessary for implementing effective disease management and secondary prevention interventions for cardiac patients. Despite this, only a few studies have examined walking speed among cardiac patients in the recovery phase. Ostir, *et al*[10] reported that the degree of deterioration in lower extremity performance during hospitalization was approximately 5- to 8-fold higher in cardiac patients compared to well-functioning elderly people. Thus, decreased walking speed may persist in cardiac patients even in the recovery phase.

The aim of this study was to evaluate the degree of reduction in walking speed in patients with a first myocardial infarction (AMI) who participated in a supervised cardiac rehabilitation program after coronary intervention, compared to age- and

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sex-matched community-dwelling adults who presented with no medical conditions. In addition, factors associated with walking speed were identified based on clinical data, including motor function, obtained at the end of the supervised cardiac rehabilitation program.

Methods

Study population: The study protocol was approved by the Ethics Committee of Kitasato University, and informed written consent was obtained from all participants after the study protocol was explained in detail. This study was conducted in accordance with the standards set forth by the latest revision of the Declaration of Helsinki. A consecutive series of 982 patients with AMI (age range, 40-79 years) who were admitted to the Cardiovascular Center of Kitasato University Hospital from March 2001 to October 2009 were recruited; these patients underwent percutaneous coronary intervention or coronary artery bypass surgery following coronary angiography to detect significant coronary lesions, and fully participated in a supervised cardiac rehabilitation program during hospitalization. Patients who were previously hospitalized for myocardial infarction or heart failure, who had uncontrolled arrhythmias, uncontrolled hypertension, chronic renal failure and had been on hemodialysis, peripheral artery disease, or diabetic retinopathy, who needed assistance with walking at hospital discharge, who had other conditions that limited walking ability (eg, dementia, low vision or blindness, orthopedic abnormalities, and paralysis due to stroke), were excluded from the study. Consequently, 210 middle-aged patients (178 men and 32 women) and 188 elderly patients (134 men and 54 women) with a first AMI (AMI group) were eligible for inclusion in the study.

Community-dwelling adults (age range, 40-79 years) registered at a temporary employment agency in Kanagawa, Japan, who were able to walk independently without any assistance or aid, had no history of cardiovascular disease, cerebrovascular disease, neuromuscular disease, or fractures in the spine or lower limbs, were recruited as controls. The temporary employment agency is an organization established to provide work or volunteer activities. Given that some individuals registered at the agency might demonstrate a higher level of daily physical activity than average people, those who self-reported that their physical activity levels were higher (eg, those who participated in regular or vigorous exercise or sports) were excluded from the study. Consequently, 87 middle-aged subjects (49 men and 38 women) and 111 elderly subjects (82 men and 29 women) were enrolled as controls (non-AMI group).

Subject characteristics: Age, sex, height, weight, and body mass index (BMI) were assessed for all subjects. In addition, the number of patients with coronary artery bypass graft surgery (CABG), left ventricular ejection fraction (LVEF) by echocardiography, peak serum creatine kinase (CK), brain natriuretic peptide (BNP) at hospital admission, and duration of hospital stay were assessed using clinical records for the AMI group.

Assessment of walking speed in AMI and non-AMI groups: Maximum walking speed was measured twice while subjects walked a distance of 10 m at maximum speed without running. The highest value for the maximum walking speed, expressed in meters per minute, was recorded. The measurement of maximum walking speed for the AMI group was performed at the end of a supervised cardiac rehabilitation program.

Assessment of motor function in AMI and non-AMI groups: Leg strength and standing balance were evaluated in the AMI and non-AMI groups. Maximum voluntary isometric knee extensor strength was measured twice with a hand-held dynamometer (μTas MT-1; Anima, Tokyo) while subjects sat on a chair with the hip and knee flexed at 90 degrees. Leg strength was expressed as a percentage of body weight (%BW) by dividing the average value of the right and left maximum isometric leg strength by body weight.

Standing balance was evaluated with two balance indices: one-leg standing time and the postural stability index. One-leg standing time reflects the ability of subjects to maintain the center of pressure within the base of support of their body. The length of time that subjects can stand on one leg with their eyes open, while holding their hands on their waist without any aid or falling, was measured using a stopwatch. The measurement was stopped if subjects hopped, stepped, put the raised foot on the other foot or on the floor, or released their hands from the waist to balance. Subjects underwent a second trial if they were unable to stand on one leg for 60 seconds in the first trial. The postural stability index reflects the ability to shift the center of pressure in a desired direction as far as possible within the base of support, and hold the center of pressure at the farthest position in the desired direction without falling. A stabilometer (gravicorder G-6100; Anima, Tokyo) was used to measure the postural stability index.[11] At first, subjects were asked to stand on the stabilometer platform barefoot with a stance width of 10 cm with their eyes open and their arms relaxed at their sides (neutral position) for 10 seconds. Subjects were then instructed to shift the center of pressure in the anterior, posterior, right, and left direction as far as possible, and hold the center of pressure at the farthest position in each direction for 10 seconds without lifting their feet off the stabilometer platform. The following equation was used: postural stability index = log {(area of stability limit + area of postural sway)/(area of postural sway)}. A low index score indicates poor standing balance.

Motor function measurements for the AMI group were performed at the end of a supervised cardiac rehabilitation program.

Supervised cardiac rehabilitation program for the AMI group: The supervised cardiac rehabilitation program at the Cardiovascular Center of Kitasato University Hospital consists of two exercise stages. The first stage comprises basic activity training, such as sitting up in bed, sit-to-stand motions, self-care, and walking within the ward, which are usually started on the second day after AMI. After patients complete the first stage, they proceed to the second stage, which involves a progressive combined exercise, in which stretching, resistance, and aerobic training are performed according to the American College of Sports Medicine's guidelines for exercise testing and prescription[12] and the Japanese Circulation Society's guidelines for rehabilitation in patients with cardiovascular disease (JCS 2007).[13] The cardiac rehabilitation exercise program is carried out for approximately 2 weeks during hospitalization unless the patient develops adverse symptoms or events after coronary intervention.

Statistical analysis: Differences in subject characteristics (age, height, weight, and BMI), maximum walking speed, and motor function (leg strength and standing balance) between the AMI and non-AMI groups were assessed for significance using Student's unpaired *t*-test; subjects were subdivided by age (middle-aged subjects, aged < 65 years; elderly subjects, aged ≥ 65 years) and sex. Data on maximum walking speed for all subjects by age and sex were assigned using a histogram of speed intervals (10 m/minute). To compare the degree of reduction in walking speed between middle-aged and elderly patients, or between men and women, maximum walking speed was expressed for each AMI subgroup by age and sex as a percentage of the mean value for the non-AMI subgroup matched by age and sex.

Univariate and multivariate regression analyses were conducted to identify factors associated with maximum walking speed in the AMI group. Correlations between age, BMI, LVEF, peak CK, BNP, duration of hospital stay, leg strength, one-leg standing time, index of postural stability, and maximum walking speed were analyzed in each AMI subgroup using Pearson's correlation coefficients. Stepwise multiple regression analysis was performed to identify independent factors associated with maximum walking speed using BMI, LVEF, BNP, duration of hospital stay, number of patients with CABG, leg strength, one-leg standing time, and index of postural stability in each AMI subgroup.

All analyses were performed using the Statistical Package for Social Sciences (SPSS version 12.0; SPSS, Chicago, IL, USA). $P < 0.05$ was considered statistically significant.

Results

Subject characteristics: The background characteristics, maximum walking speed, and motor function in all subjects by age and sex are shown in Tables I and II. No differences in height, weight, and BMI were found between the AMI and non-AMI groups regardless of age and sex.

Walking speed: Maximum walking speed in all AMI subgroups was significantly lower than that of non-AMI subgroups matched by age and sex ($P < 0.01$, respectively). The histograms of maximum walking speed by age and sex are shown in the Figure. The maximum walking speed in men and women in the middle-aged AMI subgroup decreased to 77.9% and 75.7%, respectively, relative to that of the non-AMI subgroup matched by sex; maximum walking speed in men and women in the elderly AMI subgroup decreased to 78.7% and 74.2%, respectively, relative to that of the non-AMI subgroup matched by sex.

Motor function: In the middle-aged AMI subgroup, leg strength and the postural stability index in men were significantly lower than those of non-AMI subgroups matched by age and sex ($P < 0.01$ and $P < 0.05$, respectively). Leg strength, one-leg standing time, and the postural stability index in women were significantly lower ($P < 0.01$, respectively). In the elderly AMI subgroup, leg strength, one-leg standing time, and the postural stability index in men and women were significantly lower than those of non-AMI subgroups matched by sex ($P < 0.01$, respectively).

Factors associated with maximum walking speed in the AMI group: Correlation coefficients for subject characteristics, motor function, and maximum walking speed in the AMI group by age and sex are shown in Table III. In the middle-aged AMI subgroup, the maximum walking speed in men was significantly correlated with the duration of hospital stay, leg strength, and one-leg standing time ($P < 0.01$, $P < 0.01$, and $P < 0.05$, respectively), and in women, with the duration of hospital stay, BNP, and leg strength ($P < 0.05$, $P < 0.05$, and $P < 0.01$, respectively). In the elderly AMI subgroup, the maximum walking speed in men was significantly correlated with the duration of hospital stay, BNP, leg strength, one-leg standing time, and the postural stability index ($P < 0.01$, $P < 0.01$, $P < 0.01$, $P < 0.01$, and $P < 0.01$, respectively), and in women, with height, leg strength, one-leg standing time, and the pos-

Table I. Subject Characteristics, Walking Speed, and Motor Function in Men in AMI and Non-AMI Groups

	Middle-aged		Elderly	
	non-AMI group	AMI group	non-AMI group	AMI group
Number of patients (n)	49	178	82	134
Age (years)	53.7 ± 7.0	53.7 ± 5.6	70.5 ± 3.8	70.8 ± 4.3
Height (cm)	168.7 ± 5.6	167.1 ± 6.0	162.4 ± 5.6	161.9 ± 6.1
Weight (kg)	67.8 ± 9.1	68.4 ± 9.6	62.1 ± 7.8	61.0 ± 10.3
BMI (kg/m^2)	23.7 ± 2.9	24.5 ± 3.1	23.5 ± 2.6	23.2 ± 3.2
LVEF (%)		49.5 ± 11.2		50.1 ± 11.2
Peak CK (IU/L)		2881.4 ± 2248.9		2155.4 ± 2137.0
BNP (pg/mL)		75.3 ± 123.4		231.0 ± 293.9
Percentage of patients				
CABG (%)		16.9		26.1
Diabetes mellitus (%)		53.9		34.6
Dyslipidemia (%)		86.5		49.3
Duration of hospital stay (days)		22.1 ± 10.0		25.4 ± 14.7
Maximum walking speed (m/minute)	145.4 ± 16.5	113.3 ± 17.1**	123.1 ± 20.2	96.9 ± 20.5††
Leg strength (%BW)	63.9 ± 16.7	56.3 ± 13.7**	60.2 ± 15.0	47.6 ± 13.4††
One-leg standing time (seconds)	58.2 ± 5.6	55.6 ± 12.6	48.3 ± 19.2	36.2 ± 23.8††
Postural stability index	1.73 ± 0.35	1.62 ± 0.31*	1.61 ± 0.30	1.22 ± 0.43††

Values are presented as mean ± SD. $^{*}P < 0.05$ and $^{**}P < 0.01$ versus middle-aged non-AMI group, $^{††}P < 0.01$ versus elderly non-AMI group. AMI indicates acute myocardial infarction; BMI, body mass index; LVEF, left ventricular ejection fraction; CK, creatine kinase; BNP, brain natriuretic peptide; CABG, coronary artery bypass graft; and BW, body weight.

Table II. Subject Characteristics, Walking Speed, and Motor Function in Women in AMI and Non-AMI groups

	Middle-aged		Elderly	
	non-AMI group	AMI group	non-AMI group	AMI group
Number of patients (n)	38	32	29	54
Age (years)	55.8 ± 5.2	57.4 ± 4.7	69.6 ± 3.3	70.9 ± 3.6
Height (cm)	156.2 ± 5.5	153.8 ± 5.0	150.7 ± 4.5	150.8 ± 4.5
Weight (kg)	53.0 ± 7.7	56.3 ± 9.9	52.1 ± 5.5	52.7 ± 8.4
BMI (kg/m^2)	21.7 ± 3.2	23.7 ± 3.8	23.0 ± 2.3	23.2 ± 3.4
LVEF (%)		50.4 ± 10.5		53.0 ± 13.4
Peak CK (IU/L)		1842.8 ± 1275.8		2261.9 ± 1779.2
BNP (pg/mL)		243.6 ± 358.6		200.3 ± 217.5
Percentage of patients				
CABG (%)		11.5		20.4†
Diabetes mellitus (%)		34.6		42.6†
Dyslipidemia (%)		53.8		59.3
Duration of hospital stay (days)		23.4 ± 10.9		25.5 ± 9.3
Maximum walking speed (m/minute)	127.1 ± 13.8	96.3 ± 18.6**	112.7 ± 9.2	83.6 ± 13.3††
Leg strength (%BW)	54.6 ± 12.2	41.7 ± 11.6**	52.6 ± 9.7	35.3 ± 9.9††
One-leg standing time (seconds)	60.0 ± 0.0	41.9 ± 23.9**	50.8 ± 15.7	22.9 ± 19.4††
Postural stability index	1.86 ± 0.20	1.37 ± 0.30**	1.56 ± 0.31	0.95 ± 0.50††

Values are presented as mean ± SD. $^{**}P < 0.01$ versus middle-aged non-AMI group, $^{\dagger}P < 0.01$ and $^{\dagger\dagger}P < 0.01$ versus elderly non-AMI group. AMI indicates acute myocardial infarction; BMI, body mass index; LVEF, left ventricular ejection fraction; CK, creatine kinase; BNP, brain natriuretic peptide; CABG, coronary artery bypass graft; and BW, body weight.

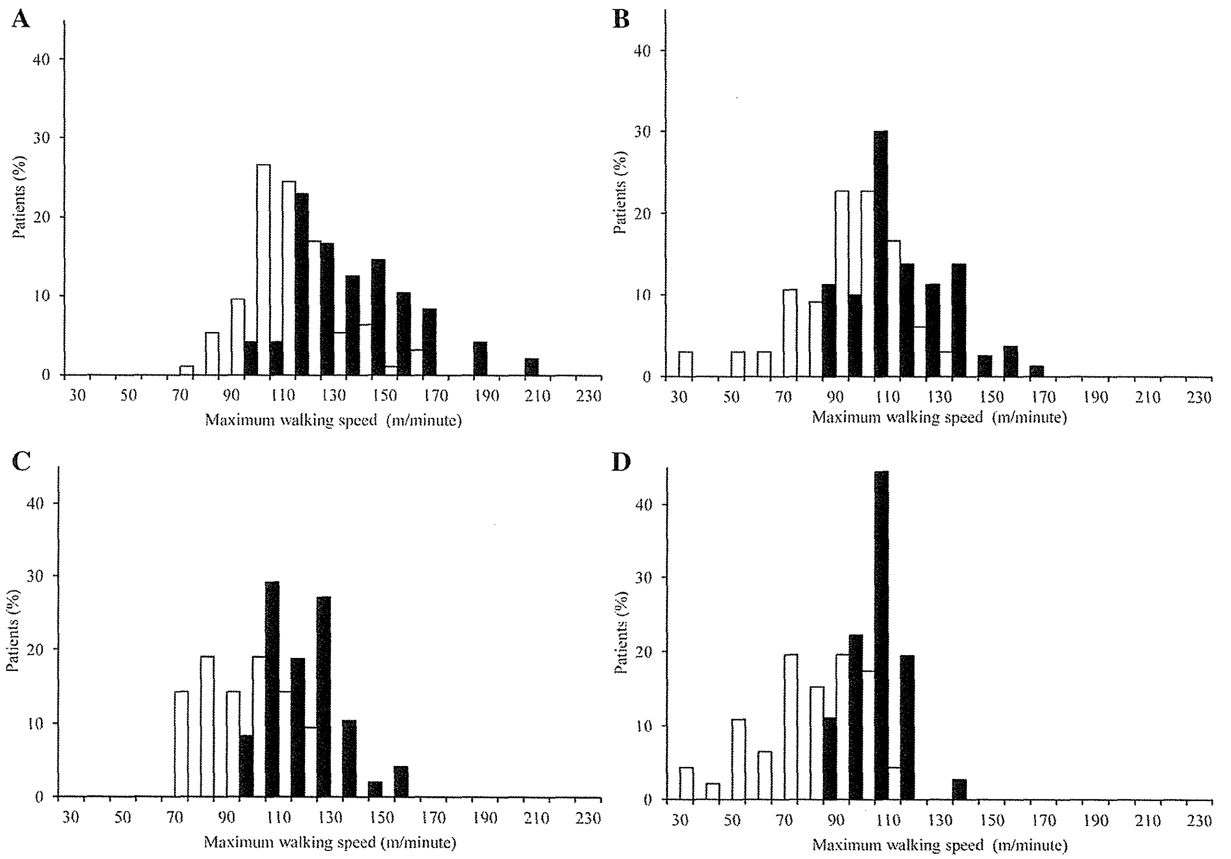

Figure. Histograms of maximum walking speed. Subjects walked a distance of 10 m at maximum speed without running. Maximum walking speed was calculated in meters per minute. Open and closed bars indicate AMI and non-AMI subgroups, respectively. **A:** Middle-aged men. **B:** Elderly men. **C:** Middle-aged women. **D:** Elderly women.

Table III. Univariate Analysis of Subject Characteristics and Motor Function Associated With Maximum Walking Speed in The AMI Group

	Pearson's correlation coefficient			
	Middle-aged men	Middle-aged women	Elderly men	Elderly women
Height	0.04	0.13	0.21	0.44*
Weight	0.03	-0.09	0.06	0.20
BMI	0.03	-0.22	-0.04	-0.03
Duration of hospital stay	-0.29**	-0.48*	-0.55**	-0.24
Peak CK	0.07	-0.35	0.03	-0.23
LVEF	0.05	0.26	-0.15	-0.29
BNP	-0.13	0.02*	-0.34**	0.22
Leg strength	0.42**	0.68**	0.58**	0.35*
One-leg standing time	0.23*	0.42	0.54**	0.36*
Postural stability index	0.17	0.08	0.46**	0.63**

$^{*}P < 0.05$, $^{**}P < 0.01$. AMI indicates acute myocardial infarction; BMI, body mass index; CK, creatine kinase; LVEF, left ventricular ejection fraction; and BNP, brain natriuretic peptide.

Table IV. Multivariate Analysis of Subject Characteristics and Motor Function Associated With Maximum Walking Speed in The AMI Group

	Unstandardized regression coefficient	Standardized regression coefficient	*P*
Middle-aged AMI subgroup			
Men			
Leg strength	0.66	0.43	< 0.01
Duration of hospital stay	-0.69	-0.25	< 0.05
Women			
Leg strength	1.30	0.71	< 0.01
Elderly AMI subgroup			
Men			
Leg strength	0.59	0.43	< 0.01
Postural stability index	16.36	0.35	< 0.01
BNP	-0.01	-0.21	< 0.05
Women			
Postural stability index	17.97	0.56	< 0.01
One-leg standing time	0.35	0.44	< 0.01
Leg strength	0.69	0.44	< 0.01

AMI indicates acute myocardial infarction and BNP, brain natriuretic peptide.

tural stability index ($P < 0.05$, $P < 0.05$, $P < 0.05$, and $P < 0.01$, respectively).

Independent factors associated with maximum walking speed identified by stepwise multiple regression analysis in the AMI group are shown in Table IV. In the middle-aged AMI subgroup, the duration of hospital stay and leg strength were significant and independent factors associated with maximum walking speed in men (adjusted $R^2 = 0.287$, $P < 0.01$), whereas leg strength was the only significant and independent factor associated with maximum walking speed in women (adjusted $R^2 = 0.452$, $P < 0.01$). In the elderly AMI subgroup, BNP, leg strength, and the postural stability index were significant and independent factors associated with maximum walking speed in men (adjusted $R^2 = 0.472$, $P < 0.01$), whereas leg strength, one-leg standing time, and the postural stability index were significant and independent factors associated with maximum walking speed in women (adjusted $R^2 = 0.652$, $P < 0.01$).

Discussion

The summary performance score consisting of scores for tests of repetitive chair stands, standing balance, and walking speed has been used to categorize community-dwelling people at risk for adverse events.[14-17] The summary performance score strongly reflects changes in lower-extremity physical function during hospitalization in subjects who suffered an AMI, chronic heart failure, and stroke.[10,18] On the other hand, recent reports demonstrated that walking speed alone could provide similar information on risk for adverse outcomes as does a more comprehensive summary measure of physical performance.[3,4] Accordingly, walking speed is considered a quick, safe, inexpensive, and highly reliable parameter in routine clinical practice for prognosis of the onset of adverse health-related events.

We assessed the degree of reduction in walking speed in patients with AMI compared to well-functioning adults who presented with no medical events. Walking speed in AMI subgroups according to age and sex were significantly lower than age- and sex-matched non-AMI subgroups; walking speed in the AMI group decreased to approximately 70% relative to that of the non-AMI group regardless of age and sex. Subjects included only those who had their first AMI and had not had any other conditions that limited walking ability, such as a stroke or orthopedic abnormality. Thus, our findings suggest that walking speed decreases occurred after AMI onset. Moreover, decreases in walking speed in patients with AMI might not improve even after participation in the supervised cardiac rehabilitation program following coronary intervention.

A recent cohort study on walking speed reported that community-dwelling people with a slow walking speed (≤ 90 m/minute for men and ≤ 81 m/minute for women) had an almost 3-fold higher risk for cardiovascular mortality compared to those with a fast walking speed (> 111 m/minute for men and > 90 m/minute for women).[5] As shown in the histograms of the Figure, our results indicate that 6.4% of men and 23.8% of women in the middle-aged AMI subgroup, and 28.8% of men and 43.5% of women in the elderly AMI subgroup, had a walking speed slower than those reported in the previous cohort study; this was not the case in the non-AMI group. The recommended walking speed for crossing over the road at a signalized intersection is reported to be 1.0-1.2 m/second (60-70 m/minute) for community-dwelling people.[19,20] In this study, only 9.1% of men and 24.4% of women in the elderly AMI subgroup had a walking speed less than 70 m/minute. The main goals of cardiac rehabilitation are to reduce the risk of another cardiovascular event or worsening of existing cardiovascular conditions, and to improve health-related quality of life and daily physical activity levels.[13,21] Our results suggest that evaluation and management of walking speed are necessary to implement effective disease management and secondary prevention interventions for cardiac patients.

We assessed factors associated with walking speed in the AMI group by multiple regression analysis to develop an effective disease management program for cardiac patients. Although motor function in the AMI subgroups according to age and sex were significantly lower than the age and sex matched non-AMI subgroups, the only motor function associated with walking speed in the middle-aged AMI subgroup was leg strength, whereas both leg strength and standing balance were associated with walking speed in the elderly AMI subgroup, regardless of sex after adjusting for clinical characteristics. The postural stability index, which reflects dynamic balance ability to shift the center of pressure as far as possible within the base of support of the body,[11] was associated with walking speed in both men and women in the elderly AMI subgroup. Our results were in line with previous studies reporting an association between dynamic standing balance and maximum walking speed in elderly community-dwelling people.[22-24] Thus, an improvement in standing balance may be necessary for maintaining or increasing walking speed in elderly patients with AMI.

We instituted a progressive combined exercise program involving stretching, resistance, and aerobic training according to guidelines for patients with AMI. However, only a few guidelines are available on improving walking speed in elderly cardiac patients. A specific exercise regimen aimed at improving standing balance should thus be recommended in a formal cardiac rehabilitation program for elderly patients.

Study limitations: This study has some limitations worth noting. First, we could not precisely measure the degree of reduction in walking speed in patients with AMI because walking speed prior to AMI onset was not available. Further studies will be needed to investigate the daily level of physical activity prior to AMI onset given the difficulties of assessing walking speed prior to or just after onset. Second, this study had a cross-sectional design; therefore, future studies should investigate changes in walking speed, physical function, and clinical characteristics in patients with AMI with a longitudinal study design.

References

1. Shinkai S, Watanabe S, Kumagai S, *et al.* Walking speed as a good predictor for the onset of functional dependence in a Japanese rural community population. Age Ageing 2000; 29: 441-6.
2. Ostir GV, Berges I, Kuo YF, *et al.* Assessing gait speed in acutely ill older patients admitted to an acute care for elders hospital unit. Arch Intern Med 2012; 172: 353-8.
3. Abellan van Kan G, Rolland Y, Andrieu S, *et al.* Gait speed at usual pace as a predictor of adverse outcomes in community-dwelling older people an International Academy on Nutrition and Aging (IANA) Task Force. J Nutr Health Aging 2009; 13: 881-9. (Review)
4. Montero-Odasso M, Schapira M, Soriano ER, *et al.* Gait velocity as a single predictor of adverse events in healthy seniors aged 75 years and older. J Gerontol A Biol Sci Med Sci 2005; 60: 1304-9.
5. Dumurgier J, Elbaz A, Ducimetière P, Tavernier B, Alpérovitch A, Tzourio C. Slow walking speed and cardiovascular death in well functioning older adults: prospective cohort study. BMJ 2009; 339: b4460.
6. Keteyian SJ, Miller NH, Ellis SJ, *et al.* A dose-response analysis of patients with Heart Failure enrolled in A Controlled Trial Investigating Outcome of Exercise Training (HF-ACTION). American College of Cardiology 2009.
7. O'Connor CM, Whellan DJ, Lee KL, *et al.* Efficacy and safety of exercise training in patients with chronic heart failure: HF-ACTION randomized controlled trial. JAMA 2009; 301: 1439-50.
8. Suzuki T, Yoshida H, Kim H, *et al.* Walking speed as a good predictor for maintenance of I-ADL among the rural community elderly in Japan: A 5-year follow-up study from TMIG-LISA. Geriatrics & Gerontology International 2003; 3: S6-S14.
9. Kumahara H, Schutz Y, Ayabe M, *et al.* The use of uniaxial accelerometry for the assessment of physical-activity-related energy expenditure: a validation study against whole-body indirect calorimetry. Br J Nutr 2004; 91: 235-43.
10. Ostir GV, Volpato S, Fried LP, *et al.* Reliability and sensitivity to change assessed for a summary measure of lower body function: results from the Women's Health and Aging Study. J Clin Epidemiol 2002; 55: 916-21.
11. Mochizuki H, Mineshima T. Reliability and validity of the index of postural stability using forceplates. J Jpn Phys Ther Assoc 2000; 27: 199-203.
12. American College of Sports Medicine. *ACSM's guidelines for exercise testing and prescription.* 7th ed. Baltimore Lippincott Williams & Wilkins, 2005.
13. The Japanese Circulation Society. Guidelines for rehabilitation in patients with cardiovascular disease (JCS 2007). Available at: http://www.j-circ.or.jp/guideline/index.htm. Accessed December 2, 2007.
14. Guralnik JM, Simonsick EM, Ferrucci L, *et al.* A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol 1994; 49: M85-94.
15. Guralnik JM, Ferrucci L, Simonsick EM, Salive ME, Wallace RB. Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. N Engl J Med 1995; 332: 556-61.
16. Ostir GV, Markides KS, Black SA, Goodwin JS. Lower body functioning as a predictor of subsequent disability among older Mexican Americans. J Gerontol A Biol Sci Med Sci 1998; 53: M491-5.
17. Rolland Y, Lauwers-Cances V, Cesari M, Vellas B, Pahor M, Grandjean H. Physical performance measures as predictors of mortality in a cohort of community-dwelling older French women. Eur J Epidemiol 2006; 21: 113-22.
18. Penninx BW, Ferrucci L, Leveille SG, Rantanen T, Pahor M, Guralnik JM. Lower extremity performance in nondisabled older persons as a predictor of subsequent hospitalization. J Gerontol A Biol Sci Med Sci 2000; 55: M691-7.
19. Langlois JA, Keyl PM, Guralnik JM, Foley DJ, Marottori RA, Wallace RB. Characteristics of older pedestrians who have difficulty crossing the street. Am J Public Health 1997; 87: 393-7.
20. Rantanen T, Guralnik JM, Izmirlian G, *et al.* Association of muscle strength with maximum walking speed in disabled older women. Am J Phys Med Rehabil 1998; 77: 299-305.
21. 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; 91: 580-615.
22. Tiedemann A, Sherrington C, Lord SR. Physiological and psychological predictors of walking speed in older community-dwelling people. Gerontology 2005; 51: 390-5.
23. Ringsberg K, Gerdhem P, Johansson J, Obrant KJ. Is there a relationship between balance, gait performance and muscular strength in 75-year-old women? Age Ageing 1999; 28: 289-93.
24. Rantanen T, Guralnik JM, Ferrucci L, *et al.* Coimpairments as predictors of severe walking disability in older women. J Am Geriatr Soc 2001; 49: 21-7.

維持期・在宅の心臓リハビリをどう実践するか（まとめ）

How to practice home-based cardiac rehabilitation and phase Ⅲ rehabilitation?

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（心臓リハビリテーション（JJCR）17（1）：53-55，2012）

心臓リハビリテーション（リハ）の有効性に関しては論を俟たないが，これらは，急性期心臓リハではなく，回復期心臓リハによってもたらされることが明らかになっている．今後は，その後の維持期や在宅での心臓リハを継続的に行うことが，心臓リハの様々な効果を維持していくために極めて重要である．

しかし，心大血管疾患リハに関する診療報酬自体が，原則として150日間と決められており，150日間を超える場合の費用に関しては自己負担となることや，維持期心臓リハを行ってくれる施設がまだ不十分であること，さらには，維持期や在宅での心臓リハを行うためのアドヒアランスをどう高めるかなど，維持期・在宅の心臓リハの実践には多くのバリアがあることも事実である．

このパネルディスカッションでは「維持期・在宅の心臓リハビリをどう実践するか」というテーマで，全国で維持期・在宅の心臓リハビリに関して先導的な役割を果たしている方々にパネラーになっていただき，具体的な実践方法や抱える問題点を指摘していただいた．

1．病院併設の医療法42条施設を利用した維持期心臓リハビリテーションの取り組みについて
民田浩一（西宮渡辺心臓血管センター 循環器内科）

心臓リハビリテーション（心リハ）は，動脈硬化性疾患の発症予防と再発予防を大きな目的にしている．このため急性期，回復期心リハが終了しても運動療法を中心に健康的な生活習慣を長期にわたり維持（維持期心リハ）していくことは重要である．しかし，わが国で報告された日本循環器学会認定循環器専門研修施設597施設における急性心筋梗塞の診療状況において急性期心リハの施行率は64％の施設でなされているのに対して通院型外来心リハ施行率は21％にすぎず，維持期心リハについては報告がないものの施行している施設はさらに少ないと思われる．

当院では維持期心リハを提供する一つの形として併設の医療法42条施設を利用することによる継続した心リハに取り組んでいる．医療法42条施設は，病院や診療所に併設する健康増進施設であり，心疾患患者の長期にわたる維持期心リハの場としては適切であると思われる．退院後に通院型の回復期心リハを行った後，併設した施設を紹介し円滑に連続して維持期に移行することができる体制をとっている．連続した心リハの場を提供することにより長期にわたる運動療法に加え，再発予防のための継続した取り込みを行うことができると思われる．これらの取り組みによりモニタリングや予防から，治療そして継続的な疾患管理に至るまでのケアサイクル全体を通しての疾病管理プログラムとして心リハを提供することを目標にしている．ただ，現時点では回復期から維持期へ移行率は決して高いとはいえない．

同一建物内にあるため医師や理学療法士から施設の健康運動士への連絡は密に行うことができ，また当院入院患者以外の方の新規入会者にメディカルチェックを容易に行うことも病院併設医療法42条施設の特徴である．今後は地域のかかりつけ主治医とも連携し，情報を共有するシステムの構築や回復期から維持期へ移行率を向上

Key word：維持期，在宅，普及，継続，心臓リハビリ

させていくことが課題として挙げられる．

2．無床診療所における維持期心臓リハビリテーションの実践

櫻井繁樹 （医療法人千心会 櫻井医院）

当院は外来心リハを実施する無床診療所であり近隣病院から紹介患者を受け入れている．平成23年2月現在40例が心リハプログラムに参加しており，うち30例は維持期心リハで，その半数は紹介元での治療を継続しながらの参加である．ほとんどの近隣病院は心リハを実施していないので，急性期心リハ・回復期心リハも実施されないまま，すでに社会復帰した状況で初めて心リハに参加する患者も多い．したがって，エントリー時の患者への介入状況は十分ではないので，維持期プログラムでも回復期と同様に，定期的に冠危険因子評価，血圧・体重管理・食事・運動状況調査を行い，評価を患者へフィードバックし，目標を再確認するというプロセスを取り入れている．また，様々なフェイズの患者が混在して心リハに参加している状況では，患者ごとのプログラム作成と進捗状況のマネジメントが重要になる．そのため，心リハ介入予定・進行状況・身体状況の把握のための温度板記録の利用や，毎日の運動時間を積み上げ式にグラフ記入できる自己記録用紙の使用など，簡潔かつ正確な状況把握のための工夫をしている．

心リハ対象疾患では，疾患からの回復のみならず，再発予防が極めて重要であり，そのために維持期心リハは総合的循環器疾患治療としての側面が大きい．地域中核病院が急速に急性期医療に特化しつつある現在において，標準的循環器疾患治療の質を維持していくためには急性期心リハを確実に実施することはもちろん，さらに切れ目なく回復期，維持期心リハへと継続していくことが必要とされている．そのために地域中核病院，近隣の診療所と連携し，心臓リハビリテーションを治療の一環として付加できるように機能することが当院の使命と考えている．

3．冠動脈バイパス術後男性患者のスポーツリハビリが心血管系疾患発症と質的生存年数（PeakVO₂ Adjusted Life Years：VALYs）に及ぼす効果

佐藤真治（大阪産業大学人間環境学部 スポーツ健康学科）

維持期心疾患患者が在宅で行う自己管理には限界があるのではないだろうか？　我々は，心疾患患者が仲間と一緒に，楽しくスポーツできる環境を地域プログラムとして設定することが，維持期の心臓リハビリが抱える様々な課題（コンプライアンスの維持，患者の高齢化等）の解決に有用であると考えている．とはいえ，維持期の心疾患患者のスポーツ実践に関して，長期的視野に基づいた効果や安全性を検証しなければならない．そこで，冠動脈バイパス術（CABG）後患者に対する週1回のスポーツ実践（スポリハ）が長期予後に及ぼす効果を検証した．

対象は，CABG施行後，当科で心肺運動負荷試験を施行した男性患者のうち，スポリハに参加した12名と従来の運動療法を継続した対照群21名であった．アウトカムは心血管系疾患（CVD）の新規発症とし，最大7年間追跡した．また，最高酸素摂取量の変化量を効用値とし，VALYsを算出し，群間比較した．その結果，平均5.3年の追跡期間中，CVDは7例（21.1%）に発生した．Cox回帰分析の結果，スポリハ群は対照群と比べ有意にCVD発症が少なかった（$p < 0.05$）．この関連性は年齢，左室駆出率，初回の最高酸素摂取量で調整しても有意であった（$p < 0.05$）．一方，VALYsには群間の差を認めなかった．我々は既に，スポリハの①運動耐容能の維持（心臓リハ，2004），②圧受容器反射感受性の改善（Int Heart J，2010），③認知機能の維持（大産大論集，2010）の効果を確認し，報告している．一方で，スポリハの効果を長期間追跡した報告は，本研究が初めてである．

以上まとめると，CABG後男性患者を対象にしたスポリハは，長期生命予後を改善した．すなわち，心疾患患者が仲間と一緒にスポーツを楽しめる場を地域に創ることは，維持期の地域プログラムの手法として有用であると考えられた．現在，我々は総合型地域スポーツクラブを活用してスポリハを普及させる試み（いきいきハートプロジェクト）を開始した．

4．「患者の知」の理解が維持期心リハの継続を促進する

山口宏美（やわたメディカルセンター 診療部）

維持期心リハを継続した実践として行うには，患者の意識がポジティブに変化していることが求められ，効果的な医療者からの支援がその役割を果たす．効果的な支援には，支援の内容である具体的な生活指導や医学的判断や指示という面ばかりでなく，患者との関係性や関わり方といった面も求められる．そのために継続している患者の知を明らかにすることを試みた．「患者の知」とは，患者がもつ疾患の知識だけではない．医師の診療や検査結果によるふりかえりや身体の感覚から得られたも

の，マスメディアの情報等からつくりあげる疾患のイメージ，またこれまで生活してきた文化的・社会的慣習をも含むものとして捉えた．研究対象者は，回復期から維持期心リハへと継続して参加した患者7名で，患者の意識変化と実践に，医療者がどのように関わっているのか参与観察を行い，エスノグラフィを用いて検討した．

医療者と患者双方は，疾患の可視化（数値化，画像，インフォームドコンセント，メディア情報等）に影響を受けながら，心リハを行っている現状があった．そこでは，血液検査や自転車負荷の数値等が目標として指導に用いられ，医療者は数値による疾患の意味付けにより，患者の前向きの姿勢を引き出そうとしていた．他方，患者は身体状況の変化と重ね合わせて数値を理解し，より前向きになっていた．内面からの意識変化がみられるときには，医療者との間に試行錯誤を含んだ実践があった．

生涯にわたる運動療法が心リハには必要とされ，これがこれからの新たな医療の型の一つになるのであれば，患者と医療者の新たな関係性が必要となる．患者の知識という視点から捉えると，患者にとっての何らかの認識の変化があることで，医療者の指示に沿った自主的な運動実践となると考えられる．患者へのアンケートや事前の問診結果を参考にしつつも，ある程度時間をかけて「患者の知」を医療者が理解し，すすめることが必要である．

5. 座長発言：維持期，在宅の心臓リハビリの可能性について

長山雅俊〔（公財）日本心臓血圧研究振興会附属榊原記念病院循環器内科〕

当院においては，急性期リハから維持期リハまで幅広い活動を展開してきた．しかしながら，患者の高齢化による重複障害の増加により心リハのニーズも変化してきており，在宅心臓リハビリの必要性についても，検討が必要と感じることが多くなった．現存する在宅医療では，心疾患についての対応は不得手である場合が多く，特に急変を伴う心疾患患者に，心リハを行うという意識はない．そこで我々は，循環器専門病院として地域連携を推進しながら，当院のリハビリスタッフの介入による訪問心臓リハビリについての可能性について，少数例ながら検討を始めたので，本パネルでの追加発言としてこれまでの少ない経験を述べた．訪問心臓リハビリには，対象患者の選択に始まり，末期心疾患患者への対応を含めて，どこまでやるのか，何を目的とするのかなど，現時点では経験を積み重ねながら模索を行う時期にあるように感じる．しかしながら，このような社会背景において，病診連携，病病連携，さらに在宅医療や介護との連携において，適切な協力体制のもとに終末期に近い医療についての心リハの関わりについても考える時期に来ているように感じている．

平成24年度診療報酬改定について

日本心臓リハビリテーション学会 診療報酬対策委員会 上月正博（委員長），小山照幸，井澤和大，及川惠子，
角口亜希子，小西治美，白石裕一，田倉智之，田城孝雄，長山雅俊，松永篤彦

（心臓リハビリテーション（JJCR）17（2）：289-292，2012）

平成24年3月5日，厚生労働省より「平成24年度診療報酬改定説明会」が開催され，4月1日より適用が開始されました．

今回の改定で心大血管疾患リハビリテーションに関係があるところは2つあります．

第一に，「早期リハビリテーション加算」が減点された一方，治療開始から14日間においてはさらに「初期加算45点」が新設されました．すなわち，改定前は「早期リハビリテーション加算」45点でしたが，今回30点に減点となりました．しかし，その代わりに治療開始から14日間においては「早期リハビリテーション加算」30点と「初期加算」45点の計75点が適用され，前回より増点になりました．つまり，より早期にリハビリテーションを介入することが推奨されたことを意味します．この用件としては「リハビリテーション科の医師が勤務している医療機関の場合」となっておりますが，「リハビリテーション科の医師」については疑義解釈（平成24年3月30日）が出ていますのでぜひ参考にしてください．

第二に，心大血管疾患リハビリテーション用の「リハビリテーション実施計画書（別紙様式21の4）（入院用），（別紙様式21の5）（外来用）」「リハビリテーション総合実施計画書（別紙様式23の4）」が新たに掲載されました．

（http://www.mhlw.go.jp/seisakunitsuite/bunya/kenkou_iryou/iryouhoken/iryouhoken15/dl/2-22-5.pdf）p4-p5
（http://www.mhlw.go.jp/seisakunitsuite/bunya/kenkou_iryou/iryouhoken/iryouhoken15/dl/2-22-7.pdf）p1-p2
（http://www.mhlw.go.jp/bunya/iryouhoken/iryouhoken15/dl/2-22.pdf）p37，38，46，47

診療報酬改定までの流れと診療報酬改定のすべての詳細につきましては，以下の厚生労働省のホームページをご参照ください．

厚労省のH24改定の資料

（http://www.mhlw.go.jp/seisakunitsuite/bunya/kenkou_iryou/iryouhoken/iryouhoken15/index.html）

（2）1 診療報酬の算定方法の一部を改正する件（告示）平成24年厚生労働省告示第76号

第2章 リハビリテーション

（http://www.mhlw.go.jp/bunya/iryouhoken/iryouhoken15/dl/2-3.pdf）

（2）2 診療報酬の算定方法の一部改正に伴う実施上の留意事項について（通知）平成24年3月5日保医発0305第1号

（http://www.mhlw.go.jp/seisakunitsuite/bunya/kenkou_iryou/iryouhoken/iryouhoken15/dl/2-25-3.pdf）p81-
（http://www.mhlw.go.jp/seisakunitsuite/bunya/kenkou_iryou/iryouhoken/iryouhoken15/dl/2-25-4.pdf）-p5

Key words：診療報酬改定，早期リハビリテーション加算，初期加算，リハビリテーション実施計画書，リハビリテーション総合実施計画書

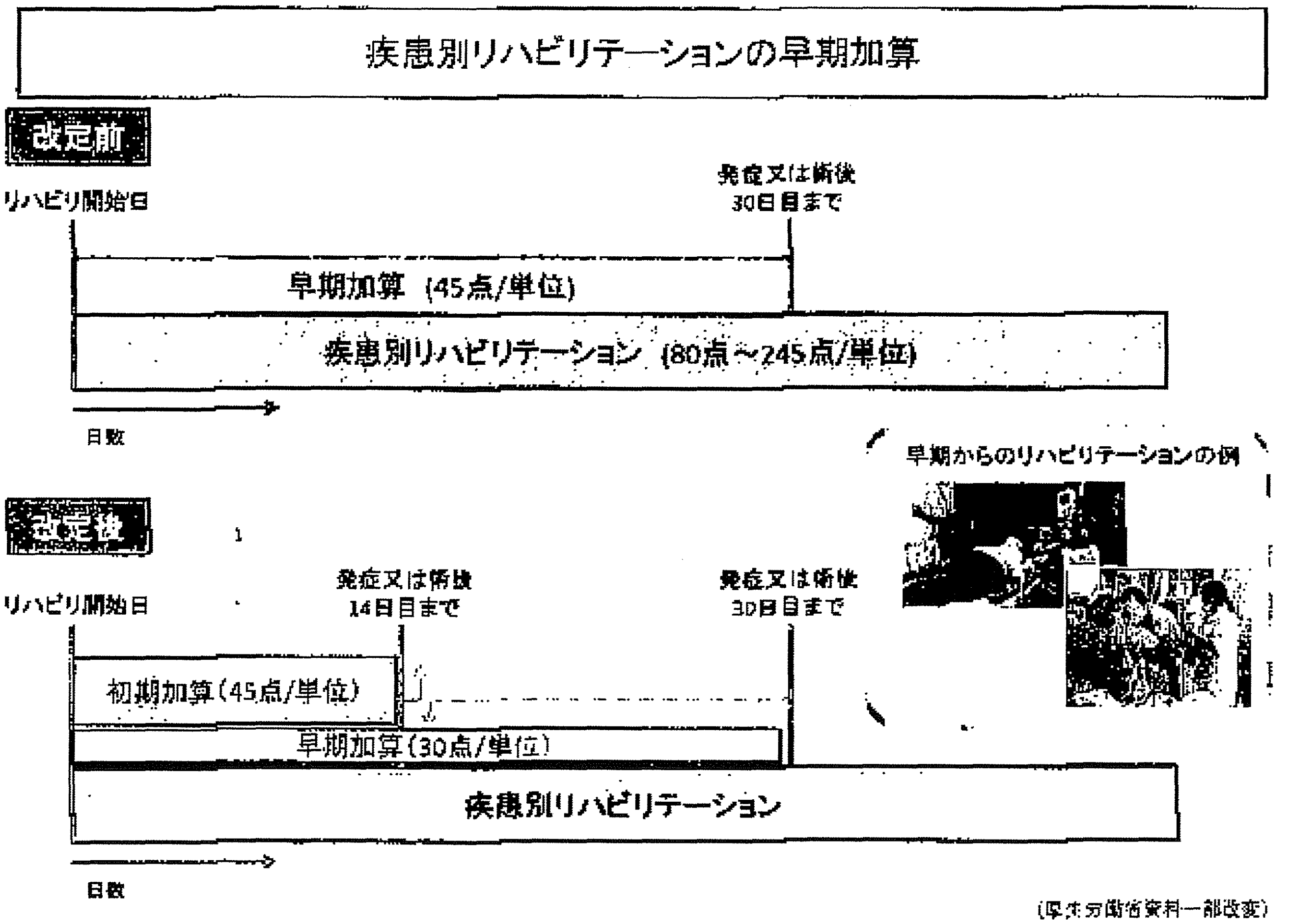
また，個別の診療報酬項目の内容，届出に関するお問い合わせは厚生局の各都道府県事務所へ、診療報酬改定に関する基本的な考え方や経緯等については，厚生労働省保険局医療課にお問い合わせください．

変更点 1

【I−6（充実が求められる分野／リハビリテーションの充実）−②】
早期リハビリテーションの評価 骨子【I−6−(2)】

第 1　基本的な考え方
発症後数日以内より開始するリハビリテーションは在院日数の短縮や ADL の改善に効果があるが，現在，早期リハビリテーションの評価は 30 日間一律となっているため，より早期からのリハビリテーションについてさらなる評価を行い，それ以降について評価を見直す．

第 2　具体的な内容
早期リハビリテーション加算について，より早期の期間における評価を引上げ，それ以降についての評価を見直す．



（厚生労働省資料一部改変）