Self Health Behaviour with Physical Activity Program slows the Deterioration of the Brachial-Ankle Pulse Wave Velocity in the Affected Leg of Hemiplegic People - RCT based study -

Akira Kimura*, Ph.D. PT

Abstract

Objective: The aim of this trial was to investigate the slower effects of a Self-Health Behaviour with Physical Activity Program (SHBPAP) on the brachial-ankle pulse wave velocity (ba-PWV) in elderly hemiplegic people.

Design: This was a prospective, randomized controlled trial.

Setting: This study took place in nursing homes.

Participants: Elderly hemiplegic men (n = 42) who attended daycare at two nursing homes in Japan were randomly assigned to either the control group (CG, n = 22) or the training group (TG, n = 20).

Interventions: A SHBPAP was administered daily to the TG over 8 weeks and was designed to increase the daily energy consumption by 40 cal/day compared with each individual's baseline value. The exercises included half-squats and passive ankle dorsiflexion/plantar flexion.

Main Outcome Measures: The effectiveness of the SHBPAP was assessed by measuring the brachial-ankle aortic pulse wave velocity (baPWV). Several physical parameters were measured weekly in both groups, including physical activity levels based on posture and intensity (PAPI).

Results: Among all of the parameters measured over the 8-week period, only the baPWV in the affected leg was significantly different between the TG and CG groups (1,852 vs. 2,211 cm/s, P < 0.01). Logistic regression analysis revealed that the baPWV significantly correlated with the presence of DM on the affected side and with the SHBPAP.

Conclusions: A SHBPAP can help slow the deterioration of vascular function that develops from disuse of the affected leg in hemiplegics. In addition to improving BMI, this regimen appears to increase blood flow in the affected leg.

Key words: Self Health Behaviour with Physical Activity Program, brachial-ankle pulse wave velocity, ankle-brachial pressure index, arterial stiffness, hemiplegia, slow deterioration, quality of life, randomized controlled trial, rehabilitation

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Introduction

Measurement of the aortic pulse wave velocity (PWV) is a noninvasive method for assessing arterial stiffening in patients with atherosclerosis (1-4). In hemiplegics, disuse of the affected limb is associated with muscle wasting, leading to the development of local atherosclerosis (5). The brachial-ankle aortic PWV (baPWV) is an indicator of early-stage deconditioning syndrome and is assessed using a device to measure PWV that is particularly useful in elderly hemiplegics. Aerobic exercises and resistance training have been shown to reduce arterial stiffness and improve the aortic PWV in healthy individuals, as well as in individuals with aortic risk factors, including elderly hemiplegics (6-10). However, an earlier study indicated that, in sedentary middle-aged men, aerobic exercise had a beneficial effect on the central arteries, but the PWV in peripheral arteries was not improved (9). Another study reported improvements in the resting systolic blood pressure (SBP) and heart rate (HR) in elderly hemiplegics (11) after regular physical activity. However, the long-term effects of physical activity are unclear. There have been some reports that taichi training improves cardiopulmonary function in the elderly (12). The half-squatting movements in taichi training may have a beneficial effect on the PWV, as well as improve metabolic syndrome (13-14). Physical activity seems to prevent deterioration of the hardness of blood vessels by improving metabolic syndrome. Additionally, repetitive movements that change the center of gravity may have the same effect as aerobic training. However, it is not known whether such movements can slow the deterioration of the PWV, nor is it known what factors may predict the results of these movements. In this study, we investigated the effect of Self-Care Physical Activity Program (SHBPAP) on aortic stiffness in the affected leg of elderly hemiplegic men through a time series analysis. This was a prospective, randomized controlled trial.

Methods

Setting and participants

Records of eligible participants were obtained from municipal health and welfare centers in a rural area of Japan (Yaizu City and Maebashi City). Elderly hemiplegic men were randomly selected according to their ID number from among the participants at nursing home daycare facilities in a rural area of Japan between June 2006 and February 2012.

The inclusion criteria were the following:
1) age above 65 years; 2) male; 3) hemiplegic; 4) onset of stroke within 5 years; 5) requiring a walking aid indoors (in some cases); 6) and requiring a walking aid outdoors (in all cases).

The exclusion criteria were as follows:
1) Severe functional limitations that precluded any increase in PA; 2) the presence of associated cardiovascular conditions, such as uncontrolled hypertension or angina; and 3) the presence of undiagnosed or untreated health conditions that manifested as abnormal findings in laboratory tests and contraindicated exercise tests.

All participants signed an informed consent form, and the study was conducted in accordance with the Declaration of Helsinki. The study was also approved by the ethics committee of Gunma PAZ College.

**Design overview**

**Main outcome**

The effectiveness of the exercise measures was assessed by measuring the baPWV. The endpoint for each patient was reached when the PWV was 200 cm/sec or more than that at baseline or at the end of the 8-week intervention period.

The following parameters were recorded: presence of SHBPAP, age, heart rate, and systolic blood pressure, amount of physical activity, hypertension, diabetes, and amount of time spent in a standing position per day.

The ABI and baPWV were measured using a recently developed device, Form ABI/PWV (Omron Healthcare Co., Ltd., Kyoto, Japan), which also measured physical activity levels based on posture and intensity (PAPI). Several physical parameters were measured weekly in both groups.

This device has four cuffs that can be used to measure blood pressure in both arms and both legs simultaneously and automatically calculate the ABI. It also records pulse waves using sensors in the cuffs, computes the difference between the transmission times in the arm and ankle, calculates the transmission distance from the right arm to each ankle according to body height, and computes the baPWV values from the transmission time and transmission distance.

**Randomization and intervention**

The subjects were randomly divided into two groups: a control group and a training group. A randomization code with equal numbers of the two treatments was generated using random number tables, which were unknown when conducting the data analysis, to allocate the patients to the treatment groups. The record of the weekly physical activities was collected for both groups by health care professionals, namely, physical therapists (PTs) and assistants or nurses, through an interview. In the control group, only the daily physical activity was measured. The training group was asked to participate in the SHBPAP once daily for 8 weeks under the supervision of a PT. The SHBPAP regimen was designed to result in a 3.3% increase (approximately 40 kcal/day) in the daily energy consumption compared with the individual baseline values. The SHBPAP consisted of aerobic, light resistance exercises, and half-squats (30° knee flexion) for approximately 20 minutes per day. In addition, the subjects performed passive ankle dorsiflexion-plantar flexion 30 times/minute for 10 minutes once daily. The aim of the SHBPAP was to increase the passive range of motion in the ankle, knee, and hip.
and to impose weight bearing on the affected leg in the standing position. The reproducibility of this physical activity was promoted by adherence to the following procedure. The participants in the control group were in a lying or sitting position all day long, and the participants in the training group spent 20 minutes in a standing position. The PIPA was calculated by the recording of the postures and the exercise intensity according to the BORG scale at 5-minute intervals by two observers.

The coefficient of correlation of the exercise intensity was significant at 0.89 between the values that were found using the BORG scale and the values recorded using the Polar Heart Monitor (11). We measured the amount of physical activity conducted by each participant by obtaining the readings from the Polar Heart Monitor. The SHBPAP resulted in a BORG scale value of approximately 10, corresponding to a heart rate of 100 beats per minute. The intensity of the SHBPAP was estimated as light or moderate for each subject during the measurement analysis.

**Statistical analysis**

The SPSS package (Version 14) was used for statistical analysis. For comparison of the frequencies and assessment of the intergroup differences, unpaired t-test was used. The patient outcomes at the end of 1, 4, and 8 weeks were compared. Multiple regression analysis was performed to identify factors influencing the amount of change of baPWV from baseline in each time period (1, 4, 8 weeks). The independent variable was the amount of change of left-baPWV (LbaPWV) and right-baPWV (RbaPWV) from Baseline, and the dependent variables were the presence of SHBPAP, age, heart rate, systolic blood pressure, amount of physical activity, the presence of hypertension, and the presence of diabetes.

**Results**

Of the 388 users of the daycare services in the nursing homes, 48 elderly hemiplegic men were selected randomly and enrolled in the study if they satisfied the inclusion and exclusion criteria. In total, 42 participants completed the study (N = 42). The baseline characteristics of all subjects were recorded before they were randomly assigned to either the control group (CG, n = 24) or the training group (TG, n = 24). The age range of the subjects was 65 to 86 years.

During the course of the study, 1 participant from the CG discontinued the study after 4 weeks, three participants discontinued the study after 8 weeks, and the participation of four participants was interrupted. Two participants in the TG discontinued the study after 4 weeks and the participation of two participants was interrupted. The physical activity of the participants before intervention was estimated to be about 1100 to 1200 kcal. This physical activity level (baseline) of the participants in this study before intervention was low. Approximately 50% of individuals in the study population were hypertensive and 62.9% were diabetic, which affected the optimal muscle contraction on the paralyzed
The various study parameters were recorded and compared between the two groups at the end of 1, 4, and 8 weeks. There were no significant differences in the SBP values between the CG and TG during the 8-week period. The ABI values in the affected and non-affected legs were similar in the CG and TG throughout the study period. The significant difference between the TG and CG observed after 8 weeks was in the baPWV values in the affected leg (left leg) (1,852 vs. 2,211 cm/s, respectively, \( P < 0.01 \), 95%CI = 93.6-624.3). This effect size was 0.84.

Discussion

In the present study, we measured the values of the baPWV for a deconditioned physiological status in 42 participants who were randomly selected from 388 hemiplegic patient users of nursing home services in rural areas of Japan. The baPWV values showed an inverse trend with the presence of SHBPAP, as observed from the significant difference in the baPWV values between the control and training groups at 8 weeks. Thus, the subjects in the CG can be considered to be at a higher risk of distal aortic disease than those in the TG. Intensity

The TG increased the duration of time spent in a standing position compared with the control group after 4 weeks. In the TG, the anxiety of applying a load to the lower limbs may also have decreased after 4 weeks. In this study, the TG performed half-squats and ankle dorsiflexion and plantar flexion. While performing half-squats, the movements of the knee and ankle need to be isolated from each other; however, the exercise allows voluntary muscle contraction to occur even if a leg is paralyzed due to central neuroparalysis. This voluntary muscle contraction (even if it results from passive movement) is believed to facilitate blood flow and increase vasodilatation.

Passive range of motion of ankle dorsiflexion and plantar flexion also causes increased blood flow. The vasodilatation reaction is known to occur after dynamic physical exercise (33). It is thought that the SHBPAP causes vasodilatation of the peripheral vessels by elevating the blood flow. In elderly hemiplegics, this vascular expansion may reverse the effects of disuse in the affected leg as the body weight decreases. In this study, after undergoing the SHBPAP regimen for 8 weeks, there was a significant change in the BMI, and a decrease in the baPWV was observed in the affected leg. The cumulative effect of SHBPAP may be relevant.

Several studies have reported on the relationship between PWV and exercises/physical activity, as found in PubMed. The effectiveness of physical exercises for the improvement of PWV is limited. Some studies have examined the effectiveness of aerobic exercises and resistance exercises. Furthermore,
there are reports on the results of investigations into the relationship between PWV and exercises in hemiplegia (on the extent that subjects could walk when supported by short leg braces) (35) and paraplegia (with spinal injuries at the T11 level) (36). However, there are limited reports based on RCT. It appears that aerobic exercises improved PWV with the lowering of blood pressure. With resistance exercises, the blood pressure was raised. In the cases in which the exercises exhibited no effectiveness, the amount of physical activity of the subjects had not been managed, in that it had not been controlled as a method of "therapeutic exercise". Many of these studies were conducted with healthy individuals as subjects. The effectiveness of exercises for hemiplegics was recorded for eight weeks after intervention and PWV indicated a significant slowdown (=improvement) compared with that in the controlled group in a small number of subjects with pre-diabetes (37). No effectiveness was shown for the PWV in connection with the exercises of the patients with spinal injuries in 6 weeks in a wheelchair (36). For the group whose level of physical activity in their daily lives was high, no effectiveness of PWV and exercises was recognized: rather, what was indicated was the unwanted possibility of prolonged physical inactivity becoming stabilized.

Figueroa et al. showed that the act of squatting (albeit at rest, which differs from this study) indicated no effectiveness on PWV in healthy individuals (37).  It is our opinion that the effectiveness of SHBPAP could be confirmed in this study from the fact that the repetition of the act of squatting constituted aerobic exercise.  SHBPAP creates an increase in the "milking" function due to the physical pressure and relaxation of the blood vessels brought about by the repeated activities. This produces an increase in the blood flow. Furthermore, hemiplegics also suffer from a spastic condition that causes a clamping down on their blood vessels anatomically. We believe that this condition could be relieved by these exercise activities. However, the duration of eccentric contraction of squat movements in this SHBPAP is about 30% of that in taichi, and the reason it did not change SBP in this research may be related to there being an insufficient cardiopulmonary load.  In addition, in order to clarify this point, clinical trials are needed that involve a condition in which 2-3 eccentric contractions of squat movement occur while enabling muscle spasticity in hemiplegia to be suppressed by applying a weight to the affected part of the leg.

A unified response of simultaneous bending of the lower limbs appears, and if the healthy hip joint extension force is strong, it is possible to implement SHBPAP. It is important to place weight on the affected side immediately after the movement is completed. The rate-dependent clonus may have been suppressed due to the slow SHBPAP movement speed.

It is conceivable that the decrease in BMI that occurred at four weeks after intervention brought about the improvement in insulin resistance, an improvement attributed to the accumulated benefits in the increase in the amount of blood flow throughout the body, as well as the promotion of lipid metabolism
made possible by the "load-bearing" repeated exercises involving the deep parts of the torso and its muscle groups (38-40). Moreover, no effectiveness was shown in the research of Tordi et al. (41) and Phillips et al. (42), which involved patients with spinal injuries. They did not investigate the benefits of unique physical activities that were adjusted in terms of the amount of physical activity in accordance with the subjects' movement impediments. For that reason, it is assumed that it was difficult for them to identify the effectiveness of the total body "weight-bearing" exercises uniquely in subjects whose physical activity level was high. This study shows the effectiveness for the improvement of the parts affected by physical inactivity in individuals whose physical activity level was low.

Study Limitations

This study cannot address the effectiveness of SHBPAP for the group whose physical activity level in their daily lives is high. Therefore, we need to carry out further investigations.

Conclusions

The SHBPAP regimen resulted in a decreased speed in the aortic PWV in the affected leg in older hemiplegic men. The existence of SHBPAP influenced the outcome of the affected side leg after 8 weeks and is a predictor of baPWV. The existence of diabetes influenced the outcome of the affected side 8 weeks after the beginning of the intervention, corresponding to a change in the baPWV. The improvement in the BMI preceded the improvement in the PWV. In contrast, the SBP was not affected by the SHBPAP in this population. Further studies are needed to evaluate whether controlled and regular physical activity in hemiplegics may aid in the prevention of deterioration of atherosclerosis in these patients.

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References


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Original Article

The Feasibility of Measurement Methodology on Morning Surge of the Hemiplegic People

Akira Kimura*, PhD, PT

Abstract

Purpose: This study was to determine implementation characteristics of the freedom body-activities on wrist with ABPM measuring a new small equipment for developed 24 hours newly to establish method of detection of the surge after the cerebrovascular disorder onset that became the bottleneck in detection of the Morning surge in the hemiplegic people.

Methods of study: Subjects: Ten hemiplegic people were in the nursing home institution rural Japan. Over 65 years old, men and women. We measured their ABPM using by sphygmomanometer (BPro, Health Stat, and Singapore) every 15 minutes during 24 hours. Morning surge was calculated how it is from (the average systolic blood pressure for 90 minutes during the 2-hour mean systolic blood pressure) – (sleep around blood pressure diastolic after getting up).

Results: The systolic blood pressure is 134.5mmHg in the daytime, and 148.5mmHg during sleep through morning surge expression. The residual is 14mmHg. There was the blood pressure sinking speed between an average of the night in 12.6%, and the ratio that a blood pressure sinking speed was poor in blood pressure descent in the night less than 10%, was 30% by night.

Conclusion: This measurement method showed a practicability to look for a Morning surge of hemiplegic people using by wearable BP device. It showed negative association among body movement, physical activity and blood pressure as Morning surge.

Keywords: Morning surge, 24 hour ambulatory blood pressure monitoring, Hemiplegia

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Background

After having awoken from sleep, the Morning surge says sudden elevated blood pressure to develop from one hour at one hour 30 minutes. It is different from early hypertension in the morning. Evidence that Morning surge accepted the onset of myocardial infarction and the stroke correlation from about 2004 came to be reported1). In other words it may be said that the Morning surge is an early health risk marker.

In addition, there is a factor inhibiting Morning surge for a multiple factor. An evaluation of the circadian rhythm is necessary to detect Morning surge. It is said by a living body fine-tuning a period of the internal cause rhythm as a clue by the time change (synchronizer) of various events of the outside world including the stimulation of the light and shade as a mechanism of the circadian rhythm for 24 hours that a phase of the internal cause rhythm and time of the outside world come to go along.

For synchronizer, 1 is included in the environment such as temperature, humidity, the noise, the vibration physical exercise, 5 diet, 4 social factor (home, a school, a company, work, play), 32 other than the light and shade (noon and night) by the light21-9).

The mammalian clock nucleus is present in a hypothalamic suprachiasmatic nucleus. Because these function, it is established.

Association of the body movement is suspected at presence and sleep of the surge in the morning when the problem disturbs the rehabilitation in the hemiplegic people after the cerebrovascular disorder onset that has already occurred from the viewpoint of Productive Aging and Secondary disease prevention, but includes that this association is unknown910). Because we must install a cuff in the upper arm for ABPM measurement as technical problems, and free action was disturbed in the patients with the flexion contracture of the arms, adaptation was difficult.

Room for technical intervention of the rehabilitation has some kind of influences to body movement during sleep by the intervention to an operating time other than classic services such as the improvement of physical activity increase at awakening, the prescription of the exercise problem to contribute to ability improvement for the movement accomplishment that we were able to take of the balance, tool and the environment control at awakening, and it is a place expecting suppression of the surge, slowing of the nature exacerbation with an improvement effect of the circadian rhythm in morning.

In other words it is a serious problem to lack these data though there are continuing
likelihood and intervention likelihood without Morning surge being inhibited after an attack. It is asymptomatic, but it can originally delay discovery of the surge in morning that it is difficult to perform ABPM though a Japanese-Chinese awakening degree decreases in hemiplegic people after the cerebrovascular disorder onset, and life rhythm is confused with night disorder of initiating sleep, and quality of life of the people himself decreases, and acuteness increases. Also, the mechanism of pathogenesis of the Morning surge is not yet elucidated, and association with the body movement is suspected at a decrease and sleep of the physical active mass based on the motor function, but it becomes the bottleneck to lack data itself because this method for measurement is non-establishment.

**Purpose**

Objective one of this study was to determine implementation characteristics of the freedom body-activities ABPM measuring a small equipment for developed 24 hours newly to establish method of detection of the surge after the cerebrovascular disorder onset that became the bottleneck in detection of the Morning surge in morning in the hemiplegic people.

**Subjects and Methods**

**Subjects**

Number of 10 hemiplegic people, over 65 years, men and women. They recruited study participants in a collaborative investigation organization and chose a candidate. **Inclusion Criteria** were decided that we measured the position body active mass of the group which met lower than, a condition more than activity (more than 3Mets intensity) one hour in a structure in the hemiplegic people due to the cerebrovascular disorder sequelae in the maintenance phase for rest two hours more than sleep six hours for the everyday time study when was it or more for five days a week, and there was it in IPAQ category I more than 1000kcal. **Exclusion Criteria** were a being dementia, hypertension, diabetes in not controlled, drug prescription contents were changed for less than three months.

The calculation of the necessary sampling subject's number: The Morning surge incidence in the group where lower exposure was standard was expected with approximately 40% by preliminary research. In this case the possibility that the morning coat of four people could confirm surge was suggested, and ten subjects thought with need in consideration of likelihood of the overestimate of the hypotension defectiveness ratio in development and the preliminary research in night of the dropout.

An investigation method, we visited the Bet side for ten subjects of the institution entrance average during periods from September, 2012 to June, 2013 and performed body movement, questioner survey in free action bottom sphygmomanometer, PWV, ABI, VRT, a behavior investigation, and the night. We obtained consent form of the investigation participation from all subjects and performed it by protocol with the approval of the Gunma PAZ College Ethical Review Board (an approval number12-05).
A measurement item and method for measurement, we measured about ten subjects consecutively the next day for 24 hours until 12:00 from 10:00. This analysis subjects of 14 sleep through blood pressure Morning surge did it with high one people of high likelihood of the Morning surge detection likelihood and high one people of the motor function, two than competency. We are the following about a measurement item and method for measurement.

1. It measured with freedom body-activities using by a new sphygmomanometer like a watch (BPro, Health Stat, and Singapore) every 15 minutes.

1) Sleep through blood pressure Morning surge calculated it from the average systolic blood pressure for 90 minutes during the 2-hour mean systolic blood pressure. We measured the blood pressure diastolic after getting up.

And when there is a difference of the blood pressure of two points within two hours before the going to bed and the blood pressure of two points within two hours after the awakening more than 15mmHg when a problem occurs in ABPM wearing; is surge in morning.

The blood pressure sinking speed calculated it from mean systolic blood pressure X 100 (in the daytime mean systolic blood pressure \cdot night mean systolic blood pressure) at the / daytime in 2) night, and a blood pressure sinking speed defined 10% of within peoples as blood pressure descent defectiveness by night by night.

Physical active mass and a basic exercise capacity cord
We made setting (60cm in height from the floor) in the bedside of subjects and the joint space and measured a chart about the time and posture, exercise intensity every 60 minutes. As for the basic exercise capacity cord, rehabilitation employment evaluated proximal limbs and distal articular flexibility (when flexibility decreases by up to 3 degrees, paralysis about shoulder, elbow, hand, 6 right and left joints of a crotch, a knee, the foot, 12 sites, we judge it with once twice depending on a possible moving direction) by voluntary movement.

Measurement of body movement during sleep

We installed it in the right shoulder 60cm distant place of the bedside of magnetism-type body movement sensor physical activity measuring assembly (HSL-101, OMRON, and Japan) subjects and we measured every one minute and measured a body movement level and duration of sleep.

An environmental indicator (light and a sound, temperature)

The quantity of light exposure set up Tondaji Company LX-1010B at the source of light lower 2m position and measured lux of 10 seconds at 60cm in a floor. The noise (sound level) measured Wensn SOUND LEVEL METER (accuracy +1.5db, level range 30-130db, sample rate 2times/second) at 60cm in a floor for ten seconds. The temperature measured a mean temperature of one minute at 60cm in a floor in A&D Company TR-71Ui.

Analysis

The regular distributed data were analyzed. The mean, standard deviation, and the median around four minutes range calculated to determine blood pressure Morning surge (sleep
through blood pressure).
To show the relationship between a motor function and the blood pressure Morning surge, we held McNemer test using by IBM-SPSS ver20.

Fig1. BPro ® transversal forearm with this device

Burro ® incorporated a patented technology termed as Modified Application Tonometry. This technology is coined as EVBPR technology. EVBPR stands for Evidence-Based Blood Pressure. Tonometry was first used for the measurement of pressure in the eyeballs.
Health STATS BProR ABPM device implements the measurement at the radial artery of the wrist. (See Fig 1, illustration below).
The figure shows the cross section of the wrist that the BProR is secured to the wrist by means of a wrist strap, similar to a watch in application.
The sensor plunger impinges upon the radial artery over the radius bone. The patented plunger system design is hemispherical in profile, and transfers pressure forces efficiently to the internal pressure sensor and provides a safe, comfortable patient interface.

The wrist strap system is specially designed to ensure that the sensor system mounted comfortably on the radial artery position. At the same time, together with the sensor housing, it provides constant applanation to the artery without compromising the comfort of the wearer. The strap system also takes into consideration in allowing for venous return at both the watch head and housing, and also avoiding any median nerve compression.
With the above features, a non-invasive reliable and accurate radial pulse wave is acquired,

Results

Almost participants performed the ABPM measurement with the like a watch device. (Fig 2). The average age was 76 years six men, four women. Six people took antihypertensive medications for hypertension.
Morning surge had found their data. (Fig 3. 4)(Table 2)
Two people contracted a disease for diabetes, and the depressive state were not found. The mean total sleep has the 485 minutes, and body movement had 24 minutes during sleep. In the daytime, the systolic blood pressure is 134.5 mmHg within Physical activity 1486 kcal. The mean of systolic blood pressure is 148.5 mmHg during sleep. The height of blood pressure as Morning surge were 14 mmHg. The right-ABI was 0.99. The left-ABI was 1.02(Table 3-6).

It is temperature of living room after getting up.
All this study was performed indoors. The room temperature was kept 27 degrees from 24
degrees.

Quantity of light exposure
As for the mean quantity of light exposure and the night mean light exposure quantity, as for indoor light quantity (from 10:00 a.m. to 19:00 p.m.), 385~465lux was 3~7lux by night (from 19:00 p.m. to 6:00 a.m.) in the daytime. It shows subjects properties in table 1.

Noise environment
The open space average noise is 55db~65db in the daytime
The bed side average noise is 35db~42db in the daytime
The bed side average noise is 30db~33db by night.

Table 1. The characteristics of subjects

<table>
<thead>
<tr>
<th>Gender</th>
<th>Case No.</th>
<th>Age [years]</th>
<th>BMI</th>
<th>BP1 [mmHg]</th>
<th>BP2 [mmHg]</th>
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<td>1.6</td>
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Table 2. The characteristics of subjects, a motor function, and sleep body movement, blood pressure data

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<tr>
<th>Gender</th>
<th>Night slot1</th>
<th>Night slot2</th>
<th>Morning slot1</th>
<th>Morning slot2</th>
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<td>11</td>
<td>10</td>
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<td>mean</td>
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<td>169</td>
<td>165</td>
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<td>S.D.</td>
<td>215</td>
<td>207</td>
<td>185</td>
<td>178</td>
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</tbody>
</table>

Table 3. Night and morning systolic blood pressure

<table>
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<th>Case No.</th>
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<th>Night slot2</th>
<th>Morning slot1</th>
<th>Morning slot2</th>
</tr>
</thead>
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<td>mean</td>
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<td>164</td>
<td>169</td>
<td>165</td>
</tr>
<tr>
<td>S.D.</td>
<td>215</td>
<td>207</td>
<td>185</td>
<td>178</td>
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</table>

Table 4. Motor function

<table>
<thead>
<tr>
<th>Case No.</th>
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<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 5. Ability for movement on the bed

<table>
<thead>
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<th>10</th>
<th>10</th>
<th>10</th>
<th>10</th>
<th>10</th>
<th>10</th>
<th>10</th>
<th>10</th>
<th>10</th>
<th>10</th>
</tr>
</thead>
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<tr>
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</tr>
<tr>
<td>min.</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Table 6. Physical activity

<table>
<thead>
<tr>
<th>Gender</th>
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</thead>
<tbody>
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<td>1397</td>
</tr>
<tr>
<td>S.D.</td>
<td>188</td>
</tr>
<tr>
<td>man</td>
<td>1696</td>
</tr>
<tr>
<td>S.D.</td>
<td>192</td>
</tr>
<tr>
<td>total</td>
<td>1490</td>
</tr>
<tr>
<td>S.D.</td>
<td>251</td>
</tr>
</tbody>
</table>

Fig2. The wearing of the ABPM device on his left wrist
Fig 3. Example Case 1. The line of ABPM Systolic BP (SYS), Diastolic BP (DBP), Pulse Wave Rate (PR). Morning surge shows in a hemiplegic people (case1)

Fig 4. Example Case 2. The line of ABPM Systolic BP (SYS), Diastolic BP (DBP), Pulse Wave Rate (PR). NO morning surge in a hemiplegic people (case2)

It is temperature of living room after getting up

All this study was performed indoors. The room temperature was kept 27 degrees from 24 degrees.

Discussion

The reason why measurement likelihood under the freedom body-activities was obtained in hemiplegic people

Even if the conventional sphygmomanometer was possible under free action without hemiplegia that there was many that a brachial cuff in the ABPM measurement technical problems included produced the flexion contracture of the arms, adaptation was difficult to be painful. However, the new measurement methodology was used to install the watch type ABPM device with elbow flexion contracture.

Because the pulse pressure degree that rubber pressure of only 2cm softball on the wrist in diameter increases did not cause an unpleasant pain in consecutive measurement, measurement under the free action thinks that possible.

Association of onset and the sleep body movement of the blood pressure Morning surge

As a result of this study, we recognized significant negative association between a motor function of the hemiplegic people and prevalence of the blood pressure Morning surge and showed positive association between body movement and dipper at sleep. It was shown by body movement became independent to body active mass about sleep through blood pressure Morning surge as for the association between blood pressure Morning surge and sleep body movement at age, sex, BMI, sex, the daytime at sleep, and having shown a significant negative correlation. There are the blood pressure Morning surge in patients with hypertension before the cerebrovascular disorder onset and living room temperature and light exposure, the report that investigated physical activity.
association in the daytime, but there is not the related report of the prevalence of the surge in a motor function and blood pressure morning of the hemiplegic people after the cerebrovascular disorder onset. Furthermore, it is results to suggest the likelihood that we can inhibit, and these results are risk factors of the strokes and a future clinic intervention study is waited for at the blood pressure in morning surge after sleep phase that is the risk factor of the recurrence by a control of the body movement.

Also, it is a study carried out in indoor environment, but association of the surge is reported till now in a controlled environment and blood pressure morning. Suppression likelihood of the blood pressure Morning surge is suggested by environmental control.

Mishima K et al. do report\(^{11}\) that melatonin secretion capacity increased by Japanese-Chinese high illuminance light exposure to the elderly people of the small sample (n=20).

Modesti PA et al\(^{12}\), Ohkubo T et al\(^{13}\), Wada T et al\(^{14}\), age showed a drinker, the thing that were significantly high in a sleep independently all-out than low rank 80% in average light exposure quantity superior 20% odds of the melatonin secretional capacity high level (20% of superior) about association of the mean light exposure quantity and melatonin secretional capacity by similar results every day in the daytime in the daytime. The association is strongly supported in the daytime by a dose-response relationship between the mean quantity of light exposure and melatonin secretional capacity.

Melatonin works in this participant’s phenomenon

Melatonin works various in vivo and may increase melatonin secretional capacity by adjusting average light exposure quantity in the daytime in outdoors that are thought to be associated with well-known hypnotic effect or not only the circadian rhythm adjustment but also anticancer activity or immunity activation effects, and the likelihood that it is possible for sleep disorders is suggested\(^{15} 16\).

In the study of Zeitzer JM et al.\(^{17}\), there was no it in the clear association for mean quantity of light exposure and melatonin during night. Approximately 60% of overall subjects sleep under dim light less than an average of three lux, and one of the law of nature reasons includes that the subjects exposed to more than 100 lux remained in 1% of the whole. Whereas even night light exposure to 3 lux provides 11% of melatonin secretion suppression, and it is said that we provide the melatonin secretion suppression of 88% in 106 lux.

We were not thought to have possibilities to detect significant association for number of the samples deficiency, and it is a future problem.

In domestic and foreign preliminary research, as for the study that investigated body movement and the association of the night blood pressure sinking speed at light exposure and sleep, it is rare in the daytime. We increase sample size more, and we adjust the number of diabetes affection and night urination that are a potential confounder having poor blood pressure descent at the same time by night, and it will be
Melatonin secretional capacity may increase by quantity of mean light exposure increase in the daytime, and likelihood decreased blood pressure descent defectiveness by night that it is suggested in a risk of a stroke and the heart disorder in the daytime by lifestyle improvement to increase average light exposure.

As for this study, subjects of multiple nursing home entrance average were mixed, and the difference of the life pattern might become the confounding, and it actually showed the tendency that there was much average light exposure quantity in the daytime in X nursing home, and there was little average light exposure quantity by night. However, there was not little diabetes in X nursing home. The Y institution residents take light well at the daytime, and is a big life pattern of the light exposure quantity amplitude not to be exposed to light by night, and is regular, and form circadian rhythm: is thought to be ideal. The subjects who took this pattern among people from an institution were present. We will think about a recurrence and the mortality of the stroke as an intervention study in future that we are stronger and can explain body movement, a light exposure and a temperature exposure and association of the health at a motor function, sleep by responding.

**Conclusions**

This measurement method showed a practicability to look for a Morning surge of hemiplegic people using by wearable BP device. It showed negative association among body movement, physical activity and blood pressure as Morning surge.

**Acknowledgement**

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**References**


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