

# Present Features of Balneotherapy in Japan

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## ABSTRACT

Balneotherapy is one of the natural therapies which uses subterranean products, such as hot spring water, gases, muds, as well as climatic factors as therapeutical elements. This therapy is conducted by combination of hot spring water bathing, various thermo- and hydrotherapies, physical exercises, drinking, inhalation, etc., as the complex therapy.

In Japan, hot spring water bathing, the so-called "bath cure", is the most popular type of the balneotherapy, in which the direct effects of the physical factors of bathing, such as hydrostatic pressure, buoyancy, water temperature, and the pharmacological properties of the hot spring water constituents play important roles. The complex therapeutic stimulation is repeatedly applied during a long-term period of 3-4 weeks. These therapeutical factors work to alter the physiological functions comprehensively and non-specifically.

The process of alteration is considered to be mediated by the autonomic nervous system, endocrine system and immune system, resulting in normalization of pathological functions, enhancement of functional capacities and self-healing potentials of the organism against endogenous and exogenous abnormal stimuli. Most physiological functions exhibit a circaseptan (about 7 days) or a circadecan (about 10 days) rhythm during the course of adaptation to the therapeutic environment and normalization.

Balneotherapy is indicated for various chronic diseases, impairment of the locomotor system, post-operative trauma, and psychosomatic disorders. Beneficial usefulness of long-term balneotherapy was demonstrated in patients with rheumatoid arthritis, bronchial asthma and diabetes mellitus.

Recently, the significance of modern balneotherapy has been increasingly emphasized especially for the purpose of preventive medicine, health promotion, and achieving wellness in which both the mind and body are maintained in good balance, and increasing of quality of life in today's aging and stressful society.

**Key words :** balneotherapy, complex natural therapy, health resort medicine, hot spring water bathing, preventive medicine

## 1. INTRODUCTION

Balneotherapy is one of the natural therapies in which subterranean products, such as hot spring water, natural gases, muds, as well as various climatic factors of the spa station are utilized for medical therapeutical purposes (Agishi, 1992). The word "balneo" is driven from "balneum" in Latin, meaning "bath" in English. Modern balneotherapy is conducted by combination of hot spring water bathing, various thermo- and hydrotherapies, physical therapies, indoor and outdoor exercises, drinking, inhalation, etc., as a complex therapy. The patients leave their daily lives to go to spa stations in clean air and stay for a certain period.

A spa station refers to a place where there are natural hot spring sources which are used for therapeutic purposes, and at least over-night accomodation facilities for treatment or refreshment with hot spring water. More recently, the term "health resort medicine (or therapy)" has been preferably used internationally instead of "spa treatment".

Balneotherapy today is part of a more comprehen-

sive health resort medicine. Nowadays, it has become more and more recognized that modern health care needs to pay prime attention to the prevention of illness.

Many diseases develop through an unhealthy life style. Detrimental habits and risk factors endanger good health. It should be recognized that balneotherapy (in the sense of health resort medicine) is a purposeful task because it is absolutely mandatory to avail ourselves of all possibilities in the endeavor to prevent illness. At no other place than at a health resort where the patient can meet the time requirements quite readily, and a close combination of balneo-therapy and physical medicine can be realized. It is quite beneficial that a variety of therapies outside the field of medicine, such as mental and physical health education, sport therapy, dietary counseling, relaxation therapy can be combined at the same time at a health resort.

## 2. HOT SPRING WATERS AND SPA STATIONS IN JAPAN

In Japan, on account of the geological and topo-

graphical nature of the country, and above all the prevalence of active volcanoes, mineral and hot springs flow abundantly all over the country. The natural development of balneotherapy is due to these special geological and geographical conditions. These natural hot springs have been long utilized by people for relaxation and medical treatment as well since ancient times principally in the same ways as in many European countries.

According to data from the Environment Agency in 1997, there existed 25,565 mineral springs distributed over 2,565 spa stations. Among them, 12,545 springs had a water temperature above 42°C. The total volume of extraction was about 2,536,000 liters per minute.

The total number of hotels as accommodation facilities in about 2,560 spa stations was approximately 15,500. The total capacity of personal accommodation facilities was about 1,300,000. Actually, the annual total number of guests who stayed in spa stations was 143,164,500 persons. This means that, on the average, every Japanese spent more than one day in spa stations. These data indicate a drastic development when compared with those in 1960, when there were only 7,000 accommodation facilities. This serves as an indicator showing what a big role the spa stations played in the huge expansion of the tourism industry which took place in parallel to the rapid economic growth of the last 3 decades.

Among about 2,500 spa stations, about 80 places have been authorized as National Thermal Resorts. They have been given special protection by law and

are supervised to guarantee proper hygienic conditions.

The spring waters are defined as the natural spring waters, which are over 25°C in temperature at the source and/or contain at least any one of the minerals in the amount of over the minimum values as Table 1.

The majority of hot springs are high in temperature, some exceed 100°C. In general, the concentration of solutes is relatively low, ranging around 1-3g per liter. Many hot springs are acid springs which contain large quantity of free mineral acids such as sulfuric acid (H<sub>2</sub>SO<sub>4</sub>), or hydrochloric acid (HCl). Moreover, the acid springs contain iron and aluminum ions as well as hydrogen sulphide. These springs are often the mixture of the acid springs, vitriol, alum and sulphur springs.

### 3. ORDINARY USE OF HOT SPRINGS IN SPA STATIONS

In Japan, any one can take a hot spring bath and can drink without a doctor's prescriptions in a spa station. It is not so exceptional to take baths 4-6 times a day every day.

In former times, Japanese people had the custom of staying in spa stations for their traditional folk medicine for one or two weeks as one-round therapy (Tohji).

Up to now, the health and welfare system have paid no attention to balneotherapy. A flat cover-all payment system for balneotherapy does not exist.

Modern medical balneotherapy can be conducted

**Table 1** The minimum values for "Hot Spring Waters" under the Japanese Hot Spring Law's definition.

1. **Temperature (as measured at the time when extracted from the source of the hot spring): 25°C or more**
2. **Ingredients (one of the following)**

Name of substance and minimum values per kg	
Dissolved matter (excluding gaseous substances).	A total of 1,000 mg
Free carbonic acid (CO <sub>2</sub> )	250 mg
Lithium ion (Li)	1 mg
Strontium ion (Sr)	10 mg
Barium ion (Ba)	5 mg
Ferro or ferric ion (Fe, Fe)	10 mg
Manganous ion (Mn)	10 mg
Hydrogen ion (H)	1 mg
Bromine ion (Br)	5 mg
Iodine ion (I)	1 mg
Fluorine ion (F)	2 mg
Hydro-arsenic acid ion (HA <sub>2</sub> O <sub>4</sub> "	1.3 mg
Meta-arsenious acid (HA <sub>2</sub> O <sub>2</sub> )	1 mg
Total sulfur (corresponding to HS' + S <sub>2</sub> O <sub>3</sub> + H <sub>2</sub> S)	1 mg
Meta-boracic acid (HBO <sub>2</sub> )	5 mg
Meta-silicic acid (H <sub>2</sub> SiO <sub>3</sub> )	50 mg
Sodium bicarbonate (NaHCO <sub>3</sub> )	340 mg
Radon (Rn)	20 (1/10 <sup>10</sup> Curie unit)
Radium salt (as Ra)	1/10 <sup>8</sup> mg

under a physician's care for ambulant or hospitalized patients as "cure treatment". The term "cure treatment" is driven from "Kurbehandlung" in German, meaning taking medical balneotherapy during a long-term stay in a spa station for 3-6 weeks.

As mentioned above, this cure treatment comprises not only frequently taking baths but also other therapeutical manoeuvres such as various hydrotherapies, physical therapies, exercise, diet, and so on. In contrast to European countries, specific therapeutical means such as drinking cures, mud therapy, inhalation, steam douche as well as climatherapy, terrain exercise therapy, thalassotherapy are not popular (Agishi & Ohtsuka, 1995).

#### 4. TYPICAL BALNEOTHERAPY IN JAPAN

The most fundamental aspect of balneotherapy in Japan is the bath cure, that is, hot spring water bathing. The ordinary Japanese are in the habit of taking very hot water baths up to the neck level at a temperature of 42-44°C for a relatively short time duration such as 5-10 minutes, usually with two successive baths, almost every day. The usual posture of bathing is a long-sitting or squatting position.

The average Japanese can tolerate very hot water bathing and cannot tolerate cold water bathing. For example, in Kusatsu Spa, there is one unique traditional bath cure with extremely acidic (pH 1.4) hot spring water, in which people take a water bath at 47-48°C for 3 minutes.

#### 5. PHYSIOLOGICAL RESPONSES TO THERMAL STIMULI BY WHOLE-BODY WATER BATHING

The main method of balneotherapy is the bath cure, in which the whole body is immersed at a considerably hot temperature of about 42°C. Thus, it is quite important to clarify the physiological responses to thermal stimuli by water bathing. There are some results of our observations.

##### 1. Endocrine responses to thermal stimuli by head-out water immersion.

In general, hormone secretion tends to increase when the water temperature reaches 40°C or higher. When the water temperature reaches 25°C or lower, secretion of some hormones is enhanced (noradrenaline, cortisol, atrial natriuretic peptide, etc.), while that of other hormones is suppressed (ADH, prolactin, renin, etc.). Circadian differences of the secretory responses to thermal stimulation are shown by cortisol, ADH, renin, cyclic-AMP, etc. (Agishi, Ohtsuka & Watanabe, 1996).

Plasma cortisol declined gradually by a hot water bathing at 42°C in the morning, but a significant increase was found in the evening. Cold water bathing at 25°C caused significant increments of plasma cortisol in the morning, but no change was observed in the evening as shown in Fig. 1.

These results suggest that there is a circadian

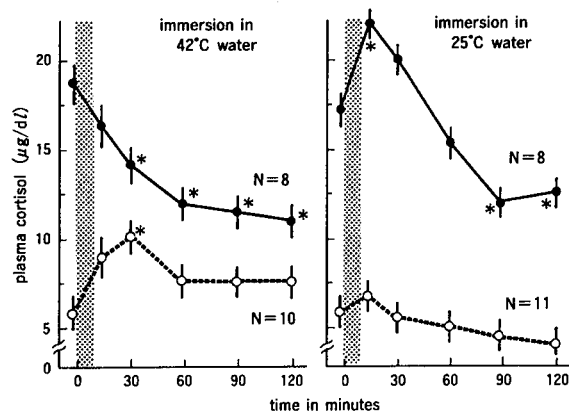


Fig. 1 Circadian difference of responsiveness of plasma cortisol to 42°C hot water and 25°C cold water bathing.

● : 09 : 00 Hr, ○ : 21 : 00 Hr. Each bar represents mean ± SE.

\*p < 0.05 compared with preimmersion value.

difference in the adrenal secretory response to thermal stimuli (Agishi & Hildebrandt, 1989).

##### 2. Glutathione metabolism in human erythrocytes and platelets by water bathing

Glutathione is present in almost all cells and plays an important role in metabolism, transport and cellular protection. It participates especially in the protection of the cells against oxidation by free radicals and reactive oxygen intermediates. It was postulated that hyperthermia treatment might increase the protection and reactivity of free radicals and peroxides. Also, heat stress is thought to be a kind of oxidative stress. In this connection, the relationship between thermal stress by water bathing and glutathione metabolism and lipid peroxidation was investigated (Ohtsuka, Yabunaka & Fujisawa, 1994, Ohtsuka, Yabunaka & Watanabe, 1995).

At a water temperature of 39°C, no remarkable change in glutathione metabolism was observed. Reduced glutathione (GSH) levels decreased and those of lipid peroxides (LPO) increased immediately after the immersion at 42°C. In contrast, GSH levels increased and those of LPO did not change by a 25°C cold water bathing. The activities of glutathione reductase (GR; both active and inactive forms) showed no change at 42°C, whereas those of the active form increased at 25°C. The activities of glutathione peroxidase (GPX) decreased at 42°C, while they increased at 25°C. These changes suggest that heat stress may cause oxidative stress in the human body, and cold stress is thought to augment the activity of the antioxidant defense system.

In another series, effects of bathing temperature on platelet glutathione metabolism was investigated by water immersion at 25°C, 36°C and 42°C. Platelet LPO levels increased at 25°C and 42°C, indicating the presence of oxidative stress at these temperatures. Consequently, induction of the antioxidative defense system was observed at 25°C and at 42°C. Platelet GSH levels, GPX and GR activities increased. These findings suggest that accumulation of LPO in platelets by repeti-

tion of heat or cold stress would stimulate platelet aggregability (Ohtsuka & Yabunaka, 1996).

3. Immunological responses to thermal stimuli by water bathing

Watanabe *et al.* demonstrated the effects of thermal stimuli by whole-body water bathing on immune systems in healthy and patients with rheumatoid arthritis (Watanabe, Ohtsuka & Noro, 1995a, 1995b). At first, changes in leucocyte and lymphocyte subpopulations were investigated in healthy men before, immediately after and 30 minutes after water bathing at 25°C for 10 minutes. Total leucocyte and lymphocyte counts revealed no remarkable change. NK (CD3-CD16/56+) cells significantly increased immediately after the immersion and recovered 30 minutes later. Helper T (CD4), native T (CD4+CD45RA+), suppressor/cytotoxic (CD8) and B (CD19) cells showed no remarkable change. Watanabe concluded that mobilization of lymphocyte subpopulations by cold water bathing was comparable to that by endurance training, in which a rapid increase of natural killer (NK) cells was observed.

In the second series, changes of lymphocyte subsets were examined before, immediately after and 60 minutes after hot water (42°C) bathing for 5 minutes in RA patients. Total leucocyte, lymphocyte counts, and NK as well as CD8 cell increased significantly just after the hot water bathing and returned to normal levels 60 minutes later.

6. POSSIBLE ACTION MECHANISM OF BALNEOTHERAPY

The direct effects of hot spring water bathing on the body are mainly physical effects (such as buoyancy, hydrostatic pressure, viscosity, etc.), thermal effects and pharmacological and chemical effects. Balneotherapy can be regarded as a kind of stimulus-adaptation therapy, because patients are repeatedly given therapeutic stimulation, including hot spring water bathing and exercises, and are exposed to climatic stimulations. The autonomic nervous system, endocrine system and immune system respond to these stimuli in a non-specific manner and the potential level of physiological functions becomes altered. As a result, pathological functions are normalized, and resistance potentials to endogenous or exogenous abnormal stimuli and the ability of biophylaxis are enhanced. It generally takes three to four weeks to achieve these changes (Fig.2) (Agishi & Hildebrandt, 1989, Agishi & Ohtsuka,1995).

Such effects of long-term balneotherapy have been examined using various indicators such as blood catecholamine, cortisol, variations in the RR interval of the electrocardiograph, blood pressure and pulse rate. A high pretreatment level may gradually decrease, and a low pretreatment level may become elevated, with the level thus approaching a certain goal line.

During the course of treatment, a variety of physiological functions have been found to be normalized

- I. **Direct actions**
  - 1. **Physical action**  
Hydrostatic pressure, buoyancy, viscosity, frictional resistance
  - 2. **Thermal effects**
  - 3. **Chemical and pharmacological actions of the components contained in the hot spring water**  
Percutaneous absorption (salts, gas components)  
Drinking hot spring water
  - 4. **Effects of combination therapy**  
Exercises, steam bath, sauna bath, *Utaseyu* (delivery of hot water from overhead in a shower-like effect), etc.

II. **Indirect actions (non-specific actions)**

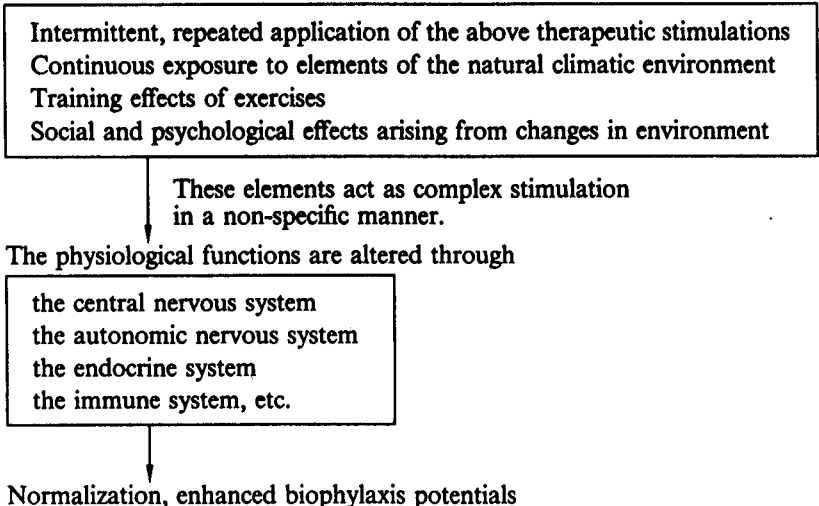


Fig. 2 Possible action mechanism of balneotherapy

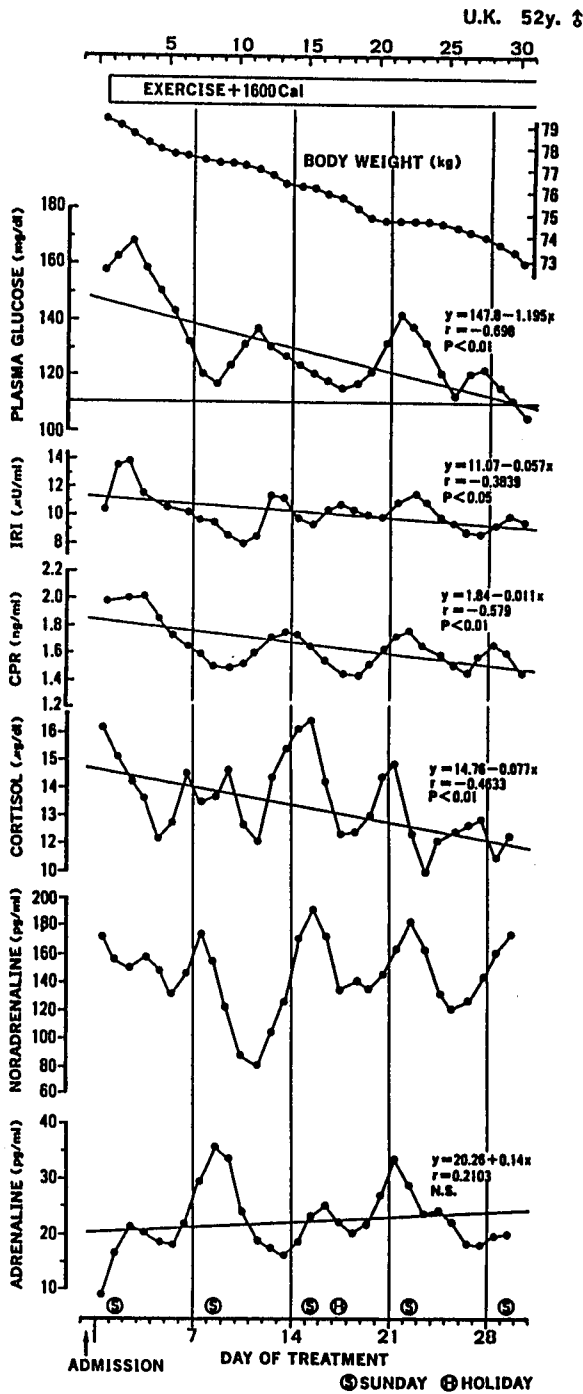


Fig. 3 Daily changes in body weight, fasting plasma glucose, IRI, CPR, cortisol, noradrenaline and adrenaline during 4-week balneotherapy in a patient with Non-Insulin-Dependent Diabetes Mellitus.

showing a circaseptan (about 7 days) or a circadecan (about 10 days) rhythmical change (Agishi & Hildebrandt, 1989).

The typical characteristics of these periodicities are shown in Fig. 3. (Agishi & Yabunaka, 1991, Agishi & Ohtsuka, 1996).

Fig. 4 shows weekly change in circadian rhythm of plasma cortisol during 4-week balneotherapy in hospitalized patients. It clearly demonstrates the lowering of the acrophase and the damping of the amplitude with time during balneotherapy (Agishi & Ohtsuka, 1995).

## 7. INDICATIONS AND CONTRAINDICATIONS OF MEDICAL BALNEOTHERAPY

Balneotherapy is nowadays indicated mainly for improvement of pathological or half-healthy (in sub-clinical state) functions, early normalization of disordered functions and enhancement of psychosomatic adaptability to endogenous and exogenous abnormal stimuli.

Recently, people are obliged to live under various injurious and stressful conditions, such as constant air conditioning, continuous artificial illumination, noxious air pollution, night-shift work, socio-psychological strain, and so on. Moreover, there exists a remarkably rapid increase in the population of aged people. Under these circumstances, the incidence of chronic as well as functional diseases has been inevitably increasing. Thus, it should be emphasized that balneotherapy is especially appropriate not only for the prevention and therapy of these disorders, but also for health promotion in the time off from work in daily life.

Conditions and diseases listed in Table 2 are indications of balneotherapy for which the therapy has been proven medically effective (Agishi, 1995).

Since balneotherapy is a kind of stimulus-adaptation therapy, patients need to keep reserve capacities sufficient to adequately respond to the therapeutical stimulations. Therefore, the therapy should be contraindicated, or should be performed with great caution, in elderly patients with reduced reserve potentials, patients with reduced physical strength, or patients who are oversensitive or respond overly to the therapeutical stimuli.

The following are the major contraindications :

- 1) acute febrile diseases with progressing or exacerbating symptoms ;
- 2) severe hypertension and uncompensated congestive heart failure ;
- 3) malignant tumor ;
- 4) serious hepatic, renal or cardiac diseases ;
- 5) serious arrhythmias and fresh myocardial infarction ;
- 6) hemorrhagic diseases and severe anemia ;
- 7) early and late phases of pregnancy.

## 8. CLINICAL USEFULNESS OF LONG-TERM BALNEOTHERAPY

Among a variety of documents concerning beneficial usefulness of long-term balneotherapy, some representative cases are presented.

Nobunaga investigated the effectiveness of balneotherapy for patients with rheumatoid arthritis. Although bathing in either hot and cold spring water showed no effect on the inflammatory activity of RA, only ameliorating effects on the pain and stiffness of joints and muscles were dominant, just like an effect of non-steroidal anti-inflammatory drugs. From results of studies on endocrine, metabolic and autonomic nervous functions, it was recommended to use balneotherapy not only for relieving pain and stiffness,

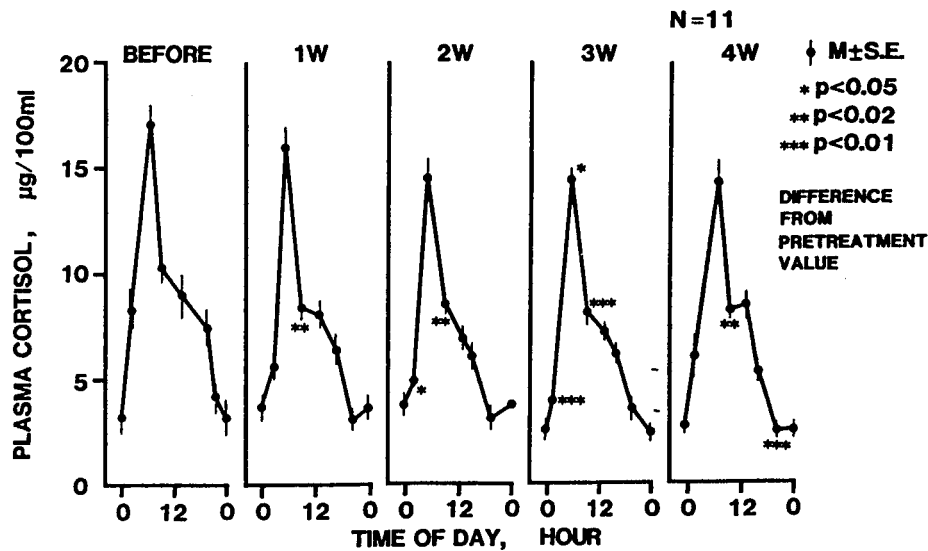


Fig. 4 Weekly change in circadian rhythm of plasma cortisol during 4-week balneotherapy.

Table 2 Indications of balneotherapy.

(1) Preventive medicine

Prevention of adult diseases and occupational diseases  
Building up physical strength, promoting health, etc.

(2) Chronic diseases

Chronic rheumatic diseases  
Functional recovery of central and peripheral neuroparalysis  
Metabolic diseases (diabetes, obesity and gout)  
Chronic gastrointestinal diseases  
Chronic mild respiratory diseases  
Circulatory diseases (moderate or less severe hypertension)  
Peripheral circulatory disorders  
Chronic dermal diseases  
Psychosomatic diseases and stress-induced diseases  
Autonomic nervous dysfunction  
Vibration disorder  
Sequelae of trauma  
Chronic gynecologic diseases

(3) Rehabilitation

Sequelae of cerebrovascular disorders  
Chronic rheumatic disease  
Sequelae of traffic accidents or accidents during surgery  
Spinal paralysis  
Treatment after cerebral surgery or orthopedic surgery

(4) Before and after surgical operations

but also for positive rehabilitation exercise (Nobunaga, 1992, Nobunaga, Tatsukawa & Ishii, 1996).

Clinical effects of balneotherapy were evaluated in patients with bronchial asthma by Tanizaki. The balneotherapy applied comprised swimming training

in a hot spring pool, inhalation of iodine salt solution, and fango therapy. Complex balneotherapy was more effective in patients with rather severe symptoms of bronchiolar obstruction or expectoration. Besides, this therapy was more effective in patients over the age of 41 years than in those under 40 years. More-

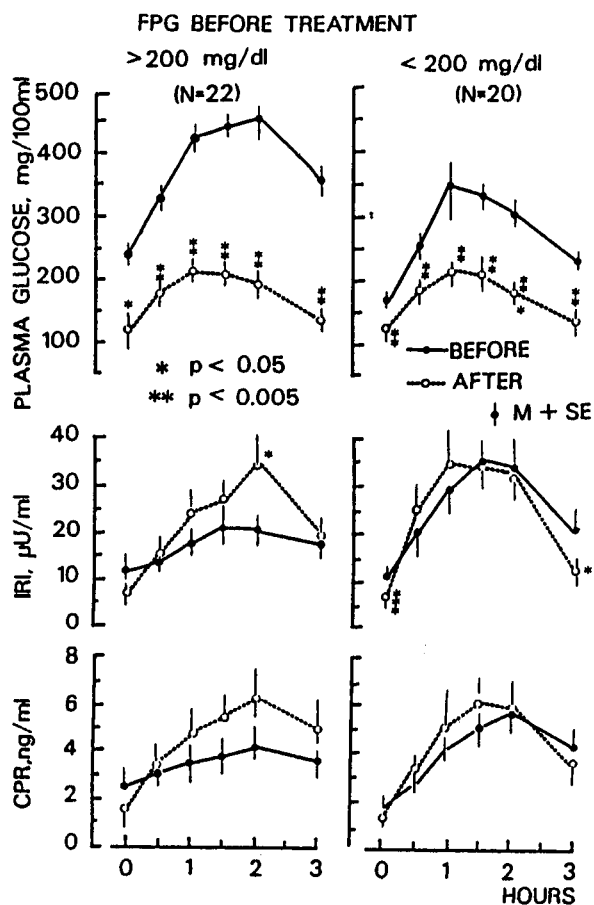


Fig. 5 Oral Glucose Tolerance Test before and after 4-week balneotherapy in patient with Diabetes Mellitus.

over, it was also more effective in patients with increased numbers of neutrophils or eosinophils in bronchoalveolar lavage (BAL) fluid than in those without BAL neutrophilia or eosinophilia (Tanizaki, 1996).

We investigated the medical usefulness of long-term balneotherapy (4 weeks) for treatment of patients with NIDDM in the early stages.

Oral Glucose Tolerance Test (OGTT) was performed before and after 4 weeks balneotherapy. Glucose tolerance capacity was clearly and significantly improved (Fig. 5). Parameters of chemical control such as HbA<sub>1c</sub>, HbA<sub>1c</sub>, and fructosamine were also ameliorated. From these results, it was thought that balneotherapy is useful especially for early mild cases of diabetics, and this kind of therapy with pleasant exercises in low intensity such as underwater gymnastics and walking provide motivation to keep such beneficial exercise habits after patients are discharged (Agishi & Ohtsuka, 1992, Agishi, Ohtsuka & Watanabe, 1996a).

## 9. SPECIAL TRADITIONAL BALNEOTHERAPIES IN JAPAN

### 1. Effect of 47°C Extremely Hot Spring Bathing Therapy "Jikan-Yu"

"Jikan-Yu," meaning time-baths, is a kind of traditional balneotherapy using hot spring water at 47 to 48°C. To date, "Jikan-Yu" has been maintained for

over 300 years by people in Kusatsu, Gunma Prefecture. The strong acidic (pH 1.4) spring water contains iron, acid-aluminum sulphate, and hydrogen sulphide. The ordinary bathing method in "Jikan-Yu" therapy is as follows: The bathers are immersed for 3 minutes. They enter to the epigastrium for the first minute, to the chest for the next minute, and to the neck for the final minute. They do not wash themselves with water after bathing. Bathing is repeated 3 times a day, over 3 successive weeks.

This "Jikan-Yu" bathing therapy has been indicated mainly for dermal diseases, such as eczema, dermatitis, psoriasis, etc.

Shirakura, *et al.*, have conducted clinical research, especially on the coagulation, fibrinolytic and endocrine systems, and immunological functions (Shirakura, Kubota & Tamura, 1996).

#### a. Coagulation and fibrinolytic systems

Plasma level of plasminogen activator inhibitor-1 (PAI-1) was transiently increased 15 minutes after the start of 3-minute hot spring bathing. In contrast, this change was not observed in 42°C bathing. In bathings of both water temperatures, tissue plasminogen activator antigen,  $\alpha_2$ -plasmin inhibitor activity, plasmin-antiplasmin complex, thrombin-antithrombin III complex, and thrombomodulin antigen were not influenced. The findings suggest that 47°C hot spring bathing may disturb the balance of thrombogenesis and fibrinolysis.

#### b. Evidence of transient rise of plasma $\beta$ -endorphin

Usually, many people who take "Jikan-Yu" therapy feel an intoxicating sensation and desire to bathe more and more. In order to elucidate the possible mechanism of this intoxicating feeling after "Jikan-Yu" bathing, changes in plasma levels of  $\beta$ -endorphin were observed in healthy humans.

Plasma  $\beta$ -endorphin levels increased markedly 5 minutes after the start of 47°C bathing, and no change in plasma  $\beta$ -endorphin level was observed after 10 minutes of 42°C bathing. Shirakura thought that this rise in plasma  $\beta$ -endorphin level might explain the intoxicating feeling that almost all people experience after "Jikan-Yu" bathing.

#### c. Effects of serial "Jikan-Yu" bathing on lymphocyte subsets

To clarify the immunological effects of "Jikan-Yu" balneotherapy, seven healthy subjects took the 47°C "Jikan-Yu" bath 3 times a day over 3 successive weeks.

The total count of peripheral blood lymphocytes decreased significantly after serial "Jikan-Yu" bathing. Also, the total count of T-cells decreased significantly, showing a slight reduction in the OKT 4 to OKT 8 ratio. No significant changes in response to PHA or Con A were observed. It was thought that serial "Jikan-Yu" bathing therapy resulted in an immune suppression, and "non-physiological" extreme hyperthermia might exert an inhibitory effect on lymphopoietic tissues.

## 2. Cold Spring Therapy "Kan-no-Jigoku"

Ordinary Japanese prefer hot spring water bathing. However, there is one unique traditional balneotherapy using the cold spring "Kan-no-Jigoku" (Hell of Cold) spa station located in Kyushu. People gather to bathe for the purposes of pleasure, improvement of physical condition, and treatment of various diseases such as dermal diseases, arthritis, asthma and so on. People have empirically believed that this cold spring has the power to cure disease or injury. The cold spring water has a temperature of 12–13°C, and the chemical characteristics is a simple hydrogen sulfide solution.

A common and traditional way of bathing is as follows; people immerse themselves in the water up to the shoulder in a sitting position for 10 to 15 minutes. After bathing, they heat themselves by staying in a heated room for about 20 minutes. They repeat this cooling and heating procedure several times a day.

There are some interesting physiological studies on single cold bathing and a serial study of repeated application of cold bathing for 12 days.

### a. Body temperature and energy expenditure by single cold spring bathing in healthy subjects

Rectal temperature and energy expenditure were measured serially during and after the bathing. Rectal temperature rapidly dropped after bathing with a minimum value at 50 minutes after bathing. Shivering began during bathing. Total energy expenditure increased to 230% of the pre-bathing value at 30 minutes after the cold immersion, which was mainly due to the increased oxidation of carbohydrates. Energy expenditure of fat increased about threefold at 120 minutes after the immersion, suggesting that thermogenesis was activated after the heat loss by Kan-no-Jigoku bathing (Asoh, 1996).

### b. Effects of repeated cold spring bathing for 12 days on physiological functions

Healthy male volunteers stayed at Kan-no-Jigoku spa station for 12 days and bathed in the cold spring for 15 minutes, twice a day, without rewarming after each bathing (Asoh, Tsuji & Shirasaka, 1987).

Serum cortisol levels were measured at the first and 23rd bathing. Cortisol significantly increased 15 min after the first bathing. However, no significant change was observed at the 23rd bathing, suggesting decreased adrenocortical responsiveness and also emotional stress against the extreme coldness of the water.

In clinical observations, Yoshida (1989) reported on 9 patients with rheumatoid arthritis treated in the traditional manner. Both grip strength and activity of daily living (ADL) improved during the 3 weeks of the therapy.

Nobunaga and Tatsukawa (1996) performed comparative studies on "Kan-no-Jigoku" cold spring bathing therapy and hot spring therapy ("Horita Sen", 40°C) in patients with rheumatoid arthritis. Serial bathings were conducted twice a day for 5–15 minutes

each time for 3 weeks. Improvement of morning stiffness, grip strength and joint pain was observed in "Kan-no-Jigoku" bathing group. ADL improved significantly after 3 weeks of serial bathing in the cold spring water, but not significantly in the hot spring bathing group. Plasma noradrenaline levels elevated significantly during bathing either in the cold or hot spring water, although the elevation was much higher in the cold spring water. According to Nobunaga, it was suggested that the stimulatory effect of cold spring water bathing on the sympathetic nervous function might result in decreasing morning stiffness and increasing grip strength and ADL, and also that "Kan-no Jigoku" therapy might be more effective than hot spring water bathing for RA patients.

## 10. CONCLUSION

Balneotherapy is a natural therapy which attempts to make the best use of natural elements such as hot springs and climate. The most fundamental aspect of balneotherapy in Japan is hot spring water bathing, which is characterized by repeated immersion of the whole body in considerably hot water and is very stimulative to the body. The action mechanisms of balneotherapy are different from those of so-called modern conventional medicine, which consist of pharmacotherapy and surgical therapy. Therefore, these two approaches should complement each other instead of competing with each other.

In today's stressful and aging society, balneotherapy should be used effectively not only for treatment of chronic diseases and rehabilitation, but also for preventing life-habit-related diseases which cannot be cured by drug therapy, and for maintaining and promoting health as well as establishing wellness in which the body and mind are in good balance.

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