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Thermal balneotherapy in Antsirabe-Madagascar: water analysis and its applications in an African context

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Summary. The Orthopaedic Rehabilitation Centre of Madagascar can be found in the city of Antsirabe. The health care facility is equipped with 2 thermal sources of bicarbonate water used for post-operative rehabilitation and for the ailment of chronic degenerative illnesses. The aim of this study, which derives from the cooperation between the School of Specialization in Thermal Therapy of the University of Parma and Antsirabe Orthopaedic Hospital, is to analyze the real properties of thermal waters utilized in this centre and to do an overview of its possible applications in this particular African context. (www.actabiomedica.it)

Key words: thermae, Africa, bicarbonate water, rehabilitation

Introduction

Confusion persists regarding the real difference between hydrotherapy and balneotherapy (BT) and their true definitions. The former employs simply water and according to the law of Archimedes, some exercises in water are made easier, while others such as walking are more difficult (1). Pain may be relieved due to the effects of pressure and temperature on nerve endings (2) and as a result of muscle relaxation (3).

On the other hand BT, term that derives from the latin "balneum", uses natural thermal mineral waters, that are characterized by medical properties (4). The treatment is based on muscle relaxation and pain reduction obtained from the physic-chemical properties of the water (hyperthermal and alkaline bicarbonate). The adjective 'thermal', instead, requires that the natural spring or welled water is 20C or higher.

In the last years BT alone went into decline and, for this reason, nowadays it is usually part of total Spa therapy.

The word 'spa' (salus per aquam) or "health resort (5) comes from the name of a Belgian town where a thermal spring was discovered in the fourteenth century (6). The problem in assessing the value of spa therapy is its complexity. Patients receive treatment not only with thermal mineral water but also other modalities such as massage, electrotherapy, and exercise. Spa treatment usually consists of a health holiday lasting some 2-3 weeks.

The use of water for medical treatment is probably as old as mankind and evolved all over the world, especially in countries rich of thermal springs.

BT in Antsirabe-Madagascar began during the end of 1800's when the French, which ruled the island at that time, decided to use its curative water for healing purposes. The spa (Fig. 1, 2) was inaugurated in 1878 and immediately exploited by the French, which built a Grand Hotel (Fig. 3), which is still running today. This monument is from the "Belle Époque" which hosted, amongst others, the King of Morocco. In order to access the service, a medical check-up is necessary,

Figure 1. Building of the Antsirabe thermae; outside views

that indicates the correct modality of application of BT, which is administered by physiotherapists.

Therapeutic indications are analogous to those of our national thermae. Patients who access the facilities under medical prescription must pay 30,000 ariary/ week and can be hosted in special prestigious housings located next to the spa (Fig. 4). Entry fees to the hot spring pool are 1,500 ariary (equivalent to 0,50€).

Physic-chemical properties of the hot spring water were at the time unknown. Our Madagascar colleagues told us that they were bicarbonate water and that they continued using crenotherapic treatments according to the guidelines used by the French physicians.

Figure 2. Antsirabe thermae; inside views

Figure 3. The thermae Grand Hotel; view from outside

Figure 4. Patient housing adjacent to the spa

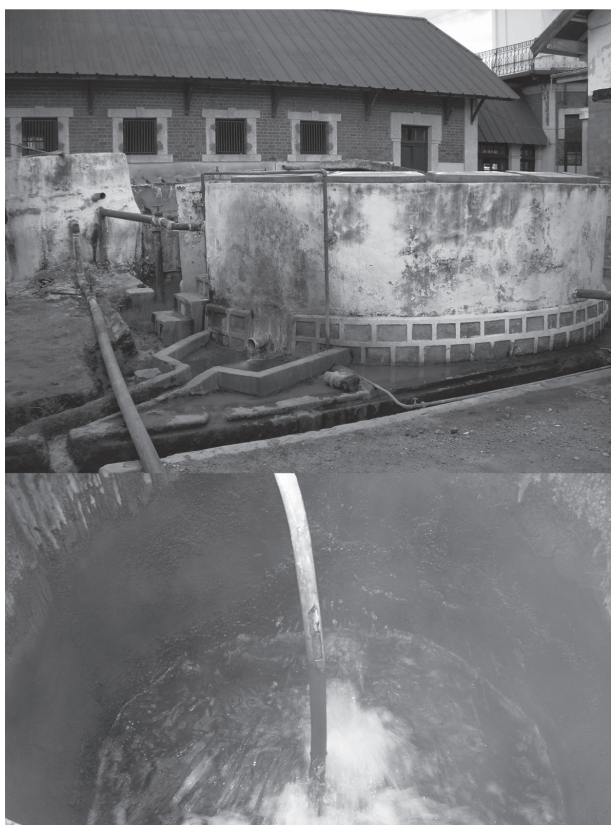

Figure 5. Images of the spring well

The aim of this study is to analyze the real properties of thermal waters utilized in this centre and to do an overview of their possible applications in this African region.

Materials and methods

The waters from both sources (Fig. 5) (warm water samples at 51°C of temperature) were sent to the capital's Pasteur Institute to undergo detailed physic-chemical analyses but unfortunately this was not possible because the Institute could only do microbiological analyses. The samples were therefore brought to Italy the next day and sedimentation time was thus preserved. The Parma University Hospital Chemistry Department did physic-chemical analyses.

Results

Results are reported in Table 1. According to these data, the water of Antsirabe is, according to the Marotta & Sica (1933) classification, mineral bicarbonate sulphate alkaline and magnesium based (>50 mg/l), calcium enriched, hyperthermal (51°C at the source), extremely hard (56°F) and with high contents of lithium. Therefore, we deduct that the soil from which the waters originate are prevalently calcareous (CaCO3). Consequently, the chemical reaction of the water and anhydride carbon attachment to the calcareous soil (calcium carbonate) with the introduction of calcium ions and bicarbonate solutions is the following:

$$CaCO3 + CO2 + H2O \text{ ----------} \rightarrow Ca^{++} + 2HCO3^{-}$$

In this thermal centre the mineral bicarbonate sulphate alkaline and magnesium-based water is used primarily for the management and rehabilitation of patients with muscular-skeletal disorders. The applications of BT in Antsirabe comprises the following modalities:

- *Pool BT*

The spa is furnished with 2 pools (Fig. 6) built with stairs and handrails on its sides to enable rehabilitation in children. These facilities receive water from 2 different sources, one annexed to the pool and the other to the thermae with depths of 30 and 25 meters, respectively. The pool used for hydrotherapy is emptied and re-filled 2x/week.

Table 1. Physic-chemical properties of the 2 different water sources

Thermal	Results (mg/l)		Pool	Results (mg/l)	
Na	1042		Na	1059	
K	176		K	174	
Ca	100		Ca	104	
Mg	73,0		Mg	75,0	
NH_4^+	n.r.		NH_4^+	n.r.	
Sr	7,12		Sr	6,57	
Fe	0,062		Fe	0,139	
B	1,05		B	1,06	
Se	0,045		Se	0,041	
Sb	0,0017		Sb	0,0017	
V	0,0012		V	0,0078	
Li	20,0		Li	20,9	
Ni	0,011		Ni	0,0010	
Cu	0,0054		Cu	0,0069	
Co	0,0032		Co	0,0031	
Cd	0,0016		Cd	0,0018	
Mn	0,001		Mn	0,021	
Ag	0,0022		Ag	0,017	
Cr	0,0030		Cr	0,0030	
Zn	n.r.		Zn	n.r.	
Pb	0,016		Pb	0,020	
Ba	0,099		Ba	0,092	
Cl^-	564		Cl^-	551	
NO_3^-	n.r.		NO_3^-	n.r.	
NO_2^-	n.r.		NO_2^-	n.r.	
SO_4^{2-}	237		SO_4^{2-}	203	
HCO_3^-	3573		HCO_3^-	3555	
Conductivity	5,67	mS/cm a 20°C	Conductivity	5,67	mS/cm a 20°C
pH	7,45		pH 7,26		
Hardness	56	°F	Hardness	56	°F

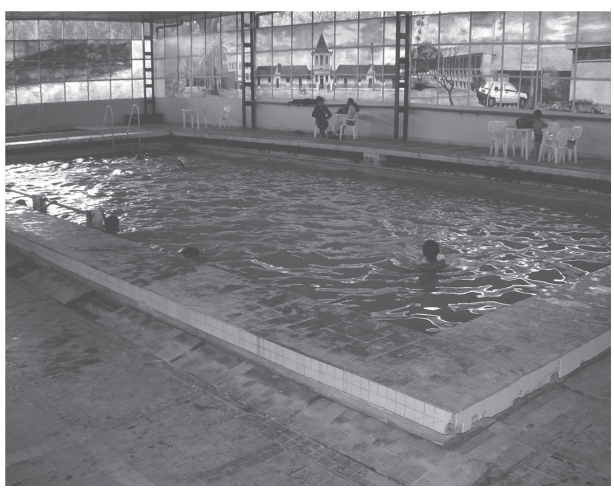

Figure 6. One of the two rehabilitative pool of the spa

- *Bathtub BT (Fig. 7)*

- *Direct spray BT*

The pressure can be regulated and the water jet does not impact the body directly but is dispersed through a multi-perforated barrier (Fig. 8).

- *Peloidotherapy (Fig. 9)*

Mud baths are also available. The mud undergoes a maturation process in a specific facility before being used for treatment. The mud is mixed, heated and applied topically over the affected area of the body, which is previously covered with a wool cloth.

Figure 7. Bathtub for hydromassage

- Massage therapy (Fig. 10)

Next to the bath facility, massage rooms are available for men and women. Some beds have an overlaying relaxation shower system.

Furthermore, adjacent to the pool, a large gymnasium offers physical rehabilitation services through the use of different equipment, such as parallel bars, walking trails with handrails, benches, wheelchairs and muscle strengthening units (Fig. 11).

Discussion

BT is utilized in order to treat different pathologies (mainly muscular-skeletal disorders), using different types of mineral waters, which are characterized by curative properties.

The nature of these waters is based on the sum of the cations of Na, K, Ca, and Mg and the anions of SO4, Cl, and HCO3 exceeding 1 g/l (7,8). The amounts of NH3, NO, and NO2 must be negligible, and the waters must be bacteria-free. Some elements, such as iodine, require contents of 1 mg/l or more.

Figure 8. Controlling of water jet and multi-perforated barriers

Also water temperature is an important variable. The clinical advantages of thermal warm water have been demonstrated by Szucs, Kovacs and Sunekik (9-11), by comparing the effects of BT with those of warm tap water in double-blind trials in osteoarthritis of the knees and in rheumatoid arthritis.

In the last years BT alone went into decline mainly as consequence of the development of effective analgesics and, for this reason, nowadays it is usually part of total Spa therapy.

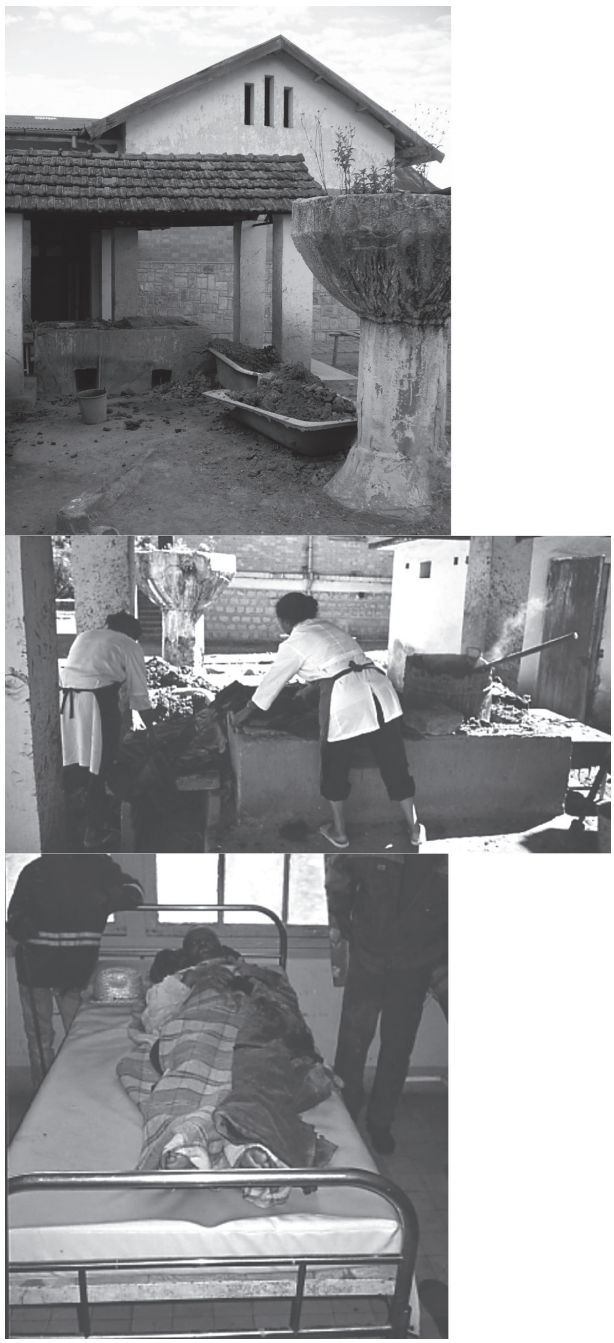

Figure 9. Maturation and mixing process of the mud and its application

Figure 10. Bad for massage therapy without and with shower system

The use of water for medical treatment is probably as old as mankind and its use in spas in the ancient world has been admirably reviewed by Jackson (12). Large quantities of warm water for bathing and immersion were rarely available in ancient times and, not surprisingly, were often considered a donation from gods. The concept of mineral waters' divinity was supported by their sulphurous smell, different feeling to the skin, and diarrhoea when taken orally.

In Homeric times, baths were applied primarily to cleanse and refresh. At the time of Hippocrates, bathing was regarded as more than a simple hygienic measure and Water therapy was an integral part of the ther-

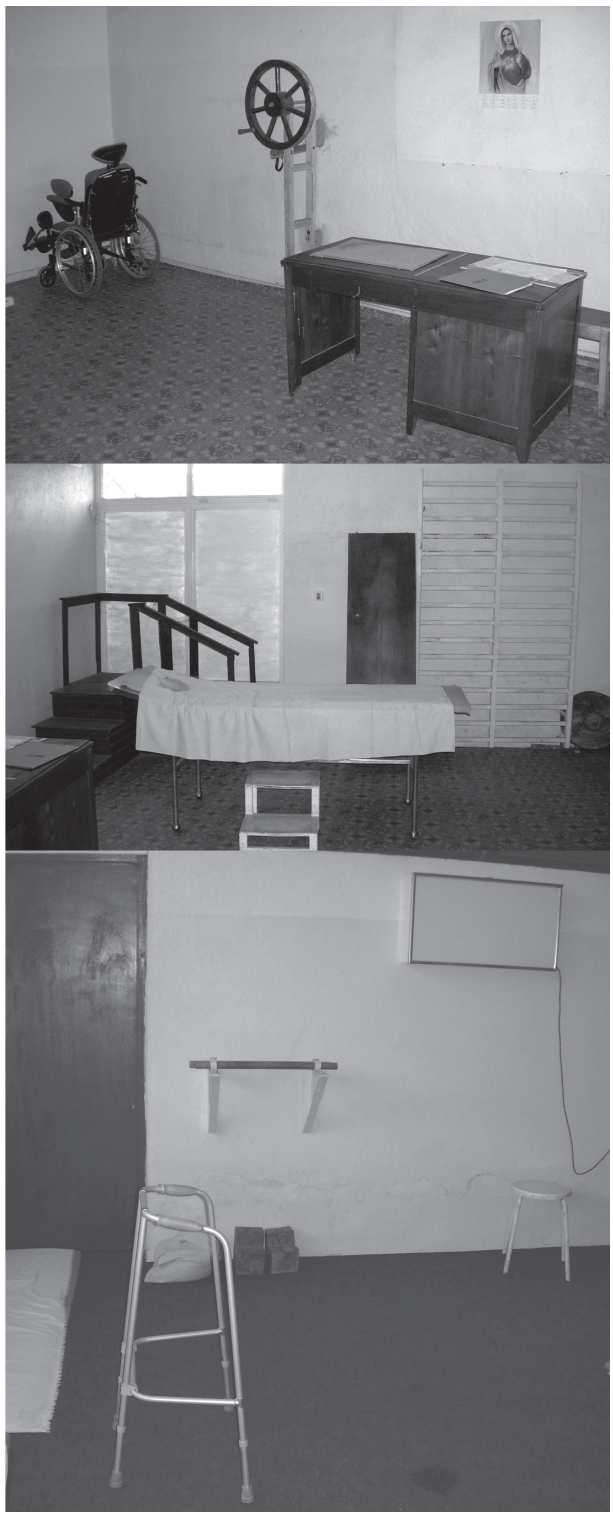

Figure 11. Gymnasium with different physical rehabilitation services

apeutic armamentarium of Aesculapius, Galen, and Celsus (12). Roman authors recognised several classes of thermal and medicinal waters not dissimilar to those of today: sulphur, alum, bitumen, alkaline, and acid.

Roman baths and spas were centres not only for cleansing, exercising, and medical treatment but also for relaxation and meeting friends and colleagues, thus introducing the concept of "spa treatment". This Roman heritage persisted not only in Britain and Europe but also in the United States of America and in all other continents until the first half of the last century (6).

Thermal water and spas exploited, mainly during colonial times, also exist in Africa but have been rarely reported in the literature (13-15).

The mechanism by which BT might work is not clear. Water (thermal water, sea water) is generally used at a temperature of between 34 and 36 °C (16,17). Hydrostatic force (Archimedes' principle) brings about relative pain relief by reducing loading (17); water reduces gravity in painful and rheumatic joints. The warmth and buoyancy of water may block nociception by acting on thermal receptors and mechanoreceptors (18). Warm water may also enhance blood flow, which is thought to help in dissipating algogenic chemicals, and may facilitate muscle relaxation (19). Aside from these mechanical and thermal mechanisms, one should not underestimate the psychological mechanisms of the spa environment. The related mental relaxation may also play a role in pain relief (20). The aim of BT is to improve the range of joint motion, relieve muscle spasm, maintain or improve functional mobility, soothe pain and, as a consequence, relieve patients' suffering and help them feel well (16,2,22).

Nowadays, when warm water is readily obtained from springs in every country, the question arises of whether this warm mineral water is of any medical importance. For this reason physic-chemical analyses are the first step in order to discover these characteristics.

The aim of this study was to analyse the physic-chemical properties of the source water found in Antsirabe, which have been considered thermal for centuries and used for healing purposes. Analyses did indeed confirm that the physic-chemical properties are similar to other thermal sources (5, 18, 23), and thus can be truly considered BT waters.

In the African context and in particular in that of Madagascar, an underdeveloped country with its GDP ranked 178 worldwide, the possibility to use these waters is somewhat limited not only in the number of treatment (few people can afford it) but also in terms of quality because of facility and instrument limitations (structures being built towards the end of the '800 and early '900).

Despite this, the authors noticed during their experience in the Antsirabe thermae great professionalism on behalf of local physicians and physiotherapists, which nonetheless guaranteed high quality services. Furthermore, the authors intend to establish a collaboration and cultural exchange with this centre to improve the facilities of Antsirabe thermae.

Conclusions

The results observed confirm the balneotherapeutical characteristics of these warm waters. The use of hyperthermal bicarbonate water integrates the rehabilitation process of patients of all ages having sustained surgeries or suffering from muscular-skeletal diseases.

In this unprivileged demographic context, which prevents accessibility to all, it is desirable to expand and modernise the facilities in order to improve the local work force of physicians and physiotherapists.

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