

# Thermal Effects of Pool Therapy on the Lower Limbs

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●Hydrotherapy in water at 35–37°C is used to mobilize stiff joints and strengthen weak muscles and is followed by a 20–30-min rest. This study of post-pool cooling in 36 subjects shows that the skin over ankle and that over knee joints cools very little in 20 min, and knee joints may still be hot 2 hr after leaving the water. Changing positions of trunk or limbs was found to influence skin temperature over the joints so that movements of the subjects had to be controlled to obtain meaningful cooling curves. The measurements were made with a portable digital temperature recorder using thermistor sensors on the skin. The implications for serial temperature measuring and for the post-pool care of patients are discussed.

Modern hydrotherapy has its roots in the treatments performed in 19th-century spas, but most of these are now considered unsuitable or inappropriate in a modern hospital. However, exercises in a warm water pool have been used increasingly while the other treatments have declined. In such treatment the patient is required to perform graded exercises aimed at mobilizing stiff joints and strengthening weak muscles in a manner suited to the individual patient and his medical condition. The temperature at which the hydrotherapy pool is maintained varies between departments and is largely dependent on the condition being treated, but will be in the range of 35 to 37°C. Rheumatology patients are usually treated in water at the upper end of this range to allow the patient to exercise in comfort.

When the body is immersed in water having a temperature at or near to the body's normal core temperature, heat loss occurs by conduction, radiation, and evaporation of sweat: heat transfer between skin and hot water is more efficient than that between skin and air, producing a heating effect while cooling by evaporation becomes ineffective.<sup>1</sup> Furthermore, heat is produced in the muscles by exercise, adding to the general rise in peripheral temperatures, and increased blood flow in the dermis.<sup>2</sup> For these reasons it is considered necessary for the patient to rest afterwards to allow the body to regain its pre-pool physiological state.

The method traditionally used in spas and later in hydrotherapy departments in hospitals was for the pa-

tient to recline on a couch, with a light covering, for 20 to 30 min. This length of resting period is quoted<sup>3</sup> as a suitable period to allow body physiology to return to normal.

The main aims of our work were to monitor the pattern of thermal recovery during the post-pool rest period and to determine the cooling time of the lower limbs. To this end, we have measured skin temperature for 20 min before pool therapy and for 2 hr afterwards, taking 43 sets of readings on 36 subjects.

## Temperature Recorder

A portable, battery-operated four-channel digital recorder has been constructed to record skin temperatures for up to 24 hours.<sup>4</sup> Programmed from a microcomputer before use, it collects and records data sequentially from four temperature sensors. At the end of a session it is reconnected to the computer to unload the data. While recording, it is strapped to the subject to allow free movement.

The temperature sensors consist of a thermistor bead fixed with epoxy resin to an aluminium plate approximately 14 mm square. The electrical leads were spiralled around the bead to reduce the effect of heat conduction along them (Fig. 1). The other side of the plate was thinly coated with petroleum jelly to improve thermal contact with the skin, and the whole was secured to the skin with thin surgical paper tape one inch wide.

## Experimental Procedure

Sites chosen for the temperature sensors were locations where the skin moves least over the underlying tissue during joint movement. Large superficial veins were also avoided; in some cases infrared thermography was used to locate such veins. Two sites were selected on each lower limb, (1) on the knee where the medial ligament crosses the articular joint space, and (2) on the ankle joint below the lateral malleolus but avoiding any obvious superficial veins.

The subject, clothed but wearing shorts or bathing costume to expose the lower limbs, was placed on a treatment couch. Positions allowed were supine lying, crook lying, or crook sitting using a backrest and pillows. The subjects, all volunteers, chose just one of these po-

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