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An accurate dual heat flux-type deep body thermometer with a calibrator

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***Abstract*—A dual heat flux method was applied to estimate deep body temperature based on the difference in temperature based on two heat flux paths using in a probe varying in thermal resistance. The temperature measurements obtained by an existing wearable clinical device are affected by the ambient temperature. We improved the accuracy of this wearable dual heat flux-type deep body thermometer.**

We developed a new calibrator that can precisely determine the deep body temperature under any ambient temperature. The dual-heat-flux type deep body thermometer consisted of four temperature sensors and determined thermal coefficient K as the difference in temperature between two heat flux paths during calibration.

***Clinical Relevance*—Non-invasive core temperature estimation is important for preventing hypothermia and heat stroke.**

I. Introduction

A dual heat flux (DHF) method can be applied to estimate deep body temperature based on the difference in temperature between two heat flux paths, using a prove difference in thermal resistance. The temperature measurements of an existing device used to evaluate core temperatures in the operating room and hospital wards are affected by the ambient temperature. Against the background of climate change and increasing ambient temperature, it is important to monitor core and deep body temperature, and the incident of heat stroke. In this study, we improved the accuracy of a wearable DHL type deep body thermometer.

II. Methods

Figure 1 shows a schematic diagram of the probe. When DHF-type deep body thermometer assumed that the difference in temperature between two heat flus paths. thermal coefficient K is related to the height of the probe. However, in addition to vertical heat flux, heat is also released to the to the environment, so the thermal coefficient is not simply determined by the height of the probe. Based on the thermal coefficient obtained from the height of the probe, temperatures measurement under ambient conditions are not accurate when there is large temperature difference between the ambient and deep body temperature.

We proposed a calibration method for precise temperature measurements. As a calibrator, an isothermal bath maintained at 37 ° C is used to simulated the deep body temperature. During calibration the thermal coefficient K is calculated from the temperature detected at sensors T1 - T4 and the water temperature (simulated deep body temperature) .

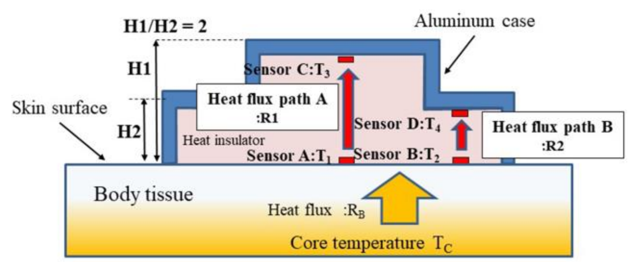

Figure 1 Schematic of the dual-heat-flux method

$$T_c = T_1 + \frac{(T_1 - T_2)(T_1 - T_3)}{K(T_2 - T_4) - (T_1 - T_2)}$$

An *in-vitro* study was performed using an isothermal bath. The ambient temperature varied from 15 - 35 °C. The thermal coefficient K. calculated in this study was 1. 4.

III. Results

Figure 2 compared thermal coefficients obtained based on the thermal resistance of the prove and calibration method values. The simply determined K had a larger error than the estimated K.

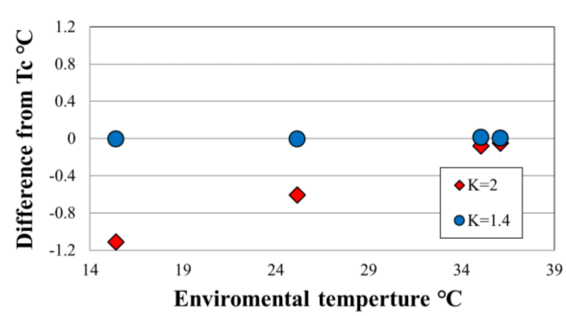

Figure 2 Experimental results.

IV. Discussion & Conclusion

The deep body temperature measurements obtained using the proposed method are not affected by changes in the ambient temperature and are therefore accurate.

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