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Development of a Body Temperature Monitoring System Installed in Bed Sheet for Medical and Nursing Care

Miki Suganuma, Kosuke Motoi, Yasuhiro Yamakoshi, Hiroaki Sakai, and Ken-ichi Yamakoshi

Abstract— **Using the bed-installed sensor units which are composed of a resistance-sensitive pressure sensor, a thermistor, and a thermal insulating material, the body temperature could be successfully obtained from the rate variation of temperature increase immediately after the pressure sensor detects that the subject has laid down. By comparing with a commercially available axillary thermometer in eleven adults, it was demonstrated that the reasonable accuracy could be obtained, being useful for less-burden and continuous measurement.**

I. INTRODUCTION

In medical and nursing care, daily body temperature measurement is necessary to early detect the fever and prevent thermoregulatory failure and the pneumonia. However, commercially available axillary and oral thermometers and wearable sensor [1] are cumbersome because of the need to attach biological sensors to the patient's body. From these viewpoints, we proposed a new non-intrusive method to measure body temperature when the bed sheet makes contact with the subject's body, while the care staff help the patient change posture to prevent pressure ulcers [2]. In this study, the prototype measurement system and its accuracy evaluation in eleven adults are reported.

II. METHODS

Figure 1 (a) shows outline of a measurement system. Three sensor units which are composed of a thermistor, a resistance-sensitive pressure sensor to detect subject's lying down, and a thermal insulating material, are located under the subject's left scapula, celiac plexus, and waist. As show in (b), body temperature transit time (*B3T*) could be calculated from the interval under threshold of the derivative of the thermistor's output (T_{der}). The body temperature, T_E, is estimated by the regression line based on scatter diagrams between the *B3T* values and actual body temperatures by a commercially available axillary thermometer, T_C [2].

III. RESULTS

From the measurement examples in figure 2, the increase of the *T* was detected after the fluctuation of *P* by the contact with subject's body and the *B3T* could be calculated from the T_{der}. In addition, the variability of *B3T* could be observed with differences in body temperature and thus the T_E coincide well with T_C as shown in each lower part. From the Bland–Altman plots between the average and the difference in the body temperature obtained from the bed system and the axillary thermometer (n = 60), good agreement could be observed (Mean = –0.0284, S.D. = 0.274).

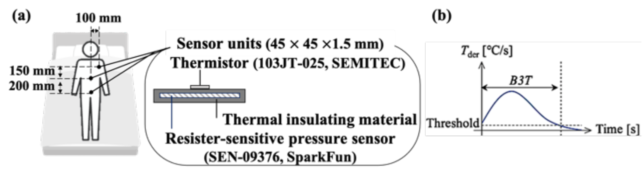

Figure 1. Outline of a measurement system installed in the bed sheet (a) and the definition of body temperature transit time (*B3T*) (b).

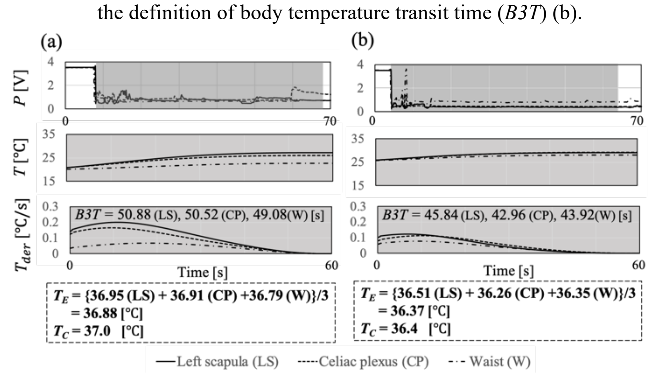

Figure 2. The measurement examples of the pressure, *P*, the temperature, *T*, and the derivative of the temperature, T_{der}, in a 23-years-old male (a) and 73-years-old female (b). The comparison between the T_E, and T_C, is also shown in each lower part.

IV. DISCUSSION & CONCLUSION

From the comparing the body temperature obtained by the prototype bed system with that obtained by a commercially available device, it was demonstrated that the proposed method can be useful for body temperature measurement with reasonable accuracy. Further investigation will be needed such as ambient temperature, bedclothing, improvement in positioning the sensor modules, and so on.

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M. Suganuma and K. Motoi are with the Graduate School of Science and Engineering, Shizuoka Institute of Science and Technology, Fukuroi 437-8555 Japan (e-mail: motoi_214@sist.ac.jp).

Y. Yamakoshi and K. Yamakoshi are with the Showa University School of Medicine, Tokyo 142-8555 Japan (e-mail: yamakoshi@med.showa-u.ac.jp, keny2257@gmail.com)

H. Sakai is with the Spinal Injuries Center, Iizuka 820-8508 Japan (e-mail: hiro_yale@yahoo.co.jp).

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