Hypoglycemia Detection Rate Differs Among Blood Glucose Monitoring Sites

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To achieve better glycemic control, self-monitoring of blood glucose (SMBG) plays an important role in diabetes management. Although fingertip capillary blood has been used for SMBG, alternative-site blood glucose testing (i.e., from the forearm or the palm of the hand) has been developed because patients have requested less painful measurement techniques. However, there has been debate about blood glucose equivalence at alternative sites because some reports suggest that glucose monitoring at the forearm shows a delayed value if blood glucose changes rapidly (1,2). One study reported that blood glucose measurement at the palm is not delayed compared with fingertip measurement after a test meal and exercise load (3). Another study reported that palm blood glucose is comparable to fingertip blood glucose in acute hypoglycemia (4). Since there has been no research comparing blood glucose values simultaneously at the fingertip, forearm, and palm of the hand in acute hypoglycemia, we performed this study to compare blood glucose values in induced acute hypoglycemia at several sites and evaluated the differences in alternative-site blood glucose testing.

RESEARCH DESIGN AND METHODS — Ten healthy volunteers participated in this study (mean age [± SD] 35.1 ± 10.8 years; 6 men and 4 women). Regular insulin (0.1 units/kg body wt) was injected intravenously after an overnight fast. Capillary blood glucose was measured using Medisafe-Mini (Terumo, Tokyo, Japan), a blood glucose meter widely used in Japan. The Medisafe-Mini system, which uses the glucose oxidase method, consists of a meter, a tip with a test strip, a lancet, and a lancing device. Trained research personnel sampled subjects' blood from the fingertip, hypothenar of the hand, and forearm simultaneously and in duplicate. Samplings were performed just before insulin administration and every 5 min until 70 min after insulin injection. The forearm skin was not rubbed before blood glucose sampling. All procedures were approved by the Ethics Committee of Saiseikai Central Hospital (Tokyo, Japan), and subjects gave written informed consent to participate in the study. All data are given as means ± SD. Differences in blood glucose among sites were assessed using a paired *t* test and regression analysis.

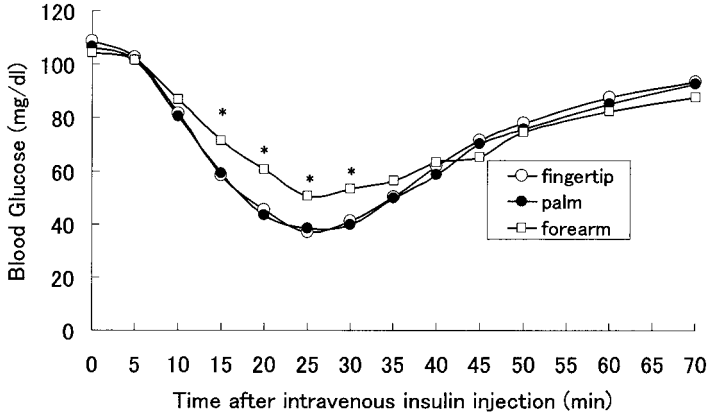

Figure 1—*Time course of blood glucose values after insulin injection. Regular insulin (0.1 units/kg body wt) was injected intravenously, and blood glucose values at the fingertip, forearm, and palm of the hand were measured. Results are shown as mean blood glucose of 10 subjects.* ○*, fingertip;* ●*, palm;* □*, forearm. Asterisks indicate significant differences of blood glucose values between the fingertip and another site* ($P < 0.05$).

RESULTS — The time course of mean blood glucose values after insulin injection is shown in Fig. 1. Mean blood glucose values at the forearm were significantly higher than mean blood glucose values at the other sites at 15, 20, 25, 30, and 35 min after insulin injection ($P < 0.05$). Regression coefficients for blood glucose were 0.928 ($y = 0.7263x + 22.397$) at the fingertip and 0.983 ($y = 0.9773x + 0.2937$) at the forearm and palm. The minimum blood glucose value while testing was 37 ± 14 mg/dl at the fingertip, 38 ± 16 mg/dl at the palm, and 50 ± 11 mg/dl at the forearm. When blood glucose at the fingertip was <40 mg/dl, only 23.8% of simultaneously measured blood glucose at the forearm showed a value <40 mg/dl, whereas 85.7% of blood glucose at the palm showed a value <40 mg/dl.

CONCLUSIONS — Our data were in agreement with the results of previous studies that suggested the inaccuracy of forearm blood glucose in acute hypoglycemia. The difference between minimum blood glucose values at the fingertip and at the forearm was 13 mg/dl, whereas the

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Abbreviations: SMBG, self-monitoring of blood glucose.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

difference between fingertip and palm was only 1 mg/dl. Blood glucose values at the palm of the hand correlated well with blood glucose at fingertip and showed no delay. Our study also showed that only less than one-quarter of blood glucose <40 mg/dl at the fingertip was detected by simultaneous forearm measurement, while 85.7% was detected by palm blood glucose measurement. Although it is unclear why forearm blood glucose measurements differed from values at other sites, blood glucose measurement at the forearm should be avoided to prevent incorrect clinical decisions based on SMBG device results. Our study suggested that the palm is a suitable blood glucose testing site because it provides accurate measurements with less pain.

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