Value of the Skin-surface Glucose Test as a Screening Procedure for Diabetes

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Recently Miller and Ridolfo[1] reported results of testing the glucose on the skin surface of fingers of diabetics and nondiabetics using glucose-oxidase test papers.* They found that persons with elevated blood glucose levels often had positive skin glucose tests but negative skin tests were also observed in these individuals. They also found positive skin glucose tests in eleven of sixty-four individuals who had no prior history suggesting diabetes. These eleven were tested with glucose tolerance tests and in some instances with cortisone-glucose tolerance tests. It was of interest that nine of the eleven had evidence of diabetes or possible diabetes by the criteria employed. Another study by Parker[2] suggested the possibility that testing the skin might be a useful adjunct to other approaches in screening for diabetes. However, Parker concluded additional information would be required in order to appraise the utility of this approach to screening. Relevant studies are reported in this paper.

METHODS

The presence or absence of glucose on the skin surface was determined according to the method described by Miller and Ridolfo.[1] Strips of glucose-oxidase paper are moistened with water and placed between the thumb and forefinger of each hand for a period of one minute. Tests were recorded as negative if the tape did not change color and positive if a color change occurred.

Positive tests occurred with equal frequency on the left and right hands. In twenty fasting diabetics who had positive skin tests, six were positive on both hands and fourteen on only one hand. Experiments in which both hands or one hand were positive were regarded as positive tests.

In only one group of subjects were hand washing instructions given. These were the diabetics whose skin tests blood glucose determinations were performed two hours after breakfast. These persons washed their hands immediately after breakfast.

True blood glucose levels were determined on venous blood using an AutoAnalyzer* which employs a principle described by Hoffman.[3]

Frequency of positive skin glucose tests in the nondiabetic individuals. Forty-four hospital employees selected at random (secretaries, technicians, nurses, and doctors) were tested between 10:00 a.m. and 11:00 a.m. Nineteen of these (43 per cent) exhibited positive tests on one or both hands. On another occasion forty-one second-year medical students were tested at approximately 5:00 p.m. Twenty-three (56 per cent) had detectable glucose on the skin surface of one or both hands. Subsequently, eighty-one ambulatory inpatients in a Veterans Hospital were tested when they came to the laboratory in a fasting state for a test other than blood glucose. None of these individuals had apparent diabetes and none had had a positive urinary glucose test. Eight of these persons (10 per cent) had detectable glucose on the fingers of one or both hands. The fingers of thirty outpatients of the University of Oklahoma Hospital with no apparent diabetes and fasting blood glucose levels below 100 mg. per 100 ml. were tested in a fasting state. Five of these subjects (17 per cent) had positive tests. Lastly, a group of twenty-four inpatients of the Veterans Hospital with no apparent diabetes were tested at 9:00 a.m., about two hours after breakfast. Nine persons (37 per cent) had positive tests.

Thus, under a variety of conditions, a total of 220 persons with no apparent diabetes showed a 29 per cent incidence of detectable glucose on fingers of one or both hands.

Incidence of diabetes in individuals with positive skin tests. Since Miller and Ridolfo[1] had found a high incidence of diabetes in their subjects with positive skin-surface tests we tested a group of our subjects who had exhibited positive skin tests. Ten of the twenty-three second-year medical students who had exhibited positive skin tests were selected at random. Fasting

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*Tes-Tape, Lilly.

*Technicon.

blood glucose levels were determined and blood glucose levels were measured two hours after 100 gm. of glucose. The fasting blood glucose levels ranged from 79 mg. per 100 ml. to 97 mg. per 100 ml., and the two-hour glucose levels ranged from 83 mg. per 100 ml. to 108 mg. per 100 ml. Thus there was no evidence of impairment of glucose tolerance in any of the ten subjects. Previously we had tested in this manner the glucose tolerance of two hospital employees upon whose fingers glucose had been found (at 10:00 a.m.). Their two-hour glucose values were 83 and 94 mg. per 100 ml., respectively. Two of the inpatients who had positive skin tests were similarly tested. One had a two-hour glucose of 97 mg. per 100 ml. and the other had a two-hour value of 120 mg. per 100 ml. Thus, of fourteen individuals with positive skin tests, only one had a two-hour value of 110 mg. per 100 ml. or greater.

Fasting blood glucose levels were performed in a group of eighty-one apparently nondiabetic inpatients with negative urine glucose tests. The fasting blood glucose values of the eight individuals in this group who had positive skin tests ranged from 70 to 105 mg. per 100 ml. and were not significantly different than those of the remaining seventy-three persons who had negative skin tests.

Correlation of the skin-surface glucose and the blood glucose. Both a fasting blood glucose and a skin surface glucose test were performed in each of 154 diabetics. This group included both inpatients and outpatients. All were tested in a fasting state between 7:00 a.m. and 9:00 a.m. and none had received any instructions concerning hand washing prior to the test. The results are summarized in figure 1. Twenty-nine individuals had fasting blood glucose levels below 101 mg. per 100 ml. and eight of these persons (28 per cent) had positive skin tests. It is of interest that the incidence of positive skin tests in these diabetic patients with normal blood glucose values (28 per cent) was somewhat greater than the incidence in 135 nondiabetic patients tested in the fasting state (17 per cent).

It is apparent from figure 1 that there is only a rough correlation between the incidence of positive skin tests and the blood glucose. In persons with fasting levels between 101 and 200 mg. per 100 ml. the incidence of positive tests was 25 per cent, while in those with blood glucose values between 201 and 300 mg. per 100 ml. it was 60 per cent. Only eight subjects were available with fasting values above 300 mg. per 100 ml. Four of the eight had positive skin tests.

Also presented in figure 1 are the results of skin-surface glucose tests two hours after breakfast in thirty-two diabetic outpatients whose blood glucose levels were also measured two hours after breakfast. It may be noted that individuals whose blood glucose levels are high were more likely to have detectable glucose on the skin. However, both "false negatives" and "false positives" were very common.

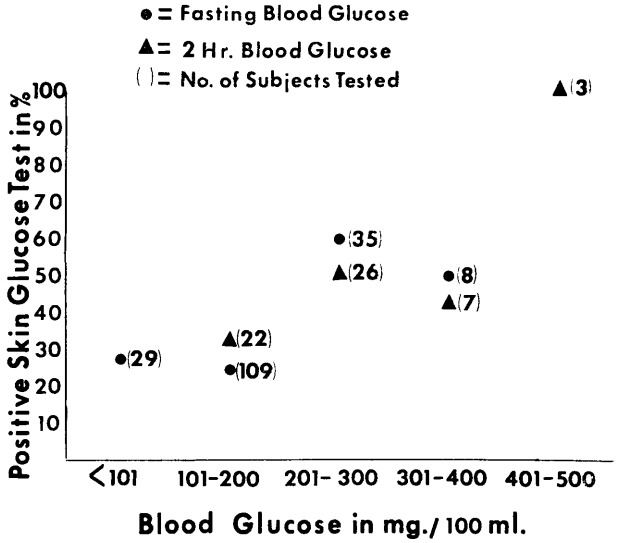

FIG. 1. The relationship between the blood glucose and the skin-surface glucose (qualitative) in 154 diabetic patients.

Effect of hand washing on skin glucose. Our experience confirms the observation by Miller and Ridolfo[3] that hand washing will change the result of a skin test from positive to negative. We repeatedly converted positive tests to negative in this way. That this conversion may be temporary is indicated by some of the data of Miller and Ridolfo. Similarly, we found that nine of twenty-four diabetics with blood glucose values between 101 and 200 mg. per 100 ml. had positive skin tests even though they had washed their hands two hours before.

DISCUSSION

These data confirm the findings of others that there is some relationship between the blood and skin glucose,[4-6] and that diabetics are more likely to exhibit positive skin tests than normals when tested with glucose-oxidase paper strips.[1,2] However, these findings with a larger number of subjects suggest that in the general population most positive tests are due to factors which are unrelated to the presence of diabetes.

We determined the incidence of positive skin tests in five different groups of subjects under conditions which were deliberately varied to simulate the situations which might prevail in mass screening surveys.

The lowest incidence of positive tests in our group with no apparent diabetes was 10 per cent. All of the ambulatory inpatients in this latter group were fasting and all or almost all had washed their hands from thirty to 120 minutes prior to testing. This incidence was slightly lower than the incidence of positive tests (17 per cent) in a group of positive subjects with no apparent diabetes tested by Miller and Ridolfo after hand washing performed thirty to 180 minutes prior to testing.[1] However, in the group of students tested by us at 5:00 p.m. who were tested four to five hours after lunch and to whom no hand washing instructions had been given the incidence of positive tests was 56 per cent. It would appear then that the incidence of positive tests can be reduced by fasting and by hand washing, but even so the incidence of positive tests remains more than ten times greater than the expected incidence of occult diabetes. Furthermore, the data in figure 1 show that the majority of diabetics have negative skin tests.

That "false" positive skin tests would be extremely frequent in a mass survey is also suggested by the fact that thirteen of the fourteen subjects we tested because of positive skin tests had clearly normal glucose tolerance and the remaining person had borderline tolerance. Furthermore, the fasting blood glucose values were not significantly different in eight individuals who exhibited positive skin tests than those of seventy-three other subjects in the same group with negative skin tests.

Thus the skin-surface glucose appears to have little specificity and limited sensitivity in the diagnosis of diabetes.

SUMMARY

Five different groups of apparently nondiabetic subjects (total of 220) were tested in order to determine whether or not glucose could be detected on the skin of the fingers using glucose-oxidase papers (Tes-Tape). In these groups, which were tested under a variety of conditions, the incidence of positive skin-surface glucose tests ranged from 10 to 56 per cent with an average of 29 per cent. Fasting blood glucose tests were performed in one of the groups and no difference was found between the blood glucose levels of the eight persons with positive tests and those of the seventy-three individuals with negative tests. Thirteen of fourteen other subjects with positive skin tests had clearly normal glucose tolerance.

In 154 diabetics the blood glucose and the skin glucose (qualitative) were determined simultaneously. There was a rough correlation between the skin-surface glucose and the blood glucose but the majority of fasting diabetics had no detectable skin glucose and some subjects with blood glucose levels exceeding 30 mg. per 100 ml. had negative skin-surface tests.

It is concluded that this skin-surface glucose test would be of practically no value in screening for diabetes.

SUMMARIO IN INTERLINGUA

Le Valor del Test pro Glucosa al Superficie Cutane Como Technica de Detection in Diabete

Cinque differente gruppos de apparentemente non-diabetic subjectos (constituente un serie total de 220 individuos) esseva testate pro determinar si o non glucos pote esser detegite al superficie del pelle del digitos co le uso de papiro a oxydase de glucosa. In iste gruppo que esseva testate sub un varietate de conditiones, l incidentia de positive tests pro glucosa al superfici cutanee variava ab 10 ad 56 pro cento. Le positivitat medie esseva 29 pro cento. Tests pro glucosa sanguine in stato jejun esseva effectuate in un del gruppos, nulle differentia esseva trovate inter le nivellos sar guinee de glucosa in le octo personas con positive tes cutanee e illos in le septanta-tres personas con tes negative. Dece-tres de dece-quatro altere subjectos co positive tests cutanee habeva normal tolerantias.

In 154 diabeticos le glucosa sanguinee e le glucos cutanee (qualitative) esseva determinate simultanee mente. Esseva constatate un crude correlation inter l glucosa al superficie del pelle e le glucosa sanguine sed le majoritate del diabeticos in stato jejun habev nulle detegibile glucosa cutanee, e certe subjectos co nivellos de glucosa sanguinee de in supra de 300 m per 100 ml habeva negative tests al superficie cutane

Es concludite que le test esserea de practicament nulle valor in le detection de diabeticos.

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