AN EVALUATION OF THE FASTING BLOOD-GLUCOSE LEVEL AS AN INDEX OF ABNORMAL CARBOHYDRATE TOLERANCE

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THE fasting blood-glucose level is widely used today as a means of screening for diabetes mellitus. Recent studies[1,2] have emphasized the inadequacy of this determination in detecting lowered carbohydrate tolerance. On the other hand, the determination of blood glucose after the administration of a known carbohydrate load is the best means of demonstrating abnormalities in carbohydrate metabolism.[2] The carbohydrate load is best given in a standard form such as a solution of weighed glucose or as a carbohydrate hydrolysate.

Method

The results of 1,057 consecutive glucose tolerance tests performed in our laboratory on 1,057 patients were reviewed to determine whether or not a correlation existed between the fasting blood-glucose level and the response to a standard carbohydrate load. Fasting patients were given a solution containing 100 gm. of glucose immediately after samples of their blood had been withdrawn for glucose determination. Specimens of venous blood were drawn at one- and two-hour intervals after the administration of the glucose. These were analyzed by means of the AutoAnalyzer using the automated ferricyanide reduction method.[3]

Results

The comparison of fasting blood-glucose levels with the results of the glucose tolerance tests appears in *Table 1*. For this study, the glucose tolerance tests were arranged in groups according to the following ranges of fasting blood-glucose levels: 80 mg. per 100 ml. or less, from 81 to 90 mg., from 91 to 100 mg., from 101 to 110 mg., and more than 110 mg. per 100 ml. Each of these categories was then further divided into normal, abnormal, or equivocal, according to the response to glucose as determined from the complete tolerance curves. The total response was considered normal when the blood-glucose level was no more than 160 mg. per 100 ml. at the first hour and had decreased to between 60 and 110 mg. per 100 ml. by the second hour. These limits were chosen somewhat arbitrarily to correspond to those criteria set forth by others.[1,2,4] In this study, no attempt was made to correlate the laboratory findings with clinical data such as age or weight; therefore, the data presented are limited to those obtained by the laboratory.

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Table 1.—*Comparison of 1,057 glucose tolerance tests with fasting blood-glucose levels*

Range of fasting blood-glucose levels, mg./100 ml.	Results of tolerance tests						Total no. of patients
	Normal*		Abnormal†		Equivocal		
	No.	(%)	No.	(%)	No.	(%)	
≦ 80	247	(55)	139	(31)	61	(14)	447
81- 90	164	(55)	113	(38)	23	(8)	300
91-100	41	(28)	97	(66)	9	(6)	147
101-110	3	(2)	68	(83)	11	(13)	82
>110	0	(0)	81	(100)	0	(0)	81
Total	455	(43)	498	(47)	104	(10)	1057

*Normal <160, 1 hr., and/or <110, 2 hr.
†Abnormal >170, 1 hr., and/or >125, 2 hr.

The tolerance was considered equivocal if at one hour the blood-glucose level was between 160 and 170 mg. per 100 ml. and by the second hour was between 110 and 125 mg. per 100 ml. If the first-hour level was more than 170 mg. per 100 ml. and the second-hour level was more than 125 mg. per 100 ml., the tolerance to glucose was considered abnormal. These interpretative ranges were discussed in a prior report.[2]

Four hundred forty-seven patients had fasting blood-glucose levels of 80 mg. per 100 ml. or less, yet 139 (31 percent) of their tolerance curves were abnormal according to the previous criteria. In each successively higher range of the fasting blood-glucose level, the proportion of abnormal tolerance tests was increased: 81-90 mg. range, 113 (38 percent) of 300 curves; 91-100 mg. range, 97 (66 percent) of 147 curves; 101-110 mg., 68 (83 percent) of 82 curves; and more than 110 mg. per 100 ml., 81 (100 percent) of 81 curves.

Comment

The results obtained in this study correspond well with those of Frethem,[1] who used slightly lower limits (approximately 10 mg. per 100 ml.) as criteria for normality of response. The high incidence of abnormality in both studies is related to the clinical selection of the patients, and conclusions drawn from the data are not necessarily applicable to a general population. The ranges of blood-glucose levels reported here may not be identical to those from other laboratories. This is particularly true if other methods for determining glucose are used.

Since 70 percent (349 of 498) of the patients with abnormal responses had fasting blood-glucose levels less than 100 mg. per 100 ml., one may conclude that the determination of the fasting blood-glucose level will fail to detect many patients with lowered carbohydrate tolerances. Although an elevated level of blood glucose in the fasting state usually can be considered evidence of lowered carbohydrate

tolerance, a normal fasting level by no means rules out the presence of diabetes mellitus. Indeed, on the basis of the results of this study it would seem appropriate for all persons whose fasting blood-glucose levels exceed 90 mg. per 100 ml. to undergo a glucose tolerance test, especially if there is a clinical suspicion of the presence of lowered tolerance. The normal range of fasting blood-glucose levels of from 65 to 90 mg. per 100 ml., reported by McGuckin[5] for the AutoAnalyzer, seems more correct than the range of from 65 to 105 mg. per 100 ml. used by many laboratories. In this study, 252 (51 percent) of 498 tests rated as abnormal had fasting blood-glucose levels less than 91 mg. per 100 ml. In these the abnormality would have been missed if the fasting blood glucose alone had been used as a criterion of altered carbohydrate tolerance.

The abbreviated glucose tolerance test in which only two blood-glucose levels are determined is quite adequate for detecting diminished carbohydrate tolerance.[2,6] Furthermore, by not drawing a specimen of blood while the patient is fasting, it is possible for the test load of glucose to be administered in the physician's office or at home to save waiting time. As emphasized in a previous study,[2] although the determination of the blood-glucose level at two hours is useful in the detection of low carbohydrate tolerance, the combination of determination both at one hour and at two hours constitutes a tolerance test of fully adequate accuracy and reliability for the detection of diabetes mellitus.

It should be noted that 10 percent of the glucose tolerance tests were in the equivocal range. We agree with Frethem,[1] who suggested that there is no sharp dividing line between normal and abnormal. Patients whose tests are near or in this equivocal category probably should be retested at a later time. It is the authors' opinion that a diagnosis of diabetes mellitus should not be made on the basis of the results of a single test.

It is possible that some of the equivocal group were elderly and/or obese. Recent studies[7] reported diminished tolerance to carbohydrate in the aged. Consideration of age, weight, and previous diet was beyond the scope of this study. The use of such factors in the interpretation, diagnosis, and treatment of the patient, however, is a matter of judgment for the physician.

Summary

Fasting blood-glucose levels in 1,057 patients who underwent glucose tolerance tests were compared with laboratory interpretations of the results of the tolerance tests. The data suggest that, with the method used, 90 mg. per 100 ml. be considered the upper limit of normal if the fasting blood-glucose level is used as an index of diminished carbohydrate tolerance. However, since 252 (51 percent) of the 498 tests with abnormal results showed fasting blood-glucose levels to be less than 91 mg. per 100 ml., the fasting blood-glucose level has little value as a screening test for diminished carbohydrate tolerance. The glucose tolerance test, consisting of

blood-glucose levels determined at one- and two-hour intervals after the ingestion of a measured amount of glucose, offers a more reliable index of carbohydrate tolerance than does the fasting blood-glucose level.

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