Diabetologia 7, 463–464 (1971)

SHORT COMMUNICATIONS

Pooling of Blood Sugar Values at Various Times in the Oral Glucose Tolerance Test with a Discriminant Analytical Technique

R. KNUSSMANN
Diabetesforschungsinstitut, Düsseldorf, Deutschland

Received: July 20, 1971, accepted: September 9, 1971

Summary. It is shown, that simply adding blood sugar values, taken at different intervals after glucose load, meets up with certain sources of error. A better method to combine different blood sugar values is the discriminant analysis. Two discriminant functions are communicated for a material of 1262 non-diabetics and 267 diabetics; these functions can be replaced by nomograms.

Addition des valeurs de la glycémie à différents moments lors du test de tolérance au glucose oral à l'aide d'une technique analytique discriminante

Résumé. L'auteur montre que le fait d'additionner simplement les valeurs de la glycémie à différents intervalles suivant une charge en glucose, comporte certaines sources d'erreur. La meilleure méthode pour combiner les différentes valeurs de la glycémie est l'analyse discriminante. Deux fonctions discriminantes sont communiquées pour un groupe de 1262 non-diabétiques et 267 diabétiques; ces fonctions peuvent être remplacées par des nomogrammes.

Zusammenfassung von Blutzuckerwerten zu verschiedenen Zeiten im oralen Glucose-Toleranztest mit einer Diskriminanz-analytischen Technik

Zusammenfassung. Es wird gezeigt, daß die einfache Addition von Blutzuckerwerten, die zu verschiedenen Intervallen nach Glucosebelastung erhalten wurden, mit Irrtümern bestimmten Ursprunges zusammentreffen. Eine bessere Methode, verschiedene Blutzuckerwerte zu kombinieren ist die Diskriminanz-Analyse. Zwei Diskriminanz-Funktionen werden mitgeteilt für ein Material von 1262 Nicht-Diabetiker und 267 Diabetiker. Diese Funktionen können durch Nomogramme ersetzt werden.

Key words: oral glucose tolerance test, blood sugar values, diagnostic measure for glucose tolerance.

Although blood sugar determinations, taken at different intervals after glucose load, prove to be more informative than a single determination, difficulties are experienced when attempting to combine these results, expressed as one diagnosis. For this purpose Köbberling and Creutzfeldt (1970) as well as Gutsche (1970) have suggested adding the 60' and 120' result (2-t-value). However, simply adding blood sugar values, taken at different intervals after the administration of glucose, meets up with certain sources of error as follows:

a) The different evidence of the values is not taken into account.
b) The minute values, which vary in the upper range of scale, become too pronounced when the same variation coefficient is present.
c) When more than two of the minute values are combined, multiple coding of information may, in part, occur by not observing intercorrelations.

In order to eliminate these methodological errors, each minute value has to be multiplied by a weighting coefficient prior to addition. The most suitable coefficients are found by linear discriminant analysis (Fisher 1936)[1]. This is possible through a multivariate discriminant function, dividing a group of diabetics from a group of non-diabetics. The following geometric model illustrates the algebraic function of discriminant analysis: Both groups, i.e. diabetics and non-diabetics, can be represented by two areas of dots in a multi-dimensional coordination system, the axes expressing the various minute values. In the discriminant analysis these two groups of scattered dots are aligned by projection into one single dimension, dividing into two ordinary distribution curves, as far apart as possible[2].

The result of the discriminant analysis depends, of course, on the selection of patients to be observed, and here lies the key problem of the procedure. It would be ideal to have available patients who are known to be diabetics, as confirmed by observation and treat-

1 as has already been pointed out at the Meeting of the European Diabetes Epidemiology Study Group in June 1970 in Düsseldorf.

2 To obtain an ideal situation for carrying out linear discriminant analysis, certain requirements must be fulfilled (see Knussmann 1962). Although this postulation has not wholly been reached, all parameters — measured on the sensitivity of the method — are within acceptable limits.

ment, in whom a glucose tolerance determination may be carried out from the onset of diabetes.

The groups in the present study, consisting of 1262 non-diabetics and 267 diabetics[3], do not fully meet up with this requirement, since the group of diabetics includes newly discovered diabetics according to the criteria for the o.GTT, as outlined by the European Diabetes Epidemiology Study Group.

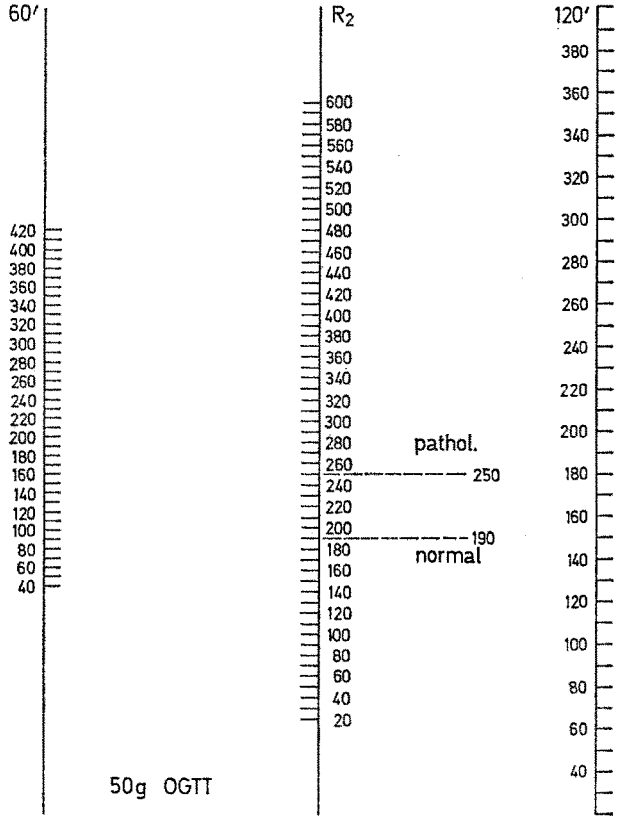

Fig. 1. Illustration for diagnostic measure R_2. From the left scale the 60′ result is taken, from the right the 120′ result and both these connected with a straight line. The point of intersection with the medial scale shows the R_2 value. As upper limit of normal the R_2 is given of a patient with a 60′ result of 160 mg % and 120′ of 120 mg %, according to the criteria of the European Diabetes Epidemiology Study Group. Consequently, the lower limit of the pathological range is consistent with a result of 60′ of 220 mg % and 120′ of 150 mg %

3 These data originate from East Berlin (Honigmann), from West Berlin (Gutsche) and from Düsseldorf. I express my gratitude to my colleagues for providing these data.

The discriminant functions for combining the 60' and 120' value as well as 0', 30', 60' and 120' value are as follows:

$$R_2 = 0.44 \cdot 60' + 120';$$

$$R_4 = 0.24 \cdot 0' + 0.64 \cdot 30' + 0.78 \cdot 60' + 120'.$$

The role of the various minute results cannot be estimated from the weighting coefficient but has to be calculated from the total of coefficient and minute value ("Trennwert", Knussmann 1962). The calculation of the R_2 or R_4 result is unnecessary in view of the graphic illustration (Fig. 1).

Because of the group of patients not being optimal (as described above) the formulas and illustrations have to be regarded as preliminary; however, efforts are being made for standardization.

Detailed publication Knussmann (1971).

Literatur

Fisher, R.A.: The use of multiple measurements in taxonomic problems. Ann. Eugenics **7**, 179–188 (1936).

Gutsche, H.: 2-t-Auswertung der Glucosetoleranz. Med. Klinik **65**, 1698–1700 (1970).

Knussmann, R.: Moderne statistische Verfahren in der Rassenkunde. In: I. Schwidetzky (Hrsg.): Die neue Rassenkunde (S. 233–285). Stuttgart (1962).

— Diskriminanzanalytische Auswertung oraler Glukosetoleranztests. Ärztliche Praxis **23**, 3398–3407 (1971).

Köbberling, J., u. Creutzfeldt, W.: Comparison of Different Methods for the Evaluation of the Oral Glucose Tolerance Test. Diabetes **19**, 870–877 (1970) (Auszug: Vergleich verschiedener Methoden für die Auswertung des oralen Glukosetoleranztestes. 5. Kongreß der Deutschen Diabetes-Gesellschaft, Bonn-Bad Godesberg, Mai 1970).

Prof. Dr. R. Knussmann
Diabetes Research Institute
D-4000 Düsseldorf-Benrath
Hospitalstr. 1