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PSYCHOPHYSIOLOGICAL EFFECTS OF STRESSFUL EXPERIENCES  
AND THE MANAGEMENT OF DIABETES MELLITUS

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ABSTRACT

Considerable medical attention has recently been focussed on the use of home blood glucose monitoring as a means of improving the management of diabetes mellitus. New developments in reflectance meters have simplified the determination of blood glucose levels to the extent that home monitoring could be a possibility for most diabetics.

It is suggested that the medical approach to home monitoring of readjusting control after disturbance has occurred is not making optimal use of the information gained. If it were possible to predict those circumstances that would be associated with changes in a diabetic's state, it may be possible to prevent physiological disruption before it occurs. Evidence is presented which demonstrates the importance of psychological factors in diabetes control. Three recommendations are made which require further investigation.

(1) Psychological demands on the individual should be considered in addition to physical demands if sense is to be made of fluctuations in blood glucose levels and if the data are to have any predictive value.

(2) Relaxation training may be a useful technique for preventing the occurrence of hyperglycaemic episodes.

(3) It is also suggested that the feedback from blood glucose determinations might be used to improve diabetics' sensitivity to their blood glucose levels and hence reduce the need for frequent random blood glucose determinations.

INTRODUCTION

This paper presents evidence to suggest that stressful ex-

periences may be associated with disruption of diabetes control. It is argued here that an understanding of the relationship between psychosocial experiences and physiological events in individual diabetics is required if the control of diabetes mellitus is to approximate physiological control.

#### *Problems of Diabetes Control*

Tchobroutsky (1978) has reviewed the now considerable evidence which suggests that poor control of diabetes is one of the major factors responsible for micro-vascular complications. Attempts to avoid these complications which include blindness, neuropathy and nephropathy are mainly directed at improving blood glucose control. Until automatic implantable devices become more than a technical possibility the only means of controlling insulin requiring diabetes is for the patients to manage the disorder themselves. Unlike patients in other areas of medicine, diabetics have been given a great deal of responsibility for their own treatment, injecting their insulin and testing their urine for sugar in addition to following diets. Urine testing, however, has always been an unsatisfactory means of obtaining feedback about the degree of diabetes control. Not only do urine glucose measures often inaccurately reflect prevailing blood glucose levels but they give no information on blood glucose fluctuations below the level of the renal threshold. In their attempts to avoid the immediate dangers of hypoglycaemia diabetics often take steps to avoid glucose free urine and aim to maintain their blood glucose levels above the renal threshold. Urine measures are therefore quite inappropriate if anything approaching physiological control is to be achieved.

#### HOME MONITORING OF BLOOD GLUCOSE LEVELS

Medical interest in improving diabetes control has received new impetus with the recent evidence concerning the long term risks of chronic hyperglycaemia. This renewed interest together with the inadequacy of urine measures as criteria for diabetic self management has led logically to the development of methods by which diabetics can estimate their own blood glucose levels.

Home blood glucose monitoring has been made possible by the development of glucose oxidase based reagent strips and reflectance meters. The most recently marketed machines<sup>1</sup> are cheaper and more convenient than earlier versions<sup>2</sup>. Tattersall (1979) has reviewed the evidence from studies investigating the feasibility and potential of home blood glucose monitoring by diabetic patients. The results are

promising. Patients are capable of obtaining measures that are sufficiently accurate for ordinary clinical practice. Furthermore, anecdotal evidence suggests that direct feedback about blood glucose levels is more meaningful and hence more useful to diabetics who were previously attempting to maintain control with inadequate information from urine tests.

However, the frequent blood glucose determinations and multiple injections of insulin required to attain maximal, near physiological, control are clearly incompatible with a normal lifestyle. Tattersall recommends as a compromise the protocol advocated by Danowski and Sunder (1978) in which patients made a fasting and one other blood glucose determination on six out of seven week days with a full profile on the seventh day. This included determinations in the fasting state, before and after each meal and one blood glucose determination during the night.

#### *Maximising the Potential of Home Monitoring of Blood Glucose*

At present the medical approach to home monitoring of blood glucose, while a considerable advance on previous regimes of diabetic management, would not seem to be making optimal use of the new resources available. Diabetic regimens involving long term use of multiple blood glucose determinations and multiple insulin injections daily may increase both patient and physician's knowledge of the disorder. However, the cost to the patient in terms of inconvenience, discomfort and the restrictions on life style necessitated by such regimes may be considerable. The compromise suggested by Tattersall recognises that the medical ideal is not a realistic possibility for most diabetics. Tattersall assumes that good diabetes control must be sacrificed to some extent. However, more efficient use of home blood glucose monitoring might be achieved if diabetics were specifically encouraged to use the blood glucose data to gain a greater understanding of the factors affecting the control of their diabetes. Rather than taking ameliorative action when hyperglycaemia has been detected with a random blood glucose determination, it may be possible to prevent the occurrence of hyperglycaemia in the first place. If home monitoring of blood glucose is to be used as a *preventative* tool it is insufficient to collect data concerned only with blood glucose levels and physical factors affecting blood glucose metabolism such as diet and exercise. Psychological factors must also be taken into account and their effects on diabetes control should be systematically investigated.

## THE ROLE OF PSYCHOLOGICAL FACTORS IN DIABETES CONTROL

An association between psychological factors particularly psychosocial stress and neuroendocrine activity has been demonstrated in many studies (e.g. Selye, 1950; Froberg, Karlsson, Levi and Lidberg, 1971; Frankenhäuser, 1975). Neuroendocrine activity is an important factor in blood glucose regulation and it is therefore likely that the experience of psychosocial events has important implications for the management of diabetes. The author investigated this possibility by examining the relationship between the experience of life events and measures of diabetes control. In this study, which has been reported in detail elsewhere (Bradley, 1979), it was hypothesised that the experience of stress in the form of life events would lead to problems in the management of diabetes which would be reflected in poorly controlled blood glucose levels, episodes of glycosuria and changes in treatment requirements. Data were collected from 114 insulin-requiring or tablet-treated diabetics. The version of life events inventory employed by Lundberg, Theorell and Lind (1975) was used in this study. Subjects rated events for "upsetting" or for "adjustment" and ticked those events they had experienced during the past year. Information concerning the patient's treatment and condition during that year was gathered from the medical records.

The data were factor analysed using principal component analysis (leaving unity in the diagonals of the correlation matrix). The factors of interest were rotated to simple structure using the varimax rotation. Separate analyses of variance were then carried out to examine differences due to sex and treatment.

Four factors were elicited with Eigen-values greater than 1.0 which together accounted for 62.7% of the variance. The first two factors will be considered here. Those variables with a loading higher than 0.4 were assumed to characterise each factor.

The number of life events experienced during the year, the number of incidences of glycosuria, changes of insulin or tablet prescription and the number of clinic attendances all loaded highly together on Factor 1. The pattern of relationships of these variables provided support for the hypothesis that the occurrence of life events is associated with problems with diabetes management.

Factor 2 was characterised by the three measures of blood glucose and also by the urine glucose measure. Higher blood glucose levels were, as would be expected, associated with greater incidence of glycosuria.

The factor analysis suggested that there was little association between the experience of life events and measures of blood glucose which loaded highly on a separate factor (Factor 2). However, mean blood glucose levels for both insulin and tablet treated diabetics exceeded the renal threshold and it appeared that the disruptive effects of life events in this poorly controlled population were reflected in the spillage of glucose into the urine.

Significant differences were found between insulin and tablet-treated diabetics in their Factor 1 scores. Insulin-treated diabetics experienced more "disturbance" than tablet-treated diabetics. ( $F = 14.386$ ;  $df 1,110$ ,  $p = 0.00024$ ) It appeared that insulin-treated diabetics were more likely to have problems with the management of their disorder which were associated with life events although there was little difference in the number of events reported by the two groups. Insulin requiring diabetes is a more severe form of the disorder where there is little or no effective insulin produced endogenously. Control is dependent upon the careful balance between insulin dose, diet and glucose metabolism. The hormonal changes associated with stressful experiences will alter glucose metabolism while the amount of insulin available remains constant. Tablet-treated diabetics, on the other hand, are likely to have some degree of endogenous homeostatic control and hence will suffer less physiological disruption in response to stressful experiences.

The results of this study suggest that the experience of stressful life events is likely to cause problems of diabetes control, particularly among insulin-requiring diabetics. Even using these gross measures of "stress" and generalising across subjects it was possible to demonstrate a relationship between stressful experiences and disturbance of diabetes control. When insulin-requiring diabetics were studied in a laboratory situation (Bradley, 1978), it was found that the effects of a demanding 15 minute task performed in noisy conditions were reflected in changes in blood glucose levels. It is likely therefore that the effects of stressful experiences in day to day living would be registered in blood glucose measures taken at the time of the event or shortly after.

#### *Predicting and Preventing Physiological Disruption*

If diabetics were encouraged to record their experiences on a daily basis together with variations in blood glucose levels, it may be possible to establish consistent patterns of physiological disruption associated with certain experie-

nces. Steps might then be taken towards preventing such disruption either, at a physiological level, by adjustments of diet or insulin or, at a psychological level, by reducing the individual's experience of stress. Relaxation techniques may be a useful means of reducing sympathetic nervous system activity in potentially stressful circumstances, thus avoiding the episodes of hyperglycaemia and glycosuria that may otherwise occur in diabetics with little or no effective endogenous insulin. There is some evidence to support this suggestion from a case report by Fowler, Budzynski and VandenBergh (1976). EMG biofeedback relaxation training was applied to a diabetic patient over a nine week period. During this period daily insulin requirements decreased. The authors also reported decreases in emotionality and in diabetic fluctuations. Blood glucose levels were not monitored in this study but the decrease in insulin requirements would suggest that maintenance of a relaxed state is an effective means of preventing hyperglycaemic episodes. Fowler *et al.* recognised that one of the problems of using a technique which may rapidly reduce insulin requirements is the danger of hypoglycaemic reactions. However, if blood glucose levels were monitored by the patient during the initial stages of relaxation training this danger could be minimised.

It would seem that home blood glucose monitoring may have an important role to play in the prevention of diabetic fluctuations without the necessity for multiple injections of insulin daily.

#### *Learning to Recognise Physiological States*

It is possible that the need for multiple blood glucose determinations themselves may also be reduced. The author is at present investigating the possibility of encouraging diabetics to use the feedback from their blood glucose determinations not only to adjust their condition and to predict future fluctuations but also to associate subjective feelings with their physiological state and to recognise changes in blood glucose without recourse to a reflectance meter. While some diabetics are sensitive to their physiological changes and recognise sensations that precede hypoglycaemic reactions, other diabetics do not spontaneously acquire this ability. Urine testing is clearly inadequate as a feedback technique because of the inevitable delay involved. The availability of immediate blood glucose measures, possibly over a relatively short period, may considerably improve the ability of diabetics to recognise changes in their blood glucose levels. The efficacy of such a training procedure rem-

ains to be established.

It is clear that the implications of home blood glucose monitoring for diabetes control are considerable but if the potential of new technology is to be maximised without imposing further restrictions and greater discomfort on diabetics the information gained should be used constructively both in predicting future fluctuations and in improving perception and recognition of changes in physiological state.

#### FOOTNOTES

<sup>1</sup> Glucocheck (Medistron Ltd., Crawley, Sussex, England) and Hypocount (Hypoguard, Ipswich, England).

<sup>2</sup> Dextrostix-Eyestone system (Ames Corporation), Replotest-Reflomat system (Boehringer, Mannheim).

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