RESEARCH

BLOOD GLUCOSE CONTROL AND COMPLIANCE OF DIABETIC CHILDREN

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ABSTRACT

Aim of Study

Non-compliance is an important factor hindering good control in diabetics. The aim of this study was to identify areas of poor compliance with the diabetes management regimen in the children attending our clinic.

Design

A questionnaire was administered to 57 patients who attend the Paediatric Diabetes Clinic. It was designed to elicit socio-demographic data and information about the diabetic regimen. Prior to the administration of the questionnaire, patients were classified as being well, satisfactorily or poorly controlled, based on their average glycosylated Haemoglobin results over the past year.

Results

All the patients used home blood glucose monitoring (HBGM) - 79% of the poorly controlled children tested twice daily or less whereas 53% of the well controlled children tested three times or more daily. The timing of injections was frequently incorrect. 42% of all patients had been admitted to hospital after diagnosis and more than 60% of them never tested their blood glucose in relation to exercise.

The patients' knowledge about their disease was generally good. The mean age of the poorly controlled group was almost 19 months older than that of the well controlled group. Poorly controlled children had also had diabetes for longer and they lived significantly further from the hospital.

A higher percentage of poorly controlled patients were in charge of their own treatment while those in the well controlled group were less reliant on doctors for insulin dose adjustments.

INTRODUCTION

Non-compliance has been identified (Belmonte, Schiffrin, Dufresne, Suissa, Goldman & Polychronakas, 1988) as the most important factor hindering the diabetic patient's achievement of good glycaemic control. The complexity of the treatment regimen, which requires attention to many factors other than simple drug administration, "is one of the main factors associated with poor compliance". (Belmonte et al, 1988)

The fact is that diabetes places numerous behaviourial demands on the patient. (Johnson, 1992) Fulfilling all these tasks properly and at the right time is not easy. An alternative term for compliance is adherence, (Johnson,1992) and perhaps the latter is to be preferred when dealing with such a complex phenomenon as the management of diabetes, as "compliance" connotes obedience to medical staff, while "adherence" implies a more positive and active role on the part of the patient.

The aim of this study was to identify areas of poor compliance with the diabetes management regimen in the children attending our clinic. This would enable us to improve patient care and education, which may reduce the risk of long-term complications of Insulin-dependent Diabetes Mellitus.

METHODS

The study was aimed at children attending the Paediatric Diabetic Clinic of Johannesburg Hospital. All age groups were included. Patients attending the Clinic between February and April 1991 were studied. A questionnaire incorporating various aspects of the diabetic regimen was designed. Apart from socio-demographic questions, the following were established: the period of time the patient had had diabetes, the insulin therapy, complications of diabetes, home blood glucose monitoring, record keeping, status of knowledge about diabetics and aspects of nutrition and exercise. Questionnaires were handed to patients or parents at their clinic visit. Before the clinic visit the patient's average HbA_{1C} over the past year was calculated and recorded on the questionnaire which was anonymous. The patients or parents filled in the questionnaire on the clinic day and placed it in a box provided for the purpose. Confidentiality was maintained by storing the questionnaires together and analyzing them after all had been collected. No identifying marks were made on the questionnaires. A total of 57 questionnaires were returned. No changes in daily diabetic management were introduced at the time of the questionnaire.

Permission to conduct research in the Johannesburg Hospital was obtained from the Superintendent. Permission was also obtained from the clinic. The study was approved by the Committee for Research on Human Subjects of the University of the Witwatersrand. Data analyses were done with the N W Statpak, using appropriate t-tests and Chi^2-tests.

RESULTS

Patients were grouped according to their average glycosylated Haemoglobin results as follows:

Group 1 HbA_{1C} less then 9,89%
- good control

Group 2 HbA_{1C} between 9,9 and 12%
- satisfactory control

Group 3 HbA_{1C} more than 12,1%
- poor control (Frankel,1987)

Table 1 indicates selected demographic data, including the age, sex, race and socio-economic status of the patients.

More girls than boys are poorly controlled but this does not reach statistical significance. Most of the patients in the study are white. This reflects the population that attends the Johannesburg Hospital Diabetes Clinic for two reasons:

1.The Johannesburg Hospital was, until about 5 years prior to the study, a segregated hospital.

2.Type I Diabetes Mellitus appears to be more common in whites than in blacks in Southern Africa.(Shires, Maier, Lustig, Barnett, Joffe, Seftel, 1983)

Table 2 reflects the distance the patients live from the hospital. The hypothesis was that poorly controlled patients may live further away from hospital than well controlled patients. There is indeed such a trend. Group 3 live significantly further away from the hospital (t = 2,061 _1,684; p 0,05). Most patients use private transport.

The mean duration of the disease in Groups 1 (3,66 ± 3,77 years) and 2 (3,48 ± 3,44 years) is similar. When comparing Groups 1 and 3 (mean 4,7 ± SD 3,68) the difference almost reaches statistical significance (t = -1,604 -1,684; 0,10 p 0,05); there is a trend towards patients in the "poor control" group having had diabetes for a longer period of time.

Control of treatment is reflected in Table 3. Parents are in charge of the treatment in half to two-thirds of all patients. There is a trend

TABLE 1: DEMOGRAPHIC DATA

	GROUP 1	GROUP 2	GROUP 3	COMBINED
Age (years) (Mean ± SD)	10 ± 4,6	10 ± 3,6	11,64 ± 3,6	
Sex				
Male	11 (65%)	7 (47%)	10 (40%)	28 (49,1%)
Female	6 (35%)	8 (53%)	15 (60%)	29 (50,9%)
Race				
White	14	13	22	49 (86%)
Black	1	0	1	2 (3,5%)
Coloured	1	0	0	1 (1,7%)
Asian	1	2	2	5 (8,8%)
Socio-economic Status				
Class 1 (Professional)	0	5	3	8 (14%)
Class 2 (Intermediate)	5	3	9	17 (30%)
Class 3 (skilled)	8	6	10	24 (42%)
Class 4 and 5(Partly skilled and unskilled)	0	0	0	0 (0%)
Economically inactive	0	1	3	4 (7%)
Unknown	4	0	0	4 (7%)
Marital Status (parents)				
Married	13	14	20	47 (82%)
Divorced	3	1	4	8 (14%)
Widowed	1	0	1	2 (4%)
Total	17	15	25	57

TABLE 2: TRANSPORT

	GROUP 1	GROUP 2	GROUP 3	COMBINED
Distance from Hospital (km ± SD)	28,7 ± 27,0	38,4 ± 21,8	49,8 ± 35,8	
Mode of Transport				
Private	11	14	23	84,25%
Public	3	1	1	8,75%
Both	3	0	1	7%

Comparison of groups 1 and 3: t = -2,061. p 0,05

Table 3: CONTROL OVER TREATMENT (in percentages)

	GROUP 1	GROUP 2	GROUP 3	COMBINED
In charge of treatment				
Patient	18%	20%	28%	
Parent	53%	67%	56%	
Both	29%	13%	16%	
Gives Injections				
Patient	41%	47%	48%	46%
Parent	47%	47%	36%	42%
Both	12%	6%	4%	7%
(Missing information)	0%	0%	12%	5%
Frequency of Clinic Attendance				
3-monthly	82%	60%	64%	
Monthly	6%	27%	24%	
Keeping appointments				
Always	16 (94%)	15 (100%)	21 (84%)	91%
Usually	1 (6%)	0	4 (16%)	9%
Infrequently	0	0	0	0%

towards more patients in Group 3 being in charge of their treatment, but this is not statistically significant. In all groups, patients and parents take approximately equal responsibility for giving injections. Clinic attendance is more often monthly in Groups 2 and 3 than in Group 1 and 16% of Group 3 patients confessed to not always keeping their appointments at the clinics, but neither of these trends is significant.

There is a trend towards increasing numbers of hospital admissions, from a third of children in Group 1, to about half the children in Group 3 having been re-admitted some time after their time of diagnosis (Table 4). Twenty per cent of Group 3 patients were admitted more than once. Hyperglycaemia was more frequently the reason for admission in Groups 2 and 3, than in Group 1.

Table 5 reflects the patients' blood glucose monitoring practices at home (HBGM). Most patients (88%) monitor blood only, and most of them (82%) own an electronic blood glucose monitoring device. No patient relies solely on the monitoring of urine. The frequency of HBGM varies considerably between the groups. About half of Group 1 patients monitor more than 3 times a day, while only 21% of Group 3 patients monitor that often. This difference is statistically significant. A small proportion of patients check their blood glucose level in relation to exercise: 12% test every day before, and 10% test every day after exercise. About two-thirds of patients never monitor their blood glucose either before (63%) or after exercise (67%). There was no difference between the groups.

Insulin therapy is noted in Table 6. Most patients are on a twice-a-day insulin regimen. The basal-bolus regimen is used by 17% of the respondents; most of these are in Group 3. All patients claim never (or hardly ever) to forget their insulin injections, and more than half take responsibility for changing the insulin dose, rather than relying exclusively on the doctor. None of the intergroup differences is statistically significant.

Knowledge of their disease was tested and results are given in Table 7. The majority of patients have an adequate knowledge of their disease as tested in this questionnaire. Ninety-three per cent know the symptoms and treatment of hyperglycaemia, as well as the site of production of insulin; 86% can name the target blood sugar levels correctly; 72% know the function of insulin and 68% that of glucagon. The patients' opinions about their education are very positive (Table 7). The majority feel that their education is adequate, that they have access to further education and that the staff is approachable.

DISCUSSION

The questionnaires were handed out over a period of seven weeks; the parent or patient then filled them in. Not all patients attended the clinic

Table 4: RE-ADMISSIONS

	GROUP 1	GROUP 2	GROUP 3	COMBINED
Ever admitted after diagnosis				
Yes	6 (35%)	6 (40%)	12 (48%)	24 (42,1%)
No	11 (65%)	9 (60%)	13 (52)	33 (57,9%)
More than once	2 (12%)	1 (7%)	5 (20%)	8 (14%)
Reasons for admission*				
Hypoglycaemia	3	2	5	41.7%
Hyperglycaemia	3	4	9	66,7%
Infection	0	0	1	4,2%
Know what ketoacidosis is				
"No"	29%	27%	32%	29%

* Refers to number of patients, not number of admissions.

during the study period, and some did not return the completed questionnaire. Reasons for the non-return of questionnaires could not be established. Dishonest answering of questions cannot be excluded but, due to the absolute confidentiality maintained during the study, respondents had no logical reason for dishonesty. Irrelevant answers or the omission of answers could not be avoided, but occurred only infrequently.

A pilot study was performed on six subjects, but no problems were encountered and the questionnaire seemed to be adequately understood. Consequently no alterations were made.

Glycated haemoglobin is a measure of glycaemia control in the preceding 8-12 weeks. An important determinant of glycaemic control is the patient's compliance with his/her management regimen.(Belmonte et al, 1988) There are, of course, other reasons for poor glycaemia control, e.g. infections, trauma, other illness and psychological stress, but the choice of the HbA_{1C} as a marker for compliance appears justified.

Age may be a determinant of compliance. Pre-school children frequently manifest behaviour problems and, in diabetics, feeding problems are common.(De Villiers, 1992). These children often have difficulty accepting home blood glucose monitoring, and the adults who have to administer the finger pricks may, therefore, do so less frequently than required. Adolescence as a developmental stage may be difficult for healthy people, even under optimal conditions. (Frankel, 1987; Tattersall, 1981) It is frequently characterised by hostility, rebelliousness and negative behaviour which often lead to poor compliance with the diabetic management regimen (Tattersall, 1981; Stearns 1959) and episodes of keto-acidosis, which Tattersall (1981) considers to be a silent expression of mental anguish. Poor metabolic control and numerous management problems are frequent in this age group. (Johnson, 1992; Frankel, 1987; Tattersall 1981)

TABLE 5: GLUCOSE MONITORING AT HOME

	GROUP 1	GROUP 2	GROUP 3	COMBINED
Type of monitoring				
Blood only	15	13	22	88%
Blood and urine	2	2	3	12%
*BGMM	13	13	21	82%
Colour strip	3	1	1	9%
BGMM and colour strip	1	1	3	9%
Frequency				
≥ 3 times per day#	9 (53%)	9 (60%)	5 (21%)	41%
Twice a day	6	5	16	48%
< twice a day	2	1	3	11%
Recording of treatment				
Always	16 (94%)	13 (87%)	21 (84%)	88%
Sometimes	1	2	4	12%

* BGMM: Electronic Blood Glucose Monitoring Machine.
# Statistically significant.
Percentages reflect number who answered the question (52) as denominator.

For these reasons, non-compliant patients may be expected more frequently in these age groups. The fact that the mean age in Group 3 was 1 year 7-3/4 months older than Group 1, confirms Daneman et al's. opinion that compliance is perhaps poorest in adolescence. (Daneman, Siminerio, Transue, Betchart, Drash & Becker, 1985)

The trend for patients in the poor control group to have had diabetes longer than those in the good control group almost reaches statistical significance. This could be due to some patients who are still in partial remission being included in the good control group, or may be due to waning patient enthusiasm. The fact that more of the Group 3 patients are adolescents also plays a role in this respect.

Patients in the poor control group live significantly further from the hospital than those in the good control group. This factor has been found to be important in the compliance of renal transplantation patients (Meichenbaum, 1987; Didlake, Dreyfus, Kerman, Van Buren, Kahan, 1988). It may be that, apart from the cost and travelling time involved, a greater distance from the hospital creates a feeling of being removed from the clinic and, therefore, distanced from both the control of the disease exerted by the clinic and the support derived from clinic staff.

Whether the patient takes direct responsibility for his treatment may depend on whether he believes that his disease and its management is controlled by forces outside himself (external locus of control) and may occur independently of his own actions, or the converse. (Frankel, 1987) Some studies state that a relationship exists between poor control and an external locus of control(Alogua, 1980; Hamburg & Inoff 1982), although a study in Johannesburg could not confirm this relationship. (Frankel, 1987)

In our study, more of the poorly controlled patients are in charge of their treatment without parental supervision (this difference does not reach statistical significance). This may reflect the fact that this group is older and has had the disease for a longer period and, therefore, does not need the supervision, but may also reflect lack of interest by the parents or conflicts which may have led to the patients excluding their parents from decisions.

On the other hand, 42% of Group 3 patients rely on the doctor for insulin dose adjustments, compared with 35% of Group 1 patients, suggesting that patients in the poor control group are more reliant on doctors, but less reliant on their parents than patients with good control. Further study is clearly necessary to explain this phenomenon.

A larger proportion of poorly controlled patients attend the clinic monthly, rather than three-monthly. This reflects the clinic's policy: newly diagnosed patients attend monthly until they are confident in the management of diabetes, as do those patients experiencing

problems and poorly controlled patients, while stable patients attend three-monthly.

Most patients claim to keep all their appointments, although fewer in the poor control group do. In a survey of our clinic records over a 6-month period, it was noted that 24% (21 out of 87) of appointments were not kept (Sr D D Green, professional diabetes nurse, personal communication). The patients' impression of their regularity in keeping appointments is, therefore, probably an overestimate.

Home blood glucose monitoring has become one of the mainstays of management of Type I diabetes, (Belmonte et al 1988) even though, not very long ago, it had to be proven that this was possible in children. (Geffner, Kaplan, Lippe & Scott, 1983). All the patients in the study use HBGM, and 12% combine it with urine testing. Most (82%) own an electronic blood glucose monitoring device. This is in accordance with the socio-economic status of our clinic population.

Significantly more of the children in Group 3 test their blood glucose level twice a day or less often, compared with those in Group 1 (79% vs. 47%). It is interesting to note that this is in contradiction to the clinic's policy, which is that a newly diagnosed, ill, or poorly controlled diabetic should test more often than twice a day, and should stagger the timing of the tests, but that well controlled diabetics need test only twice a day. While it is not surprising that the poorly controlled patients do not test frequently enough, since they have been defined as not adhering to their management, it is noteworthy that more than half of the well-controlled patients, in contradiction to clinic policy, test frequently. It has been stated that testing twice a day is necessarily associated with poorer control than testing four times a day (Schiffrin & Belmonte, 1982) - an association that has also been shown here.

Whether this is true when testing twice a day, but in staggered fashion over a week, is not clear. However, the clinic may have to modify its recommendations and, indeed, recommend more frequent testing for all patients except, perhaps, those who are enjoying a remission.

A very small proportion of our patients test regularly before or after exercise, and a staggering two-thirds *never* test in relation to exercise. It is the clinic's policy that patients ought to test in relation to exercise whenever a change occurs, e.g. a new exercise programme is embarked on (this will include the commencement of a new season in a sport the diabetic has taken part in before); any part of the diabetic management regimen is changed (e.g. insulin dose, insulin distribution or change in diet); or when symptoms occur during or after exercise sessions. Patients are also expected to test occasionally (frequency not defined) when the exercise and diabetic management regimens are stable. It is likely that the patients are not sufficiently aware of this policy. However, many of our patients perceive it to be socially unacceptable to do blood tests near the sport fields or in changing rooms. The clinic will need to stress this aspect.

TABLE 6: INSULIN THERAPY

	GROUP 1	GROUP 2	GROUP 3	COMBINED
Frequency of dose				
Morning and evening	12	11	19	78%
Before meals and at bedtime	1	3	5	17%
Once a day	2	0	1	5%
Timing of dose: Same time?				
Yes	11	8	14	58%
No	0	2	2	7%
Usually	6	5	9	35%
Forgetting injection				
Very rarely/never				100%
Adjustment of insulin dose				
Patient	11	7	14	58%
Doctor	6	7	10	42%

TABLE 7: KNOWLEDGE AND EDUCATION

	ANSWER		
	Correct	Wrong	No answer
Function of insulin	72%	21%	7%
Site of production of insulin	93%	2%	5%
What is glucagon used for?	68%	9%	23%
Symptoms and treatment of hypoglycaemia	93%	0,5%	6,5%
Target blood sugar level	86%	0%	14%
	Yes	No	Mostly
Are staff approachable?	96%	0%	4%
Adequate diabetes education	75%	3,5%	21,5%
Access to further information	77%	23%	0%

The percentage of patients on a basal-bolus regimen increases from Group 1, through Group 2 to Group 3. The basal-bolus regimen is not a guarantee of improved glycaemic control, but we did not expect that the basal-bolus regimen would be associated with worse control than a twice-a-day mixed insulin regimen. We therefore ascribe this finding to the older age of the patients in Group 3.

All the patients claim to give all their injections, although about 40% do not give these at the same time every day. If the 17% of the sample on the basal-bolus regimen who are allowed to vary the time of their meals and injections are excluded one-fifth of these children still do not adhere to the correct timing of their injections.

Thirty per cent of the children do not know what glucagon is used for, nor what the function of insulin is.

While the answer to the latter question may not be very important in practical terms, the answer to the former question is, and may influence how these patients and their parents approach an attack of hypoglycaemia.

In general, however, the knowledge of these patients is good. They also feel that the staff is approachable, and that they have adequate access to further information.

CONCLUSION

Distance from the hospital contributed to poor control, as did duration of diabetes, frequency of breaking appointments and infrequent self testing of blood glucose.

In all groups, an unacceptably high percentage of patients needed readmission for diabetes-related problems, and testing in relation to exercise was unsatisfactory. Timing of injections was also incorrect in too many cases. These issues will be addressed in the clinic's internal diabetes education programme.

The patients had sufficient knowledge of their disease and were positive about the contribution of the clinic. Their behaviour did, however, not always match up to their knowledge and attitude.

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