Archives of Disease in Childhood, 1976, **51**, 796.

Use of 100 units/ml insulin in treatment of diabetic children

IAN McKINLAY and JAMES W. FARQUHAR

From the Royal Hospital for Sick Children, Edinburgh, and Department of Child Life and Health, University of Edinburgh

McKinlay, I., and Farquhar, J. W. (1976). *Archives of Disease in Childhood*, **51**, 796. **Use of 100 units/ml insulin in treatment of diabetic children.** The three traditional concentrations in which European insulins are prepared for therapeutic purposes often hinder understanding, sometimes cause accidents and occasionally disaster. When syringes other than the BS1619 are used the risks are increased. Insulin preparations containing 100 units/ml used with syringes graduated to contain one unit in one division (e.g. a tuberculin syringe) have been tested as part of a trial organized by the British Diabetic Association. Parents preferred the new system, which facilitated learning and reduced the possibility of error.

The existence of three different strengths of insulin is a possible source of error in the calculation of dosage by diabetic patients. The risk of error and even tragedy may be greater when the patient is a child. According to Galloway and Floyd (1974), the availability of 40 units/ml (U-40) and 80 units/ml (U-80) insulin has been a source of untold numbers of dosage errors. In February 1973, 100 units/ml (U-100) insulin was released for commercial use in the United States with the aim that U-80 and U-40 insulin would disappear leaving U-100 as the only available preparation (American Diabetes Association, 1972; Goetz, Watkins, and Gastineau, 1972). Any potential means with which the dismay of parents confronted by the problem of a diabetic child may be diminished deserves to be explored. The simplicity of one graduation mark equalling one unit is attractive. The British Diabetic Association therefore organized an assessment of U-100 insulin in several different centres. This paper refers to experience with it in an outpatient clinic for diabetic children in Edinburgh.

Materials and Methods

Design of study. 18 insulin-dependent diabetic children from varying social backgrounds and with parents of differing ability were included. All had been diagnosed previously and were regular attenders at the diabetic clinic of the Royal Hospital for Sick Children, Edinburgh. Treatment policy has been described elsewhere (Farquhar, 1971–72, 1975), i.e. food is restricted only in that carbohydrate is evenly spaced, soluble and isophane insulins are used once or twice a day, and urine is tested for glucose four times daily.

Insulin. Soluble and isophane insulins containing 100 units/ml were provided for the trial and were used singly or in combination, as are the usual British insulins at 20 (soluble only), 40, and 80 units/ml.

Syringes. Two types of glass syringe were provided, each graduated at 1 mark per unit. One contained 1 ml (100 marks) and one 0·35 ml (35 marks).

Records. Records were kept over a 4-week period during which the child received the usual insulin type, strength, and dose, and were also kept during the next 4 weeks when 100 units/ml insulins were used. The child or the parents tested the patient's urine with Clinitest 4 times daily and the results were recorded. Weight was measured at each attendance and intercurrent illnesses noted. Parental observations on the comparative ease of measuring and injecting the usual dosage and the 100 units/ml insulin were obtained.

Speed and accuracy of insulin measurement. At the end of the control and test periods parental measurement of three standard arbitrarily chosen doses of insulin was assessed and the results recorded. The person usually responsible for drawing up the insulin was asked to draw up in their usual syringe 10, 24, and 34 units of the insulin normally used. Accuracy was

Received 9 January 1976.

TABLE I

Sex, age, carbohydrate intake, and daily insulin doses of children studied

Case no.	Sex	Age (years)	Carbohydrate exchange (each 10 g) at main meals and snacks	Total daily insulin units*	
				Soluble	Isophane
1	F	12	3–2–5–2–5–2	44	48
2	M	6	4–2–4–2–4–1	10	10
3	F	4	3–1–4–1–4–1	4	16
4	F	10	5–2–5–2–5–1 or 2	18	28
5	M	10	5–2–5–3–5–2	14	20
6	M	9	4–3–5–2–5–2	4	20
7	F	8	2–2–5–2–5–0	6	18
8	F	7	2–2–3–2–3–1	20	36
9	M	7	4–2–4–1–5–1	4	18
10	F	11	3–2–5–3–5–2	12	54
11	M	10	5–3–6–2–5–2	–	26
12	M	11	4–2–5–2–5–2	6	14
13	F	14	5–3–5–3–5–2	48	72
14	M	9	4–2–5–2–4–2	4	16
15	F	14	5–3–6–3–5–2	28	46
16	M	14	5–3–6–3–6–2	16	36
17	F	8	3–2–4–2–4–2	8	14
18	M	6	3–2–4–2–3–2	–	16

*Given in one dose or in morning or evening doses.

recorded and the time noted. The test was repeated with an 'unfamiliar' strength of British insulin, and after the period of trial with U-100 insulin.

Results

Children. The children (Table I) (who were a representative group by age, sex, and circumstances) remained well throughout except for 2 who had upper respiratory tract infections, one who developed rubella, and one who had influenza. The new insulin was readily understood by all but the very young. Weight (Table II) moved appropriately during the trial and the mean increased.

TABLE II

Weight during trial

	No. of children	
	Normal insulin	100 unit insulin
Weight increase	15	12
Weight decrease	1*	3†

*One patient with upper respiratory tract infection.
†One patient with rubella, one had influenza, and one with upper respiratory tract infection.

Control. Control was maintained throughout (Table III) without significant alterations in carbohydrate intake or daily insulin dose. The mean number of alterations of dose (3) was the same in control and U-100 test periods.

TABLE III

Comparison of glucosuria during control and trial periods (mean values for 18 children)

Period	Urine test results at each glucose concentration (%)					
	0	¼	½	¾	1	2
Control	47·4	15·7	9·4	10·9	6·8	9·8
Test	46·2	13·5	8·8	10·9	10·8	9·8

Parents. The parents were pleased with the simple principle involved and measured the insulin more accurately and confidently than they did the traditional preparations. All got the dose correct first time when using the new 100 units/ml preparation and though the mean time was longer it was still less than one minute and could be excused on grounds of awkward syringes which could easily be improved. Only three-quarters of parents measured the dose accurately when using their familiar British insulin (some were nervous on testing but the test conditions were no less worrying when 100 units/ml was successfully used). Only half the parents got the dose right when using an unfamiliar strength of British insulin.

Discussion

Parents rapidly grasped the principle of measuring units directly from the graduations on the syringes—the particularly good feature of the syringes. In the test almost 1 in 4 seemed not to have mastered

the concept of calculating marks on the syringe from units of insulin prescribed and this emphasizes the value of a simpler system. Accuracy in so simple an arithmetic calculation cannot be assumed even in medical practitioners, although the BS1619 makes life easier than when syringes bearing different numbers of graduation marks to the ml are used.

Unfortunately the mechanical function of the pistons in the imported syringes used in this trial was unsatisfactory, as some fell out of the barrel and shattered, others jammed. The smaller syringe seemed too small for some parents and children to handle confidently. Those unfamiliar with the sterilizing of glass syringes sometimes needed reassurance and only two of those accustomed to using the Palmer Injector were able to adapt the new syringe to it (using tape). The injectors were not used with the Hypoguard and might well have fitted satisfactorily, but the 0·35 ml syringe would be very small and light relative to the injector. A reusable plastic adaptor for the Busher Injector is available in Canada (Romans, 1974). Given a more satisfactory syringe and a regular supply of U-100 insulin the parents and physicians of this children's clinic would use them immediately in preference to those which have been in use until now. These were the conclusions also of Rosenbloom (1974) in an American trial.

J. W. F. thanks the British Diabetic Association for supplies of insulin and syringes, and his colleagues on the Medical Advisory Committee of the Association for permission to publish separately this report on children. Both authors thank the parents and children who volunteered for the trial, and the nursing and secretarial staff of the RHSC for much administrative help.

References

American Diabetes Association (1972). Special Report. U-100 insulin: a new era in diabetes mellitus therapy. *Diabetes*, **21**, 832.

Farquhar, J. W. (1971–72). Care of the diabetic child. *British Journal of Hospital Medicine*, **7**, 208.

Farquhar, J. W. (1975). *Notes for the Guidance of Parents of Diabetic Children*, 2nd ed. Churchill Livingstone, Edinburgh.

Galloway, J. A., and Floyd, J. C. (1974). *American Diabetes Association Forecast 27, May-June.*

Goetz, F. C., Watkins, J. D., and Gastineau, C. F. (1972). U-100 insulin: a new area in diabetes therapy. *American Diabetes Association Forecast 25 Sept.-Oct.*

Romans, R. G. (1974). *Canadian Diabetic Association Newsletter: 1st Quarter.*

Rosenbloom, A. L. (1974). Advances in commerical insulin preparations. *American Journal of Diseases of Children*, **128**, 631.

Correspondence to Dr. J. W. Farquhar, Department of Child Life and Health, 17 Hatton Place, Edinburgh EH9 1UW.