Diabetic pregnancy 1977–1990: have we reached a plateau?

ABSTRACT—We have compared 81 pregnancies in women with type 1 (insulin dependent) diabetes in 1984–1990 with 58 in 1977–1983. In 1984–1990, women booked earlier (8 weeks [median] vs 12 weeks), mean haemoglobin A1 was lower in each trimester, and fewer days were spent in hospital before delivery (5.3 days [mean] vs 15). The latter was due to more experience in managing diabetic control as outpatients and fewer admissions for fetal monitoring. Most admissions are now for pre-eclampsia and intercurrent illnesses. The proportion of deliveries by caesarean section has not changed significantly (53% in 1984–1990 vs 66% in 1977–1983), but most are now done as emergencies. The incidence of macrosomia is constant (26% in 1984–1990 vs 21% in 1977–1983). There was one stillbirth, one intra-uterine death (complicating maternal ketoacidosis) and one perinatal death in 1984–1990, compared with no losses in 1977–1983. Two babies had major congenital abnormalities in 1984–1990, compared with one in 1977–1983. These results compare favourably with those from other centres in the United Kingdom. We conclude we have reached a nearly irreducible minimum for hospital days before delivery and congenital abnormalities, but that there is scope for a small reduction in the caesarean section rate.

Our experience in the management of pregnancy in type 1 (insulin dependent) diabetes from 1977 to 1983 showed the value of home blood glucose monitoring in reducing the number of hospital bed days before delivery with equivalent blood glucose control [1]. Since 1983 our standard obstetric practice has changed so that patients are no longer electively induced at 38 weeks and the aim is to allow spontaneous labour at term if possible.

We have analysed all pregnancies since 1983 to establish whether there has been a change in outcome as measured by hospital stay before delivery, blood glucose control, caesarean section rate, fetal death, perinatal mortality and morbidity, and congenital malformations.

R. GREGORY, DM, MRCP(UK), *Clinical Research Fellow*
A. R. SCOTT, DM, MRCP, *Senior Registrar*
M. MOHAJER, MRCOG, *Clinical Research Fellow, Department of Obstetrics and Gynaecology*
R. B. TATTERSALL, MD, FRCP, *Professor of Clinical Diabetes*
Diabetes Unit, University Hospital, Nottingham

Patients and methods

All pregnancies which continued beyond 24 weeks gestation in women with type 1 diabetes consecutively referred to the combined diabetic–obstetric antenatal clinic at University Hospital Nottingham from January 1984 to December 1990 were included. We collected information from the hospital case notes and, since December 1986, the computerised register in the obstetrics department. Eighty-three pregnancies were ascertained, but there were inadequate data for two. The other 81 have been assessed and compared with an equivalent consecutive series of 58 from 1977–1983.

All women were cared for by one obstetric firm, one diabetes firm and a diabetes specialist nurse. Three obstetrics lecturers and five diabetes registrars ran the clinic during 1984–1990.

The main change in obstetric management since 1983 had been to drop the policy of elective delivery at 38 weeks in favour of delivery at term, as long as the pregnancy was progressing normally and diabetic control was good.

Women were asked to measure capillary blood glucose concentrations with glucose oxidase strips (BM 1-44: Boehringer Mannheim, Lewes, East Sussex) and a reflectance meter (Reflolux-II: Boehringer Mannheim, Lewes, East Sussex) which was lent to those who did not already own one. They were asked to record seven-point profiles two or three times a week with measurements before and $1^1/_2$ hours after each meal, and before going to bed; the target values were 4–5 mmol/l before meals and 6–8 mmol/l after meals. Women and their partners were counselled about the increased incidence of hypoglycaemia and were told that the usual early warning symptoms might be lost. The partner or a relative was taught to use glucagon in case of severe hypoglycaemia.

Women attended the combined antenatal clinic monthly up to 30 weeks, in alternate weeks until 36 weeks and weekly thereafter. Random blood glucose and haemoglobin A1 (HbA1), measured by electro-endosmosis [2] (normal all-purpose laboratory range 4.0–7.5%), were determined at each clinic visit. The blood glucose result was available when the patient was seen, and that for HbA1 3 days later. Regular contact with each patient was maintained by telephone or meetings with the diabetes nurses between clinic visits.

Patients were encouraged to contact the diabetes team directly if problems arose. Management of diabetes during labour was with intravenous glucose and insulin as previously described [1]. Babies were returned to the ward with their mothers whenever possible for blood glucose monitoring, after assessment by a paediatrician in the delivery room.

Macrosomia was defined as birth weight greater than the 90th centile, and small for dates as less than the 10th centile adjusted for gestational age. A major congenital abnormality was one causing death or serious handicap or requiring major surgery. Perinatal morbidity figures relate to those babies who needed to be admitted to the neonatal unit. In 1977–1983 the major problem for each premature baby was identified and recorded (hypoglycaemia, jaundice, respiratory distress), whereas in 1984–1990 the more general term prematurity was applied.

Statistical methods. Differences between outcome measures in the two cohorts were analysed by the chi-squared test, with Yates's correction where appropriate. HbA1 values from each trimester in 1984–1990 were compared with those from 1977–1983 using *t*-tests for unpaired data. Two-tailed tests were applied in all cases and p values of <0.05 were accepted as significant.

Results

Eighty-one pregnancies in 65 women with established type 1 diabetes were managed in 1984–1990 compared with 58 in 51 women in 1977–1983, an increase of 40%. The increase in all deliveries in this unit between the same two 7-year periods was 83%.

There was no significant difference in the age, socio-economic status or obstetric or diabetic backgrounds of the two groups of women. The median age at booking in 1984–1990 was 26 years (range 18–40), and 25 years (16–40) in 1977–1983. In 1984–1990 89% of pregnancies were to women who were married or in a stable relationship compared with 82% in 1977–1983. In 1984–1990, 61 of 65 women were Caucasian compared with 50 of 51 in the previous period. In 1984–1990, 31% of women came from families receiving social security payments or in unskilled employment versus 33% previously.

In 1984–1990 there were 29 primigravidae (36%). A further 15 (19%) had never had a pregnancy go to term, having 14 abortions and 6 terminations amongst them. The remaining 37 pregnancies were to women who had previously had 52 live births, 20 abortions, 4 terminations and 1 stillbirth. The corresponding figures for 1977–1983 were 26 primigravidae (45%), five (9%) had never completed a pregnancy (two abortions and three terminations) and the remaining 27 pregnancies were to women who had 37 live births and 3 stillbirths previously.

The mother was smoking at the time of the booking clinic in 33 pregnancies (41%) in 1984–1990. We cannot discover how many continued to smoke, and there are no comparable data for 1977–1983. There was no significant difference between the number of women with microvascular complications in either period (Table 1).

Women booked earlier in the last seven years (8 weeks [median] 5–30 [range] vs 12 weeks, 6–24). A haemoglobin A1 result during the 12 months before pregnancy was recorded for 66 (81%) of pregnancies in 1984–1990. If the most recent non-pregnant value is considered for each, the mean pre-pregnancy HbA1 was 11.1 ± 2.7% (mean ± 1 SD), compared with 9.8 ± 2.5% at booking. Mean HbA1 in each trimester was lower in 1984–1990 than in 1977–1983: first trimester 9.2 ± 2.4% (vs 10.3 ± 2.0%), $p < 0.025$; second trimester 7.6 ± 1.7% (vs 8.5 ± 1.1%), $p < 0.001$; third trimester 7.5 ± 1.5% (vs 8.1 ± 1.3%), $p < 0.001$.

There was a further reduction in the number of hospital days before delivery; in the 1977–1983 series mean hospital stay fell from 24 days in 1977–1979 to 9 days in 1980–1983. The mean stay in 1984–1990 was 5.3 days, with a heavily skewed distribution: twenty women (25%) had no admission while at the other extreme one spent 45 days in hospital with pre-eclampsia. The changing criteria for admission are shown in Table 2. In 1977–1983 the main reasons were obstetric caution, defined as concern about fetal well-being and placental function (35% of inpatient days), poor diabetic control outside hospital (22%) and hypertension (18%). By contrast there was a significant redistribution in 1984–1990 (chi-squared test on 2 × 4 contingency table; $p < 0.001$); hypertension accounted for 43% of inpatient days, but diabetic control for only 12% and obstetric caution 3%. The remaining days included admissions for vomiting, pyelonephritis and other intercurrent illnesses.

In 1984–1990 there were 79 live births, one stillbirth and one intra-uterine death, compared with 58 live births and no losses in the previous 7 years. The intra–

Table 1. White's classification of pregnancies in two consecutive seven-year periods.

			Number (%) 1977–83	1984–90
B	Age at onset	>20 years ± duration 10 years	19(33)	25(31)
C	Age at onset	10–19 years ± duration 10–19 years	20(34)	24(30)
D	Age at onset	<10 years ± duration >20 years ± benign retinopathy	14(24)	20(25)
R/F	Nephropathy or proliferative retinopathy		5(9)	12(15)

Table 2. Reasons for hospital admission before delivery in the two seven-year periods.

Reason for admission	Inpatient days (%)	
	1977–1983 58 pregnancies	1984–1990 81 pregnancies
Hypertension	157 (18)	185 (43)
Diabetic control	191 (22)	50 (12)
Obstetric caution	305 (35)	15 (3)
Miscellaneous	218 (25)	179 (42)
Total	871	429

This shows a significant change in the pattern of reasons for admission (chi-squared test on 2×4 contingency table; $p < 0.001$) due to reductions in admissions for diabetic control and obstetric caution.

Table 3. Reasons for caesarean section in the two seven-year periods.

1977–1983		1984–1990	
Elective			
Previous section	6	Previous section	7
Hypertension	6	Hypertension	3
Presentation/lie	3	Presentation/lie	2
Unfavourable cervix	9	Cephalo-pelvic disproportion	2
Elderly primigravida	1	Placental failure	2
Total	25	Total	16
Emergency			
Failed trial of labour	7	Failed trial of labour	14
Hypertension	3	Hypertension	5
Fetal distress	2	Fetal distress	4
Abruption	1	Placental failure	2
		Previous section admitted in labour	1
Total	13	Total	26

More caesarean sections during the second period were designated emergencies ($p < 0.05$). The numbers in each category are too small to allow statistical comparison.

uterine death was caused by maternal ketoacidosis at 30.5 weeks gestation. The stillbirth (at 38 weeks) was to a woman who had spent 12 days in hospital with pregnancy-induced hypertension.

The mean gestational age at delivery was 37 weeks in 1977–1983 compared with 37.5 weeks in 1984–1990. The incidence of macrosomia was 21% in the earlier and 26% in the more recent period. The corresponding incidences of small for dates babies were 7% and 9%.

There was one perinatal death in 1984–1990 (a baby born at 29 weeks with no apparent abnormality) and none in the earlier period. One baby had a major congenital abnormality in 1977–1983 (pulmonary stenosis), compared with two in 1984–1990 (sacral agenesis and bilateral short femurs).

The proportion of caesarean sections has not changed significantly (66% in 1977–1983, 53% in 1984–1990; $p < 0.25$). The corresponding overall caesarean section rates for this unit were 9.8% and 11.6% respectively. Of sections done in diabetic women in 1984–1990 more were emergency (62%) than elective, compared with the earlier period when 66% were elective ($p < 0.05$). The indications for sections in the two study periods are shown in Table 3. In 1977–1983, 50% of women were delivered by caesarean section without labour, compared with 29% in 1984–1990. There was a corresponding increase in the proportion of women who laboured spontaneously (from 9% to 30%), although the induction rate (41%) remained unchanged.

The incidence of premature labour (<37 weeks gestation) in 1984–1990 was 11% compared with 9% in 1977–1983. The incidence of perinatal morbidity was similar in the two groups (38% in 1977–1983, 42% in 1984–1990). The problems are listed in Table 4.

Discussion

We have reported the results of a retrospective analysis of the outcome of pregnancy in type 1 diabetes for two consecutive 7-year periods. The major innovation at the start of the first study was the introduction of home blood glucose monitoring for all women, and the results justified this practice in terms of safety, efficacy and cost [1], as confirmed by others [3,4]. We wished to know whether there had been a continued improvement in outcome as measured by hospital stay before delivery, antenatal blood glucose control, caesarean section rate, perinatal mortality and morbidity, and congenital malformations.

There were encouraging trends towards earlier booking, better blood glucose control in each trimester (which has not been associated with a significant decrease in the incidence of macrosomia), and fewer days spent in hospital before delivery. The experience in Bristol [3] with 85 pregnancies in 1981–1985,

Table 4. Perinatal morbidity in the two seven-year periods.

1977–1983		1984–1990	
Respiratory distress	1	Prematurity/IUGR*	14
Hypoglycaemia	9	Hypoglycaemia	11
Jaundice	11	Jaundice	6
Hypocalcaemia	1	Shoulder dystocia	2
Total	22	Total	33

* Intra-uterine growth retardation; includes one perinatal death.

The data relate to babies requiring admission, however briefly, to the neonatal unit. As the method of recording morbidity data in each period differed (see text) the figures are not precisely comparable.

managed as outpatients in a very similar way to the 1984–1990 cohort in Nottingham, was of a progressive reduction in the number of antenatal days spent in hospital, from 14 (median) in 1981 to 0 (median) in 1985. The median for our series was 3 days. The reduction of antenatal days in hospital is explained by increased experience in the outpatient management by the diabetes team, which has reduced admissions for stabilisation of diabetes from 3.3 days per patient in 1977–1983 to 0.6 in 1984–1990, and also by the introduction of an obstetric day case unit for fetal monitoring, which has reduced admissions for 'obstetric caution' from 5.3 days per patient in 1977–1983 to 0.2 in 1984–1990. We believe we have reached an irreducible minimum of antenatal admissions. Pregnancy-associated hypertension was the single largest reason for admission in the last 14 years. The standardised figures for days in hospital with this condition were constant (2.7 days per patient in 1977–1983 vs 2.3 in 1984–1990). It is well recognised that there is a considerably increased incidence of pregnancy-induced hypertension in diabetic women, and this frequently leads to preterm delivery and consequent neonatal morbidity.

Until 1985 women in our unit were routinely delivered at 38 weeks, whereas now our policy is to postpone delivery to as near term as possible, provided that there are no obstetric or other complications. It is disappointing that this change in policy has only succeeded in prolonging the average duration of pregnancy by half a week. Nevertheless, the 'ideal' situation where a woman goes into labour spontaneously and delivers vaginally at term was achieved in 9 cases (11%) in 1984–1990 compared with none in 1977–1983. Five women (6%) delivered vaginally preterm in 1984–1990 compared with three (5%) in 1977–1983.

While the caesarean section rate for diabetic patients did not change significantly (66% in the first versus 53% in the second period), there was an increase in overall caesarean section rate for our unit from 9.8% to 11.6%, and in the diabetic patients we saw a significant shift from elective to emergency procedures (62% emergency in 1984–1990 versus 34% in 1977–1983). The rate of induction (41%) was the same for both periods but in 1984–1990 24 women (30%) laboured spontaneously compared with only 5 (9%) in 1977–1983. The single largest indication for emergency caesarean section in both periods was failed induction, which is unlikely to change unless more pregnancies can be prolonged beyond 39 weeks, which seems unlikely in the present medico-legal climate in which obstetrics is practised; the pressure to ensure a live baby at 38 weeks in the knowledge that it might die *in utero* if left another week is well nigh irresistible, and current methods of fetal monitoring are a double-edged sword in that minor abnormalities of fetal heart rate are common and may precipitate rather than retard delivery by induction. The perinatal mortality in 1984–1990 was three cases (3.7%), which comprised one intra-uterine death, one stillbirth and one neonatal death. No deaths had occurred in the previous 7 years and the perinatal mortality over 14 years was 2.2%. The Bristol figure for 1981–1985 was two cases (2.4%)—one stillbirth and one neonatal death. The intra-uterine death in our series and the stillbirth from Bristol were both avoidable, being caused by maternal ketoacidosis. Our patient decided (incorrectly) to omit her insulin when she started vomiting at 30.5 weeks gestation. The Bristol patient was non-compliant. This serves to emphasise that all women should be reminded about the rules for managing diabetes during intercurrent illness, and encouraged to telephone for advice rather than guess what to do.

A development during the past decade which we have not adopted is a formal pre-pregnancy clinic as pioneered by Steel and her colleagues in Edinburgh in 1976 [6]. The aim of such a clinic is to help women optimise blood glucose control before conception so as to reduce the incidence of congenital abnormalities. The Edinburgh group [7] justify their approach by pointing out the significant difference in congenital abnormalities between babies of women who attended the clinic (2/143; 1.4%) compared with those who did not 10/96;10.4%). We do not have a formal pre-pregnancy clinic but encourage all women of childbearing age to achieve good blood glucose control before conception and to contact us immediately they suspect they are pregnant. Most pre-pregnancy counselling is given by one of our three full-time diabetes specialist nurses on an individual basis. This clearly works, since the rate of major congenital abnormalities in Nottingham between 1977 and 1990 was 3/139 pregnancies (2.2%) compared with 12/239 (5.0%) in Edinburgh [7] and 4/85 (4.7%) in Bristol [3]. Five years ago overall rates of major congenital malformation in infants of unselected diabetic women in the United States and the United Kingdom were between 6% and 9%, two to three times the rate in the non-diabetic population [8,9]. Rates in specialised units are now lower and approach that in the non-diabetic population [10].

One measure of success of diabetes carers in preparing patients for pregnancy is the number who have a normal HbA1 at booking. In 1984–1990, 14% of Nottingham patients achieved this demanding goal, but unfortunately no comparable data were available for the previous 7 years. Mean HbA1 at booking for women who attended the Edinburgh pre-pregnancy clinic was 8.9% (normal range 5.9–8.0%), compared with 10.9% in the non-attenders. As in Edinburgh, we found a drop in HbA1 between routine clinic visits in the year before pregnancy and the booking visit. The woman whose baby had sacral agenesis, an abnormality virtually confined to infants of diabetic mothers [8], had an HbA1 of 6.8% at booking at 10 weeks. This is consistent with the findings of the Diabetes in Early Pregnancy Study that even well controlled women had

a greater incidence of major malformations than non-diabetic women, but that the risk rises steeply in those with poor control [11]. Although there is good evidence that maternal hypoglycaemia during organogenesis does not increase the overall rate of congenital malformations [5], it can induce malformations in animals [12], and sacral agenesis may come into the same category in humans, although, because of its extreme rarity, this will be difficult to prove or disprove. The recording of hypoglycaemia in the pregnancy records was not standardised during 1977–1990 and we have not presented any data.

In conclusion, we feel that there is limited scope for improving the outcome of pregnancy in women with type 1 diabetes. In our series, one intra-uterine death (due to maternal ketoacidosis) was avoidable. Attention to the optimum timing of delivery might reduce the still high caesarean section rate. There may be a case for making patients aware of the results of audit, so that they may have a more realistic attitude to the outcome of their pregnancies. Reaching women who are contemplating pregnancy but whose diabetic control is unsatisfactory is a major problem, but we are sceptical about the beneficial claims made for formal pre-pregnancy counselling clinics.

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Address for correspondence: Dr R. Gregory, Diabetes Unit, C Floor South, University Hospital, Nottingham NG7 2UH.