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ORIGINAL RESEARCH

Pre-Gestational Diabetes and Pregnancy Outcomes

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ABSTRACT

Introduction: Pre-gestational, type 1 and type 2 diabetes are associated with adverse neonatal outcomes and increased rates of emergency caesarean sections.

Methods: We studied pregnancy outcomes associated with pre-gestational diabetes in 174 women who attended the National Maternity Hospital in Dublin, Ireland, between 2015 and 2017.

Results: Fifty women (28.6%) had type 2 diabetes mellitus, and 124 women (71.4%) had type 1 diabetes mellitus. Women with type 2 diabetes mellitus were older (36 vs. 34 years, p 0.02) and had a higher BMI (32.6 vs. 26.2 kg/m^2, p 0.00). Duration of diabetes mellitus in type 1 and type 2 was 15.7 and 5.7 years, respectively, and mean HbA1c in type 2 diabetes mellitus at booking was 44.5 mmol/mol (6.2%) and in type 1 diabetes mellitus was 56.3 mmol/mol (7.3%). Forty women (32%) with type 1 diabetes mellitus used continuous subcutaneous insulin infusion. In our cohort, 45.4% had a caesarean delivery. Offspring of patients with multiple dose injections were lighter (3.58 kg) than infants of continuous subcutaneous insulin infusion-treated patients (3.75 kg). More emergency caesarean sections were observed in the continuous subcutaneous insulin infusion group than in the group treated with multiple dose injections (37.5% vs. 28.5%), while the elective caesarean section rate was higher in the multiple dose injection group (17.8% vs. 12.5%). Women treated with continuous subcutaneous insulin infusion had a higher rate of miscarriage (25% vs. 19%) with more congenital malformations (10% vs. 2.3%).

Conclusions: Women in our study with pre-gestational diabetes were overweight, were older and had long-standing diabetes mellitus. Our patients with type 2 diabetes had a higher BMI, were older, had a shorter duration of diabetes mellitus and had better diabetes control compared to women with type 1 diabetes. Women treated with continuous subcutaneous insulin infusion had a higher rate of miscarriage with more congenital malformations. The initial inadequate diabetes control was

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significantly improved during pregnancy.**Keywords:** Diabetes; Diabetes in pregnancy; Pre-gestational pregnancy and diabetes outcomes; Type 1 diabetes; Type 2 diabetes

Key Summary Points
Why carry out this study?
Pre-gestational, type 1 and type 2 diabetes are associated with adverse neonatal outcomes.
Previous studies found that adverse maternal outcomes are still high for women with pre-existing diabetes mellitus.
The aim was to study the pre-gestational diabetes impact on pregnancy outcomes in a large maternity hospital with a multidisciplinary team with the intention to improve diabetes in pregnancy outcomes.
What was learned from the study?
Women with pre-gestational diabetes were overweight and older with long-standing diabetes mellitus; inadequate initial diabetes control significantly improved during pregnancy.
In our study 32% women with type 1 diabetes were treated with continuous subcutaneous insulin infusion (CSII) in pregnancy.
With an appropriate multidisciplinary team approach, we can minimise adverse outcomes and identified areas for improvement in delivery of care in the future.

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INTRODUCTION

Pre-gestational diabetes mellitus, type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM) are associated with adverse outcomes [1]. Pregnant women with pre-existing diabetes mellitus are at increased risk of congenital malformations [1, 2], stillbirth [1, 3, 4], perinatal mortality [4, 5], macrosomia [1, 2, 4, 6], prematurity [4], operative delivery or increased rates of caesarean section (CS) [1, 2, 4]. However, the quality of the care offered to women with diabetes mellitus can affect the adverse birth outcomes [7] in reducing congenital malformations and stillbirths [6]. The level of support during pregnancy improves outcomes in women with diabetes mellitus [8]. Providing appropriate clinical care to women with pre-existing diabetes mellitus has a positive impact on pregnancy outcomes. Previous national and international studies found that adverse maternal outcomes are still high for women with pre-existing diabetes mellitus [6, 9–11]. The goal of the St Vincent Declaration, which was set in 1997, was “achieving pregnancy outcomes in women with diabetes mellitus that approximates that of women with no diabetes mellitus”. This declaration has not been accomplished yet [12].

METHODS

This is a retrospective study of pregnancy outcomes associated with pre-gestational diabetes in women attending the National Maternity Hospital, Dublin, Ireland, over the 3-year period of 2015–2017. The aim of this study was to review the pre-gestational diabetes impact on pregnancy outcomes with the intention to improve diabetes in pregnancy treatment and pregnancy outcomes in a large maternity hospital with a multidisciplinary team. The data were collected from patients’ electronic and hard copy medical records. All women had retinal screening at the time of confirmation of

the pregnancy and in each trimester thereafter. All women with pre-gestation diabetes were treated by a multidisciplinary team including an obstetrician, an endocrinologist, a dietician, a diabetes midwife specialist, an ophthalmologist with 2–3 weekly reviews and weekly phone contacts with diabetes midwives. Miscarriage was defined as spontaneous loss of the foetus before 20 weeks' gestation. Intrauterine foetal death (IUFD) was defined as death that occurred in utero or during delivery at the 20th week of pregnancy or more, or death of the foetus with weight $\geq$ 500 g in utero or during delivery. Live births were neonates who survived $\geq$ 6 weeks post-delivery. Large for gestational age (LGA) was defined as foetuses measuring > 90th centile and small for gestational age (SGA) defined as < 10th centile based on gender-specific hospital growth charts. Pregnancy-induced hypertension (PIH) was defined as systolic blood pressure (SBP) > 140 mmHg and diastolic blood pressure (DBP) > 90 mmHg. Pre-eclampsia was defined as new onset hypertension (> 140 mmHg systolic or > 90 mmHg diastolic) after 20 weeks of pregnancy and the coexistence of one or both of the following new-onset conditions: proteinuria (urine protein:creatinine ratio $\geq$ 30 mg/mmol or albumin:creatinine ratio $\geq$ 8 mg/mmol or $\geq$ 1 g/l [2 +] on dipstick testing), other maternal organ dysfunction, including features such as renal or liver involvement, neurological or haematological complications, or uteroplacental dysfunction (such as foetal growth restriction, abnormal umbilical artery Doppler waveform analysis or stillbirth). Congenital anomalies were defined as birth defects that exist at birth and have a possible impact on the health, development and/or survival of the infants [13]. Assisted delivery was defined as using tools (forceps, vacuum) to help deliver the foetus vaginally. Neonatal hypoglycaemia was defined as capillary blood glucose of < 2.6 mmol/l. Near normal maternal HbA1c (48 mmol/mol/6.5%) was described as target A1c in our cohort at their booking visit [14–17]. The data collection for this study was approved by the Research Ethics Committee National Maternity Hospital, Holles Street, Dublin, Ireland. Statistical analysis was performed using the Statistical Package for the Social Sciences, version 26.0 for Windows (IBM SPSS, USA). Continuous variables with normal distribution were presented as mean, standard deviation and median; however, categorical data were presented as frequencies. For binary outcomes, the proportions between groups were compared using chi-square and Fisher's exact tests.

RESULTS

A total of 174 pregnancies with pre-gestational diabetes mellitus were included in the study (Table 1); 124 (71.4%) women had T1DM and the remaining 50 (28.6%) had T2DM. Women with T2DM were older (36 vs. 34 years, p 0.02), had a higher BMI (32.6 vs. 26.2 kg/m^2, p 0.00) and had a shorter duration of diabetes mellitus (5.5 vs. 15.7 years, p 0.00) compared to women with T1DM. Most of the women studied in our population were multiparous (58%). The majority of women with T1DM were of European descent (96%), whereas the group with T2DM had a higher percentage of non-white ethnic patients (41%) (p 0.00). Most of the non-European women were of Asian, Middle Eastern and South American descents. Women with T1DM had a higher documented rate of retinopathy (43% vs. 11%, p 0.008). Hypothyroidism was also found in both groups but more common in women with type 1 diabetes mellitus (21% vs. 17%).

Pre-pregnancy structured clinics was more common in the T1DM group (n = 49, 62%). The majority of women with T2DM were treated with metformin and multiple daily injections (MDIs) throughout their pregnancy (44%); however, 20% used metformin alone and 28% were on insulin therapy alone. In the group of women with T1DM, 67% were on MDI and 32% were treated with continuous subcutaneous insulin infusion CSII throughout their pregnancies.

Labour and foetal outcomes in our cohort (Table 2) showed that 79 (45.4%) women had a caesarean section (CS) delivery, 40 (24.3%) had normal vaginal delivery and 13 (7.4%) required assisted vaginal delivery; 36 (20.6%) pregnancies unfortunately ended with miscarriage.

Table 1 Maternal baseline characteristics

Mean ± SD	**All patients** ***n*** **= 174**	**Type 1 diabetes** ***n*** **= 124 (71.4)**	**Type 2 diabetes** ***n*** **= 50 (28.6)**	***P*** **value**
Age (years)	34.2 ± 4.5	33.8 ± 4.7	35.5 ± 3.8	0.020
Booking BMI (kg/m^2)	28.3 ± 6.6	26.2 ± 4.5	32.6 ± 8.1	0.000
Duration of diabetes (years)	12.7 ± 8.6	15.7 ± 8.0	5.49 ± 4.4	0.000
Booking Gestational age (weeks)	6.7 ± 3.0	6.0 ± 1.7	7.8 ± 4.4	0.190
Percentage (%)				
European origin	85.7	96.0	59.0	0.000
Yes (n = 149)				
Primiparous	42.0	44.0	36.0	0.384
Yes (n = 69)				
Pre-conception clinic attendee	57.2	62.0	46.0	0.117
Yes (n = 67)				
Preconception folic acid (5 mg)	68.3	70.0	64.0	0.530
Yes (n = 80)				
Hypothyroidism	20.0	21.0	17.0	0.672
Yes (n = 34)				
Diabetes complications				
Retinopathy	36.1	43.0	11.0	0.008
Yes (n = 31)				
Pregnancy treatment				
Metformin	5.7	–	20.0	
Yes (n = 10)				
MDI	56.3	67.0	28.0	
Yes (n = 98)				
CSII	23.0	32.0	–	
Yes (n = 40)				
MDI + metformin	12.5	–	44.0	
Yes (n = 22)				
Diet only	0.5	–	2	
Yes (n = 1)				

Data are presented as mean ± standard deviation (SD) or %
BMI body mass index, *MDI* multiple daily injections, *CSII* continuous subcutaneous insulin infusion

Table 2 Delivery and neonatal outcomes

Mean ± SD	**All patients** ***n*** **= 174**	**Type 1 diabetes** ***n*** **= 124 (71)**	**Type 2 diabetes** ***n*** **= 50 (29)**	***P*** **value**
Birth weight (kg)	3.6 ± 0.72	3.6 ± 0.76	3.5 ± 0.6	0.260
Mode of delivery	Percentage (%)			
Spontaneous vaginal delivery	24.3	23.4	26.0	0.549
Yes (*n* = 40)				
Elective CS	17.2	16.0	20.0	0.508
Yes (*n* = 30)				
Emergency CS	28.1	32.0	18.0	0.092
Yes (*n* = 49)				
Assisted normal delivery	7.4	7.2	8.1	0.760
Yes (*n* = 13)				
Miscarriage	20.6	20.8	18.3	0.835
Yes (*n* = 36)				
Intrauterine foetal death	3.4	2.4	8.1	0.099
Yes (*n* = 6)				
Live births	76.5	77.6	74.0	0.268
Yes (*n* = 134)				
Foetal complications				
Postnatal hypoglycaemia	27.4	31.3	19.3	0.331
Yes (*n* = 27)				
NICU admission	45.9	52.2	32.0	0.082
Yes (*n* = 45)				
Abdominal circumference > 95th	19.4	23.8	6.8	0.058
Yes (*n* = 22)				
Birth weight > 4.5 kg	5.2	7.2	–	0.189
Yes (*n* = 7)				
Birth weight > 4.0 kg	23.1	20.6	30.0	0.263
Yes (*n* = 31)				
Congenital anomalies	5.3	6.3	2.7	0.675
Yes (*n* = 7)				

Table 2 continued

Mean ± SD	All patients *n* = 174	Type 1 diabetes *n* = 124 (71)	Type 2 diabetes *n* = 50 (29)	*P* value
Maternal complications				
Pre-eclampsia	9.2	10.5	5.4	0.514
Yes (*n* = 13)				
Pregnancy-induced hypertension	19.2	21.4	13.5	0.340
Yes (*n* = 26)				

Data are presented as mean ± standard deviation (SD) or %
BMI body mass index, *MDI* multiple daily injections, *CSII* continuous subcutaneous insulin infusion

There were six (3.4%) recorded cases of intrauterine foetal death, most of which occurred in women with type 2 diabetes mellitus compared to type 1 diabetes mellitus (8.1% vs. 2.4%, *p* 0.099). The rate of pre-eclampsia was nearly double in T1DM compared to T2DM patients (10.5% vs. 5.4%). One-fifth of women studied had pregnancy-induced hypertension (19.2%). There were 134 (76.5%) live births recorded. Offspring of women with T1DM were more likely to be admitted to the neonatal intensive care unit (NICU) (52% vs. 32%, *p* 0.082) and more likely to get postnatal hypoglycaemia (31% vs. 19%) compared to the offspring of T2DM women. The mean birth weight in the T1DM groups was similar to that in the T2DM group, which was about 3.6 kg. The sonographic appearance of the abdominal circumference of > 95th percentiles was nearly four fold higher in the infants of the T1DM cohort (23.8% vs. 6.8%, *p* 0.058). Congenital anomalies were higher among the T1DM cohort (6.3% vs. 2.7%). Overall, 23.1% (31, *n* = 134) of our studied infants were large for gestational age (LGA) (> 4 kg). Seven (5.2%) offspring of T1DM patients weighed > 4.5 kg, whereas no offspring weighed > 4.5 kg in T2DM. Glycaemic control among our studied population is summarised in Table 3. Women with T2DM had better glycaemic control at the booking visit compared to those with T1DM (HbA1c 45 mmol/mol (6.2%) vs. 56 mmol/mol (7.3%), *p* 0.04). More than half of women with T2DM had HbA1c at target on their first visit (52.2% vs. 16.9%, *p* 0.00). Diabetes control was better in both groups in the second and third trimesters of pregnancy; however, the HBA1c level was significantly lower in the T2DM cohort compared to the T1DM group ($p = 0.005$ and $p = 0.002$, respectively).

The baseline characteristics of the women with T1DM only are summarised in Table 4. Our cohort treated with CSII had a longer duration of diabetes mellitus compared to those with MDI (18.5 years vs. 14 years, $p = 0.015$) and had earlier pregnancy bookings (5.3 weeks gestation vs. 6.6 weeks, $p = 0.024$). Most women with T1DM attended pre-pregnancy clinics and had been taking folic acid 5 mg daily prior to conception, 62% and 71%, respectively. Hypothyroidism was observed more frequently in the CSII group (33% vs. 15%, $p = 0.07$).

Maternal and foetal outcomes in T1DM women are summarised in Table 4. Offspring of women with MDI treatment were lighter (3.58 kg) than infants of CSII-treated women (3.75 kg). Only 4.4% of infants in the MDI group had weight > 4.5 kg (4.4%), while 13.7% of infants of mothers on CSII had weight > 4.5 kg. More emergency CSs were observed in the CSII group (37.5% vs. 28.5%), while the elective CS rate was higher in the MDI group (17.8% vs. 12.5%). Women treated with CSII had a higher rate of miscarriage (25% vs. 19%)

Table 3 Glycaemic outcomes and diabetes

	Type 1 diabetes $n = 124$ (71)	CSII $n = 40$ (32)	MDI $n = 84$ (67)	Type 2 diabetes $n = 50$ (29)	*P* value
First trimester					
HBA1c at booking (%)	7.3	7.1	7.4	6.2	
Mean HBA1c (mmol/mol)	56.3 ± 15.2	54.2 ± 13.6	57.4 ± 16.0	44.57 ± 9.4	0.040
Booking < 43 mmol/mol (6.1%)	16.9%	17.5%	16.6%	52.2%	0.000
Yes ($n = 42$)					
Second trimester					
HBA1c (%)	6.0	5.9	6.1	5.4	
Mean HBA1c (mmol/mol)	42.43 ± 8.9	40.7 ± 8.1	43.2 ± 9.2	35.11 ± 5.8	0.005
Third trimester					
HBA1c (%)	6.2	6.2	6.3	5.6	
Mean HBA1c (mmol/mol)	44.22 ± 8.0	43.0 ± 8.0	45.0 ± 8.0	37.53 ± 6.4	0.002

Data are presented as mean ± standard deviation (SD) or %
HBA1c Haemoglobin A1c

and more congenital malformations (10% vs. 2.3%). The intrauteral foetal death rate was marginally higher among CSII patients (2.5% vs. 2.3%, $p = 0.05$). The admission rate in NICU was higher in infants of the MDI group (54%), but the rate of neonatal hypoglycaemia was similar in both groups (31%). Pre-eclampsia and pregnancy-induced hypertension were similar in both groups (9% vs. 11.2% and 20% vs. 22%).

DISCUSSION

In this observational retrospective analysis, we studied baseline characteristics, diabetes-related complications, comorbidities, pregnancy and foetal outcomes in patients with pre-pregnancy diabetes mellitus. Our cohort with T2DM were of wide ethnic diversity with 41% being of non-European descent, whereas, the majority of our T1DM cohort were of European origin (96%). Women with T2DM were overweight, older, had lower attendance to pre-pregnancy service and presented at booking visit at a greater gestational age. On the other hand, women with T1DM had a longer duration of the disease, more diabetic retinopathy, hypothyroidism, a higher risk for developing pre-eclampsia and higher rates of pregnancy-induced hypertension. Both of our cohorts showed good adherence to high-dose folic acid prior to conception. Moreover, we found that pregnant women with T2DM and T1DM started their pregnancies with different glycaemic control levels; T1DM women had a better improvement in HbA1c throughout pregnancy than their T2DM counterparts. In further analysis of glycaemic control, women with type 2 diabetes mellitus had a better HbA1c at their booking visit and throughout the pregnancy compared with T1DM patients who had suboptimal glycaemic control at booking with subsequent improvement throughout the pregnancy.

It is established that diabetes mellitus care during the pre-pregnancy period is one of the most important factors leading to better glycaemic control and favourable obstetrical outcomes in pregnant women with diabetes mellitus[7].Improvement in glycaemic control during pregnancy decreased the risk of LGA infants [18–20], preterm delivery [21] and preeclampsia [22] in previous studies. We found

Table 4 Maternal, obstetric and foetal characteristics of type 1 diabetes patients

Mean ± SD	All type 1 diabetes $n = 124$	CSII $n = 40$ (32)	MDI $n = 84$ (67)	*P* value
Age (years)	33.8 ± 4.7	34.3 ± 4.0	33.5 ± 5.0	0.524
Booking BMI (kg/m^2)	26.3 ± 4.5	26.6 ± 4.7	26.2 ± 4.4	0.296
Duration of diabetes (years)	15.7 ± 8.0	18.5 ± 8.3	14.3 ± 7.6	0.015
Booking gestational age (weeks)	6.0 ± 1.7	5.3 ± .93	6.6 ± 2.0	0.024
Birth weight (kg)	3.63 ± 0.76	3.75 ± 0.71	3.58 ± 0.78	0.306
Percentage (%)				
European origin	96.0	100	94.0	0.130
Yes ($n = 120$)				
Primiparous	44.4	52.5	40.2	0.207
Yes ($n = 52$)				
Pre-conception clinic attendee	62.0	66.6	59.6	0.538
Yes ($n = 49$)				
Preconception folic acid (5 mg)	70.5	74.0	68.6	0.614
Yes ($n = 44$)				
Hypothyroidism	21.0	33.3	15.4	0.070
Yes ($n = 26$)				
Diabetes complications				
Documented retinopathy	42.6	45.0	41.6	0.064
Yes ($n = 29$)				
Mode of delivery				
Spontaneous vaginal delivery	21.6	15.0	25.0	0.339
Yes ($n = 27$)				
Elective CS	16.0	12.5	17.8	0.623
Yes ($n = 20$)				
Emergency CS	32.0	37.5	28.5	0.194
Yes ($n = 40$)				
Assisted normal delivery	7.2	7.5	7.1	0.925
Yes ($n = 9$)				

Table 4 continued

Mean ± SD	All type 1 diabetes *n* = 124	CSII *n* = 40 (32)	MDI *n* = 84 (67)	*P* value
Miscarriage	20.8	25.0	19.0	0.596
Yes (*n* = 26)				
Intrauterine foetal death	2.4	2.5	2.3	**0.050**
Yes (*n* = 3)				
Live births	76.0	70.0	78.5	0.447
Yes (*n* = 95)				
Foetal complications				
Postnatal hypoglycaemia	31.3	31.8	31.8	0.684
Yes (*n* = 21)				
NICU admission	52.2	45.4	54.5	0.407
Yes (*n* = 35)				
Abdominal circumference > 95th	23.8	25.0	23.3	**0.026**
Yes (*n* = 20)				
Birth weight > 4.5 kg (LGA)	7.2	13.7	4.4	0.284
Yes (*n* = 7)				
Birth weight > 4.0 kg	20.6	17.2	22.3	0.671
Yes (*n* = 20)				
Congenital anomalies	4.8	10.0	2.3	0.198
Yes (*n* = 6)				
Postnatal hypoglycaemia	31.3	31.8	31.8	0.684
Yes (*n* = 21)				
Pre-eclampsia	10.6	9.0	11.2	0.116
Yes (*n* = 11)				
Pregnancy-induced hypertension	21.4	20.0	22.0	0.523
Yes (*n* = 21)				

Data are presented as mean ± standard deviation (SD) or %
Bold indicates the significant values ($p < 0.05$)
BMI body mass index, *MDI* multiple daily injections, *CSII* continuous subcutaneous insulin infusion, *NICU* neonatal intensive care unit, *CS* caesarean section

that insulin pump users and MDI users with T1DM started pregnancy with similar glycaemic control levels; however, SCII users had lower HbA1c throughout pregnancy. This has been reported in a number of previous studies [23–27]; the opposite finding was seen in one recent trial using continuous glucose monitoring [28]. In one study, SCII patients had higher

rates of miscarriage and emergency CS and a marginally raised rate of IUFD and congenital anomalies; their babies were heavier and had a higher rate of LGA. These findings were explained by the possibility of the effect of gestational weight gain in CSII users compared to MDI users [29]. Our study showed similar foetal and maternal outcomes. The majority of our SCII users were commenced on the treatment before pregnancy. There was no difference in neonatal hypoglycaemia between SCII and MDI users. We found no statistically significant differences in glycaemic control in the second and third trimester between the groups, and both achieved the pregnancy target of HbA1c $\leq$ 48 mmol/mol 6.5%. A study by Murphy et al. on glucose disposal and plasma insulin concentration in T1DM during pregnancy found significant delays in postprandial glucose disposal during late gestation in SCII users [30]. This is likely to result in prolonged postprandial hyperglycemia in late pregnancy and impact the overall glycaemic control. In our study SCII users achieved similar glycaemic control during late pregnancy compared to MDI users. Offspring of women on MDI treatment had higher rates of NICU admissions in our study, different from the finding observed in the CONCEPTT trial [28]. In one study of T1DM-complicated pregnancy, CSII compared to MDI therapy resulted in better first trimester glycaemic control; this difference decreased in subsequent trimesters. CSII therapy was associated with lower insulin requirements, higher GWG and altered risk for infants being LGA and SGA [31]. MDI and CSII are both effective approaches in pregnancy. However, if CSII is to be initiated, it should be started well before conception to allow women time to acclimate to the pump and ensure tight diabetes control before pregnancy, and all supporting staff should be comfortable using this treatment.

Strengths of our study include a large number of patients with pre-existing diabetes, especially type 1 diabetes mellitus, with a large proportion of patients using CSII therapy throughout the pregnancy. Our patients were treated with a multidisciplinary team consisting of endocrinologists, obstetricians, diabetes specialised midwives, dietitians, an ophthalmologist and psychologists. All patients received diabetes self-management education with instructions to optimise insulin adjustment. We used self-blood glucose monitoring with glucose targets recommended by the NICE guideline [32]. However, a weakness of this study is its retrospective analysis, and women attending our service had pre-pregnancy attendance in their general diabetes centres outside our institution. We do not have accurate data on total daily doses of insulin as nearly all of our women used insulin with meals calculating from the individual insulin to carbohydrate ratio.

CONCLUSIONS

Women in our study with pre-gestational diabetes were overweight, were older and had long-standing diabetes mellitus. Our patients with type 2 diabetes were older, had a higher BMI, had a shorter duration of diabetes mellitus and had better diabetes control compared to women with type 1 diabetes. Women treated with continuous subcutaneous insulin infusion had a higher rate of miscarriage with more congenital malformations. The initial inadequate diabetes control was significantly improved during pregnancy. With an appropriate multidisciplinary team approach, we minimised adverse outcomes and identified areas for improvement in delivery of care in the future.

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Disclosures. Dalal S Ali, Recie Davern, Eimear Rutter, Ciara Coveney, Hilary Devine, Jennifer M. Walsh, Mary Higgins and Mensud Hatunic have nothing to disclose.

Compliance with Ethics Guidelines. The data collection for this study was approved by the Research Ethics Committee National Maternity Hospital, Holles Street, Dublin, Ireland.

Data Availability. The datasets generated and analysed during the study are not publicly available due European GDPR law.

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