Trends in Deliveries, Prenatal Care, and Obstetrical Complications in Women With Pregestational Diabetes

A population-based study in Ontario, Canada, 1996–2001

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OBJECTIVE — To describe recent trends in the proportion of deliveries in women with pregestational diabetes (PGD), their use of services, and diabetes-related obstetrical complications.

RESEARCH DESIGN AND METHODS — In this population-based retrospective cohort study, comprehensive administrative data were used to identify all women (with and without PGD) who gave birth in an Ontario, Canada, hospital from 1996 to 2001. Data on maternal complications and interventions were obtained from hospital discharge records; data on use of prenatal services were obtained from fee-for-service claims.

RESULTS — The proportion of deliveries in women with PGD increased steadily from 0.8% in 1996 to 1.2% in 2001 ($P < 0.001$). In 2001, women with PGD were more likely to be diagnosed with shoulder dystocia (adjusted odds ratio 2.00 [95% CI 1.55–2.58]), hypertension (4.13 [3.44–4.96]), and preeclampsia/eclampsia (4.44 [3.43–5.73]) and have higher rates of inductions (1.69 [1.52–1.88]) and caesarean sections (1.78 [1.60–1.98]) than women without PGD. In 2001, 50% of the women with PGD had a visit to a diabetes specialist during pregnancy and only 30% of women had claims for a prenatal retinal examination. Both of these rates have decreased over the study period.

CONCLUSIONS — Women with PGD now account for a larger proportion of deliveries. These women continue to have higher obstetrical complication and intervention rates than women without PGD and many do not receive recommended specialty care during pregnancy.

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In 1989, the World Health Organization and the International Diabetes Federation challenged health care systems to "achieve pregnancy outcomes in the diabetic woman that approximate that of the nondiabetic woman" (1). This declaration was based on the belief that access to appropriate care could provide women with pregestational diabetes (PGD) with the opportunity to have no greater risk of poor obstetrical outcomes than women without PGD. This is a laudable goal and one that has important implications as health care systems in developed countries brace themselves to deal with the "diabetes epidemic" (2). An increase in diabetes rates in the overall population will translate into higher rates of PGD overall and a shift toward diagnosis of type 2 diabetes at younger ages (3). This will place more women and fetuses at risk, resulting in a greater need for prenatal services and obstetrical interventions to reduce these risks.

Since PGD is associated with an increased risk of congenital malformations (4–6), comprehensive pregestational care including a clear management plan with defined blood glucose goals is crucial. In addition, since PGD is also associated with increased rates of maternal complications such as hypertension, preeclampsia, obstructed labor, and shoulder dystocia (7,8), care during pregnancy is important as well. In order to avoid these complications, both induction and caesarean section rates have been higher in women with PGD (9).

Clinical practice guidelines recommend tight glucose control for women with PGD while avoiding hypoglycemia (10,11). A team approach to managing PGD, including diabetes specialists familiar with the care of this high-risk population and screening and treatment for retinopathy, which is effective in reducing morbidity, are also essential (10,11).

The purpose of this article is to use comprehensive administrative data from Ontario, Canada (a province in which there are ~130,000 deliveries per year), to examine recent population-based trends in the proportion of deliveries that occur in women with PGD. The article focuses on care for these women during pregnancy and their obstetrical complications and intervention rates compared with women without PGD. The research builds on previous research on obstetrical care (12,13) and the development of a validated algorithm for identifying individuals with diabetes (14).

RESEARCH DESIGN AND METHODS

A cohort of women who delivered in Ontario hospitals between April 1996 and March 2002 was identified using a national hospital discharge abstracts database prepared by the Canadian Institute for Health Information and methods outlined in previous research (12,13). This database was then linked to the Ontario Diabetes Database (ODD), an administrative data-derived registry of all people in the province diag-

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Abbreviations: ODD, Ontario Diabetes Database; PGD, pregestational diabetes.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Characteristics of women who gave birth in Ontario hospitals, 1996–2001*

Year	Total deliveries	Deliveries in Women with PGD	Age (years) Women with PGD	Age (years) Women without PGD
1996	133,316	1,122 (0.8)	30.7 ± 5.5	28.9 ± 5.4
1997	131,685	1,191 (0.9)	30.7 ± 5.3	29.0 ± 5.5
1998	129,470	1,296 (1.0)	30.9 ± 5.3	29.1 ± 5.5
1999	128,679	1,352 (1.1)	31.0 ± 5.3	29.2 ± 5.5
2000	124,605	1,455 (1.2)	31.2 ± 5.5	29.3 ± 5.6
2001	128,745	1,532 (1.2)	31.2 ± 5.4	29.5 ± 5.5

Data are *n* (%) or means ± SD.

nosed with diabetes (14). Women were only included in this study if they entered the ODD >270 days before delivery, thereby excluding women with gestational diabetes. The ODD has been validated against data abstracted from primary care charts and found to have a sensitivity of 86% and a specificity of >97% (14).

Data on the age of the women, their diagnoses, and procedures were obtained from the discharge abstract for the hospitalization during which the women delivered. The abstract contains up to 16 separate ICD-9 diagnoses and up to 10 procedure codes. Four obstetrical complications associated with PGD were defined based on the presence of diagnostic codes in the discharge abstract, two general complications and two more specific subsets. Obstructed labor was defined as ICD-9 codes 660.0–660.6 and 660.8–660.9, and, more specifically, shoulder dystocia was defined as ICD-9 code 660.4. Hypertension complicating pregnancy was defined as ICD-9 code 642, and within that, preeclampsia/eclampsia was defined as ICD-9 codes 642.4–642.7.

Caesarean sections and inductions were identified in the discharge abstract using the Canadian Classification of Procedure Codes as outlined in previous publications (12,13). The discharge abstract was also used to provide data on diagnoses that could be related to caesarean section (previous caesarean section, ICD-9 code 654.2) and induction (prolonged pregnancy, ICD-9 code 645). The discharge abstract does not contain data on parity. The unique patient identifier was used to link the discharge abstract to prior deliveries over the previous 9 years to create a proxy for parity.

In order to obtain information on pregestational specialist care for our cohort, unique patient identifiers were used to link the women who delivered to the fee-for-service claims for physician and professional services in the 270 days before the delivery date. As in previous studies of access to services (15), visits to diabetes specialists were defined as any service provided by an endocrinologist or a service provided by an internist that noted a diagnosis of diabetes. A retinal exam was identified as any visit to an ophthalmologist or an optometrist with a diagnosis of diabetes or diabetic retinopathy or if the optometrist billed for a major assessment. Retinal examinations in Canada are primarily performed by ophthalmologists or optometrists. Socioeconomic status was measured at an ecological level using Statistics Canada census files on average family income for the woman's census area of residence. Ethics approval for this study was not required.

Statistical analysis

The percentage of women with diabetes among all women who delivered was computed for each year. *T* tests were used to determine whether there was a difference in the average age between women with and without PGD. Logistic regression was used to determine whether, controlling for maternal age, the incidence of PGD increased over the study period.

The incidence of obstetrical complications and interventions was compared in women with PGD to those without PGD using logistic regression. Within each study year, the regression model included the complication or the intervention as the dependent variable and age, 9-year parity, and PGD status as independent variables. Additionally, the regression model for induction included a variable indicating whether the pregnancy was prolonged, while the regression model for caesarean section included a variable indicating if there was a previous caesarean section. The results of these models provided adjusted odds ratios (OR) for the complications or interventions controlling for the other factors within a year. Across study years, the regression models were repeated with the inclusion of study year and an interaction term of year with PGD status, to provide estimates of whether or not the effect of PGD status on the outcome changed over time.

Logistic regression was also used to assess trends in the use of specialist care and eye exams over time. In women with PGD, controlling for age and socioeconomic status, year was included as a continuous variable to estimate if there was a change in use over the study period.

RESULTS — In 2001, 1,532 women with PGD delivered in Ontario hospitals, an increase of 36.5% from the 1,122 women in 1996. Women with PGD were on average slightly older (31.2 vs. 29.5 years in 2001, $P < 0.001$) than women without PGD. The proportion of deliveries in women with PGD increased steadily from 8.42 per 1,000 deliveries in 1996 to 11.90 per 1,000 deliveries in 2001, and this was statistically significant ($P <$ 0.0001) after controlling for age (see Table 1).

Table 2 compares the rates of specific obstetrical complications and interventions in women with and without PGD in the years 1996 and 2001, within each year as well as over time. In 2001, ~9% of women with PGD had a diagnosis of hypertension in pregnancy, while 4% of women with PGD were diagnosed with preeclampsia/eclampsia. For both hypertension and preeclampsia/eclampsia, these rates were ~4 times higher than in women without PGD. About 4% of women with PGD had a diagnosis of shoulder dystocia at delivery, a rate that was consistently about twice as high as found in women without PGD. There was no trend in the ORs over time for any of the obstetrical complications.

Induction rates were just over 30% in women with PGD in both 1996 and 2001. These were consistently 50% higher than in women without PGD, and there was no trend in the relative rates over time. Over one-third of women with PGD had a caesarean section in both 1996 and 2001. In women without PGD, the caesarean section rate increased over this period, resulting in a drop in relative rates over time.

In 1996, only 55% of women with PGD had a visit to an endocrinologist or

Table 2—*Rates of obstetrical intervention and complications in women with and without PGD in Ontario, 1996 and 2001*

Intervention	Women with PGD (rate per 100 deliveries)	Women without PGD (rate per 100 deliveries)	Adjusted OR (95% CI)*	*P* value for OR PGD vs. non-PGD	*P* value for trend†
Caesarean section					
1996	6.6	18.3	2.56 (2,258–2,893)	<0.0001	<0.0001
2001	34.9	22.7	1.78 (1,597–1,979)	<0.0001	
Induction					
1996	31.6	21.4	1.76 (1,551–1,999)	<0.0001	0.611
2001	33.1	23.4	1.69 (1,517–1,882)	<0.0001	
Complication					
Obstructed labor					
1996	8.8	6.7	1.45 (1,176–1,786)	0.001	0.366
2001	8.4	7.2	1.27 (1,059–1,527)	0.010	
Shoulder dystocia					
1996	3.8	1.6	2.39 (1,756–3,255)	<0.0001	0.344
2001	4.2	2.1	2.00 (1,553–2,580)	<0.0001	
Hypertension					
1996	9.0	2.0	5.15 (4,169–6,353)	<0.0001	0.110
2001	8.8	2.5	4.13 (3,445–4,961)	<0.0001	
Preeclampsia/eclampsia					
1996	3.6	1.0	4.16 (3,010–5,741)	<0.0001	0.754
2001	4.1	1.1	4.44 (3,426–5,765)	<0.0001	

*ORs within each year were adjusted for age, age squared, and parity (9-year lookback). †*P* value for trend is a result of modeling each outcome on PGD, age, age squared, parity, year, and year-by-PGD interaction. The *P* value is for the year-by-PGD interaction, to reflect the change in the effect of PGD between 1996 and 2001.

an internist during their pregnancy, specifically for their diabetes. This dropped to 50% by 2001 (see Table 3). Over the study period, ~30% of women with PGD had a visit to an ophthalmologist or an optometrist that would be expected to include a retinal exam during their pregnancy. This rate also dropped during the study period but the trend did not reach significance.

CONCLUSIONS — This study found that the rate of deliveries in women with pregestational diabetes rose steadily in Ontario between 1996 and 2001 with an overall increase of 41%. By 2001, almost 12 in 1,000 deliveries occurred in women with PGD. This rate is substantially higher than the rate of 0.5% reported in previous studies (16,17). One explanation for this difference might be the reliance on different data sources. Our study used population-based comprehensive administrative data and an algorithm for defining individuals with diabetes that has been validated against chart audit data. Alternatively, our data may reflect a true increase in the incidence of PGD. Although the algorithm used to identify individuals with diabetes cannot distinguish between type 1 and type 2 diabetes, the increased incidence of PGD is consistent with other research showing that there is a steady increase in type 2 diabetes in those of child-bearing age (18). The incidence rates for diabetes in Ontario in women aged 20–34 years rose from 0.15% in 1995 to 0.18% in 1999 (15). Other countries are experiencing similar increases in diabetes in women and therefore may well be seeing similar rates of increase in PGD (19). The rapid increase in PGD combined with the notion that appropriate care can minimize risks to both the mother and fetus during pregnancy will exert increasing pressure on the health care system to provide access to that care.

Table 3—*Percentage of women with PGD receiving specialist care or undergoing eye exams during pregnancy, 1996–2001*

	Specialist visit	Retinal visit
1996	55	30.5
1997	54	34.0
1998	55	30.9
1999	56	29.4
2000	50	29.7
2001	50	29.3
Time trend (*P* value)	0.001	0.061

Data are percent.

Furthermore, this study shows that maternal complications such as shoulder dystocia and hypertension, as well as obstetrical interventions such as caesarean section and induction, were much more common in women with PGD than those without. These complications and interventions have important implications for obstetrical outcomes. If women with PGD are to reach the stated goal of achieving outcomes that approximate those of other women, then the rates of these complications and interventions should be similar in the two groups. The results of this study indicate that there has been little progress, if any, in Ontario between 1996 and 2001 to decrease the rate of these complications and/or interventions in women with PGD.

We also found that only 50% of women with PGD are cared for by an endocrinologist or internist. Care of patients with PGD at centers with expertise in both the obstetrical and diabetic management of these pregnancies has been recommended by the American Diabetes Association (10) and the British Report of the Pregnancy and Neonatal Care Group (20), a strategy that may improve these outcomes. There is evidence that retinopathy can progress in pregnancy and that this progression is mitigated by tight glycemic control (21). In addition, treatment of proliferative and preproliferative retinopathy with laser therapy has been shown to decrease the risk of severe visual impairment and is considered safe in pregnancy (22). In light of this evidence, the American Diabetes Association and Canadian Diabetes Association have recommended that all women with preexisting diabetes receive a dilated comprehensive eye examination before pregnancy and again during pregnancy (10,11). Despite this, our study indicates that in Ontario only ~30% of women undergo a retinal examination during pregnancy. The reason for this is unclear and may be a matter of access.

The strength of our study lies in the fact that it provides population-based data on >500,000 deliveries over a recent time period that can provide useful insights into trends in prevalence, some key markers of obstetrical risk associated with PGD, and important aspects of care. Our study also has some limitations. Women with gestational diabetes were excluded from the study group and hence were part of the control group. This may have served to decrease the OR in women with PGD, especially for obstructed labor and shoulder dystocia; hence, the OR for these complications may in fact be even higher. We were not able to identify visits to maternal fetal medicine specialists; however, in Ontario, obstetricians, even those with maternal fetal medicine certificates, are not responsible for predelivery diabetes care in women with PGD. The information on complications and procedures is based on data collected in the mother's hospital chart from the delivery hospitalization and recorded by trained abstractors and submitted to a national agency. As with any administrative database there may be issues related to the validity and reliability of coding. We were unable to obtain data on stillbirths, early neonatal deaths, or congenital anomalies. We were able to control for age and parity when comparing complication rates, but we were unable to control for other possible confounders such as maternal obesity. As diabetes in pregnancy becomes more common, there is a growing need for more research to define efficacious interventions and better policies to ensure that women have access to these interventions, to meet the challenge set out by the World Health Organization.

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References

1. Diabetes Care and Research in Europe: The Saint Vincent Declaration. *Diabet Med* 7:360, 1990
2. Zimmet P, Alberti KG, Shaw J: Global and societal implications of the diabetes epidemic. *Nature* 414:782–787, 2001
3. Feig DS, Palda VA: Type 2 diabetes in pregnancy: a growing concern. *Lancet* 359:1690–1692, 2002
4. Fuhrman K, Reiher H, Semmler K, Fischer F, Fischer M, Glockner E: Prevention of congenital malformations in infants of insulin-dependent diabetic mothers. *Diabetes Care* 6:219–224, 1983
5. Kitzmiller JL, Gavin LA, Gin GD, Jovanovic-Peterson J, Main EK, Zigrang WD: Preconception care of diabetes: glycemic control prevents congenital anomalies. *JAMA* 265:731–736, 1991
6. Steel JM, Johnstone FD, Smith AF, Duncan LJP: Five years' experience of a "prepregnancy" clinic for insulin-dependent diabetics. *Br Med J* 285:353–356, 1982
7. Hanson U, Persson B: Epidemiology of pregnancy-induced hypertension and preeclampsia in type 1 (insulin-dependent) diabetic pregnancies in Sweden. *Acta Obstet Gynecol Scand* 77:620–624, 1998
8. Acker DB, Sachs BP, Friedman EA: Risk factors for shoulder dystocia. *Obstet Gynecol* 66:762–768, 1985
9. Wylie BR, Kong J, Kozak SE, Marshall CJ, On Tong S, Thompson DM: Normal perinatal mortality in type 1 diabetes mellitus in a series of 300 consecutive pregnancy outcomes. *Am J Perinatology* 19:169–176, 2002
10. American Diabetes Association: Preconception care of women with diabetes (Position Statement). *Diabetes Care* 26 (Suppl. 1):S76–S78, 2004
11. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee: Canadian Diabetes Association 2003 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes* 27 (Suppl. 2): S94–S98, 2003
12. Anderson GM: Hospital Obstetrical Care. In *Ontario Women's Health Status Report.* Stewart DE et al., Eds. Toronto, Ontario, Canada, Ontario Women's Health Council, 2002, p. 191–199
13. Anderson G, Lomas J: Determinants of the increasing cesarean birth rate: Ontario data 1979–1982. *N Engl J Med* 311:887–892, 1984
14. Hux JE, Ivis F, Flintoft V, Bica A: Diabetes in Ontario: determination of prevalence and incidence using a validated administrative data algorithm. *Diabetes Care* 25: 512–516, 2002
15. Hux JE, Booth GL, Slaughter PM, Laupacis AL (Eds.): *Diabetes in Ontario: An ICES Atlas*. Toronto, Ontario, Canada, Institute for Clinical Evaluative Sciences, 2003
16. Centers for Disease Control: Perinatal mortality and congenital malformations in infants born to women with insulin-dependent diabetes mellitus: United States, Canada and Europe, 1940–1988. *MMWR* 39:363–365, 1990
17. Engelgau MM, Herman WH, Smith P, German RR, Aubert RE: The epidemiology of diabetes and pregnancy in the U.S., 1988. *Diabetes Care* 18:1029–1033, 1995
18. Mokdad AH, Ford ES, Bowman BA, Nelson DE, Engelgau MM, Vincor F, Marks JS: Diabetes trends in the US: 1990–1998. *Diabetes Care* 23:1278–1283, 2000
19. Omori Y, Minei S, Testuo T, Nemoto K, Shimizu M, Sanaka M: Current status of pregnancy in diabetic women: a comparison of pregnancy in IDDM and NIDDM mothers. *Diabetes Res and Clin Pract* 24 (Suppl.):S273–S278, 1994
20. Brown CJ, Dawson A, Dodds R, Gamsu H, Gillmer M, Hall M, Hounsome B, Knopfler A, Ostler J, Peacock I, Rothman D, Steel J: Report of the pregnancy and neonatal care group. *Diabet Med* 13 (Suppl. 4):S43–S53, 1996
21. The Diabetes Control and Complications Trial Research Group: Obstetrics: pregnancy outcomes in the Diabetes Control and Complications Trial. *Am J Ob Gyne* 174:1343–1353, 1996
22. Best RM, Chakravarthy U: Diabetic retinopathy in pregnancy. *Br J Ophthalmol Mar* 81:249–251, 1997