Long-Term Effects of a Diabetes and Pregnancy Program

Does the education last?

DENICE S. FEIG, MD, MSC[1–3]
BARBARA CLEAVE, RN, BSCN[2]
GEORGE TOMLINSON, PHD[3]

OBJECTIVE — To determine whether women with pregestational diabetes obtained long-term benefits from an intensive diabetes management program during pregnancy.

RESEARCH DESIGN AND METHODS — Women with pregestational diabetes who had attended an intensive diabetes management program in pregnancy between 1991 and 1999 were interviewed regarding diabetes self-management behaviors and current glycemic control. A retrospective chart review was done to obtain information on self-management behaviors at entry to the program and at delivery and compared with the present.

RESULTS — Comparing entry to the program to delivery, all diabetes self-management behaviors improved significantly, including frequency of self-monitoring of blood glucose, frequency of insulin injections, and frequency and complexity of insulin dose adjustment (IDA). HbA_{1c} (A1C) also improved significantly from entry to delivery (mean 0.073–0.060) ($P < 0.0001$). Comparing entry to the present, frequency of insulin injections improved significantly ($P = 0.0004$), frequency of IDA improved significantly ($P = 0.004$), and complexity of IDA improved significantly ($P = 0.0032$). However, there was no significant change in frequency of self-monitoring of blood glucose ($P = 0.766$) from before pregnancy to the present, and A1C significantly worsened by 0.015 ($P < 0.0001$, 95% CI 0.009–0.021) from entry to the program to the present.

CONCLUSIONS — Women participating in an intensive diabetes management program during pregnancy improve significantly from entry to delivery in diabetes self-management behaviors and glycemic control and, in the long term, retain some of these behaviors and knowledge. However, this is not reflected in an improved A1C level. This may be explained by the loss of contact with the diabetes care team and/or the discontinuation of frequent self-monitoring of blood glucose—a critical behavior necessary for achieving optimal glycemic control.

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In pregnancy, glycemic control must be tighter than at any other time of life. Because of this, most programs that offer care to the pregnant woman with type 1 or type 2 diabetes offer an intensive therapy program that includes use of a multiple-dose insulin regimen or insulin pump with an insulin dose scale or correction dose and teaching of insulin dose adjustment and carbohydrate counting. Patients are seen every 1–2 weeks by the physician, nurse, and dietitian, who work closely with the patients to achieve this almost normal glycemic control. The patients are taught concepts similar to those taught in a program of nonpregnant patients. However, patients in a pregnancy program are seen more frequently and for a longer duration than those in programs for nonpregnant patients. These self-care behaviors are reinforced every 1–2 weeks for the duration of the pregnancy. We hypothesized that women would retain the self-care behaviors that they had learned during this intensive educational experience and that this would translate into better glycemic control when compared with entry into the program.

RESEARCH DESIGN AND METHODS

— Women with type 1 or type 2 diabetes who had attended the Diabetes and Pregnancy Clinic at Mount Sinai Hospital between 1991 and 1999 and were at least 1 year postpartum were interviewed by phone by a nurse who was not part of the Diabetes and Pregnancy Clinic. Patients were excluded if they delivered before 20 weeks.

Information regarding diabetes self-management behaviors was obtained, as was current HbA_{1c} (A1C) level. These behaviors included frequency of self-monitoring of blood glucose, frequency of insulin injections, and level of insulin adjustment for diet and exercise. Level of insulin adjustment was rated as either 0 (no adjustment), 1 (beginner), or 2 (advanced). Patients were rated as beginners (level 1) if they adjusted their insulin according to a correction dose or scale but did not adjust for diet or activity. They were rated as advanced (level 2) if they did anticipatory adjustment for diet and activity (Table 1).

A retrospective chart review was done to obtain similar diabetes self-management information at entry to the Diabetes and Pregnancy Program and at delivery. Self-care behaviors, along with A1C, were compared from entry to the program, to delivery, and to the present. As well, basic demographic data were obtained including age, duration of diabetes, diabetes complications, and information regarding prepregnancy planning. Two authors reviewed the charts (D.S.F. and B.C.) independently, and the results were compared. When a disagreement was found, a final decision was made through consensus.

Face validity of the questionnaire was assessed by asking other health care professionals whether they agreed with the

From the [1]Department of Medicine, University of Toronto, Toronto, Ontario, Canada; the [2]Division of Endocrinology and Metabolism, Mount Sinai Hospital, Toronto, Ontario, Canada; and the [3]Department of Health Policy, Management, and Evaluation, University of Toronto, Toronto, Ontario, Canada.

Address correspondence and reprint requests to Dr. Denice Feig, Mount Sinai Hospital, 600 University Ave., Lebovic Building, Suite 5027, Toronto, Ontario, Canada, M5G 1X5. E-mail: d.feig@utoronto.ca.

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A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Criteria for level of adjustment*

Level 1 insulin dose adjustment (any one of the following two statements)
Client follows instructions of VIDS
Client may make appropriate supplemental adjustments but they are not based on pattern recognition.
Level 2 insulin dose adjustment (any one or more of the following three statements)
Client recognizes patterns in blood glucose and makes necessary dose adjustments.
Client makes appropriate anticipatory and supplemental adjustments for food and activity changes based on previous patterns.
Client changes aspects of the VIDS independently based on patterns.

VIDS, variable insulin dose scale.

definitions used for the level of insulin adjustment. Modifications to the definitions were made based on the feedback.

Statistical analysis

Descriptive statistics were computed for the entire sample and for type 1 and 2 diabetic subjects separately. Continuous variables were compared between these two groups with a two-sample *t* test, and binary variables were compared with Fisher's exact test. Changes in self-management behaviors and insulin injection frequency between entry and delivery were analyzed with McNemar's test. Changes in A1C between entry and delivery and between delivery and the present were assessed with a paired *t* test. *P* values <0.05 were treated as significant. All analyses were carried out in S-Plus 6.1 Professional (Insightful, Seattle, WA).

RESULTS — There were 69 patients seen in the Diabetes and Pregnancy Program over 10 years. Of these, five patients were excluded because they delivered before 20 weeks. Of the 64 patients, 39 patients had type 1 diabetes and 25 had type 2 diabetes. Data from four patients were included during their pregnancy but could not be located to include in the postpartum data set. At the time of the interview, patients were on average 2.63 years after delivery (range 0.95–8.01).

Patient demographics on entry to the program are shown in Table 2. The patients with type 2 diabetes tended to be older than patients with type 1 diabetes (32.7 vs. 29.1 years, $P < 0.01$). The average duration of diabetes for women with type 1 diabetes was 12.4 years, compared with only 3.5 years for women with type 2 diabetes ($P < 0.001$). Approximately 50% of women with type 1 diabetes had microvascular complications (51% with retinopathy, 28% with nephropathy, 16% with hypertension). In contrast, only 8% of women with type 2 diabetes had retinopathy, whereas 16% had some evidence of nephropathy. Interestingly, more women with type 2 diabetes had hypertension at entry to the Diabetes and Pregnancy Program (21 vs. 16%, NS).

Entry to the Diabetes and Pregnancy Program to delivery

All diabetes self-management behaviors improved significantly from entry to the program to the time of delivery. A significant number of women had increased the frequency of self-monitoring of blood glucose by delivery, i.e., 70.6% were monitoring more frequently and 27.5% were monitoring the same, whereas only 2.0% were monitoring less frequently (95% CI of proportion that improved: 56.17–82.51%, $P < 0.001$ by McNemar's test) (Fig. 1). Before pregnancy, only 42% of women with type 1 diabetes were on a multiple-dose insulin regimen of three to four injections per day; however, this rose to 100% by the time of delivery ($P < 0.0001$). Regarding insulin adjustment, 42.6% who were rated as "never, unknown, rarely, or sometimes" doing insulin adjustment at entry had improved to "always" adjusting insulin by the time of delivery ($P = 0.0001$) (Fig. 2). Regarding level of insulin adjustment, 53.7% of those rated as level 0, level 1, or unknown at entry (0 = no adjustment, 1 = beginner) were rated as level 2 (advanced) by delivery ($P < 0.0001$). A1C also improved significantly from entry to delivery: mean A1C entry 0.073 (0.041–0.065) vs. 0.060 (0.041–0.065) at delivery ($P < 0.0001$).

Entry to the Diabetes and Pregnancy Program to the present

The frequency of insulin injections improved significantly (calculated for women with type 1 diabetes only) from entry to the present: 48.6% who injected only once or twice per day at entry to the program were now injecting three to four times per day ($P = 0.0004$). Frequency of insulin adjustment improved significantly (calculated for women on insulin before pregnancy): 19.9% who were rated as "never, unknown, rarely, or sometimes" at entry improved to "always" adjusting insulin at present ($P = 0.004$). Level of adjustment also improved significantly: 48.1% of those rated as level 0, level 1, or unknown at entry (0 = no adjustment, 1 = beginner) were rated as level 2 (advanced) at present ($P = 0.0032$). However, there was no significant change in frequency of self-monitoring of blood glucose ($P = 0.766$) from before pregnancy to the present (Fig. 1), and A1C significantly worsened by 0.015 ($P < 0.0001$, 95% CI 0.009–0.021) from entry to the program to the present.

CONCLUSIONS — We examined the effect of an intensive diabetes management program during pregnancy on patients' self-management behaviors and glycemic control from entering the program to delivery and in the long term (≥1

Table 2—*Demographic characteristics (at entry to pregnancy program)*

	All patients	Type 1 diabetic patients	Type 2 diabetic patients
n	64	32	25
Age (years)	30.52 ± 5.45	29.12 ± 5.43	32.68 ± 4.82*
Duration of diabetes (years)	8.92 ± 7.54	12.38 ± 7.24	3.52 ± 4.03†
No retinopathy	65.6	48.7	92.0
Background retinopathy	23.4	35.9	4.0
Proliferative retinopathy	11.0	15.4	7.9
No nephropathy	76.6	71.8	84.0
Microalbuminuria	14.0	18.0	8.0
Proteinuria	9.3	10.2	8.0
Hypertension	17.2	15.8	21

Data are means ± SD or percent. *$P < 0.01$, †$P < 0.001$.

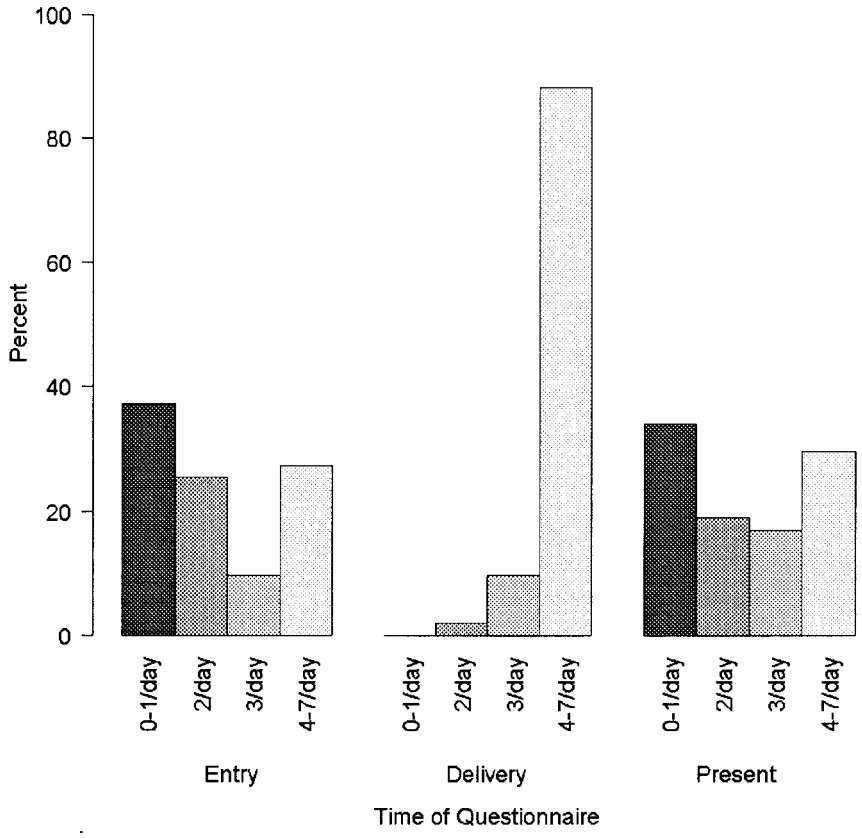

Figure 1—*Frequency of self-monitoring of blood glucose by study time in women at three time points: entry into the program, at the time of delivery, and at present (1–5 years postpartum). The proportion that improved from entry to delivery was 70.6% (entry vs. delivery, P < 0.001). There was no significant change in frequency of self-monitoring of blood glucose from before pregnancy to the present (entry vs. present, P = 0.766).*

year postpartum). Women participating in this program improved significantly from entry to delivery in their diabetes self-management behaviors and glycemic control. They increased their frequency of self-monitoring of blood glucose and used a multiple-dose insulin regimen. More women adjusted their insulin and did so at a higher level of complexity, i.e., adjusted not just according to a scale but also took into account food and activity. Other studies have shown that patients who can respond to glucose readings by modifying insulin doses improve glycemic control (1–4). This kind of success in pregnancy is not surprising because our experience has shown that women are highly motivated during pregnancy to maintain good glycemic control. Pregnancy also provides a longer, more intense self-management educational experience than other intensive management programs, since women are followed more frequently (every 2 weeks) and for a longer period of time (≥9 months depending on whether they receive prepregnancy counseling). Most high-risk pregnancy programs have achieved this kind of success with a multidisciplinary team working together (5–7); however, little is reported about their long-term impact.

We found that women did retain some of these self-management behaviors in the long term. Compared with their behaviors at entry to the program, more women continued with a multiple-dose insulin regimen, and more women continued to adjust their insulin and continued to do so at a higher level of complexity. However, this was not reflected in improved glycemic control. In fact, the glycemic control worsened compared with entry to the program. This comparison is limited by the fact that most of the women who entered the program were already pregnant; therefore, part of their glycosylated hemoglobin would have reflected time in pregnancy. Also, some women may have been trying for excellent glycemic control as part of prepregnancy planning. However, with the continued self-management behaviors and better knowledge, we expected to see better glycemic control in the long-term. A similar observation was noted in another retrospective study that documented a rapid deterioration in glycemic control, back to prepregnancy levels by 6–12 months postpartum in 30 women with type 1 diabetes (8).

The lack of better glycemic control may be largely explained by a discontinuation of frequent self-monitoring of blood glucose and emphasizes the importance of this essential behavior. Even if women are willing and able to adjust insulin doses according to food and activity, self-monitoring of blood glucose is also needed to allow for adjustment according to ambient blood glucose. A correlation between glycosylated hemoglobin and self-monitoring of blood glucose frequency has been shown in several studies of patients with either type 1 or type 2 diabetes (9–13). In a prospective trial of insulin-treated patients with type 1 and type 2 diabetes, there was a negative correlation between A1C and number of glucose tests per day, with significantly lower levels in patients who tested twice or more per day (14). In a cohort study of patients with type 1 diabetes seen in a managed care organization, self-monitoring of blood glucose (three or more times per day) was associated with a significant decrease in A1C (1.0 percentage point), even after adjusting for several demographic and socioeconomic variables (15). This same association was also found in pharmacologically treated patients with type 2 diabetes and those on diet alone.

The lack of sustained improvement in glycemic control may also relate to the lack of reinforcement through frequent contact with the diabetes team. It is difficult to sustain self-care behaviors over the long term, and relapse is a common problem. In a systematic review of randomized controlled trials of self-management training in patients with type 2 diabetes, interventions that focused on acquisition of knowledge had beneficial effects on glycemic control in the short term but mixed results with a follow-up >1 year (11). Some studies with prolonged interventions that used regular patient contact did show improved glycemic control; however, several others could not demonstrate a benefit despite the maintenance of contact (16). Other factors may need to be continuously addressed to achieve long-term behavioral change, including patient attitude and motivation, patient readiness for change (13,17), self-efficacy

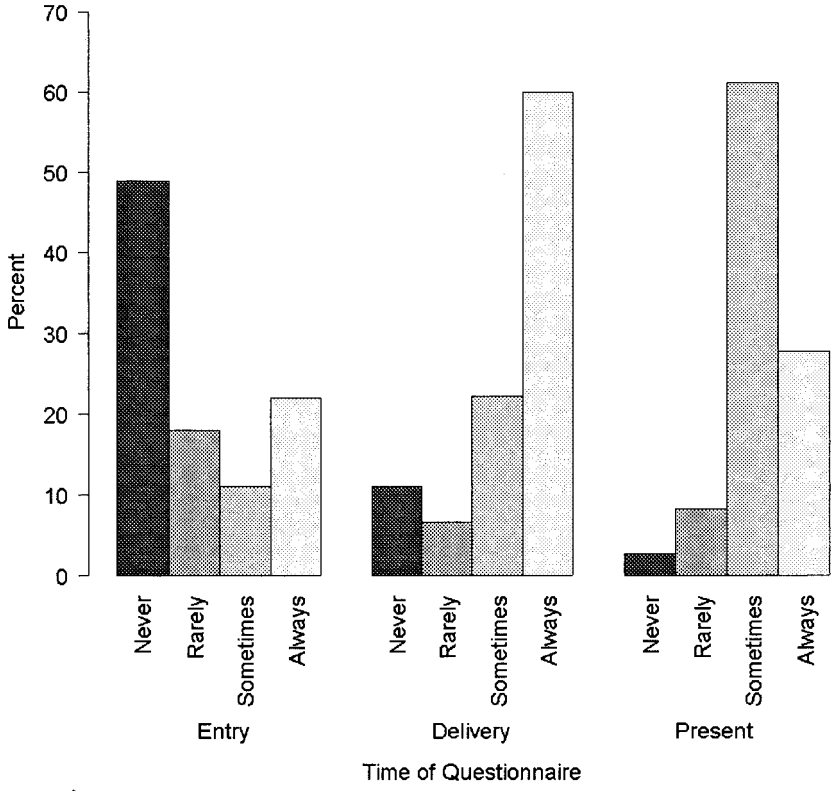

Figure 2—*Frequency of insulin dose adjustment by study time in women at three time points: entry into the program, at the time of delivery, and at present (1–5 years postpartum). Proportion that improved to "always" adjusting insulin from entry to delivery was 42.6% (entry vs. delivery,* P = *0.0001). Proportion that improved to "always" adjusting insulin from entry to present was 19.9% (entry vs. present,* P = *0.004).*

and active coping behavior (18), and social supports (16,19).

Maintenance of self-care behaviors in this population of young mothers may also not be realistic or feasible. Some researchers suggest that full functional status as defined as "complete assumption of the desired or required infant care responsibilities and the resumption of self-care, household, social/community, and occupational activities at the predelivery level" (20) may take 3–10 months and may never be achievable by some women (21). In a study by McVeigh (22) investigating the functional status of 200 women after delivery, only 0.7% of women had reached their desired level of function for self-care by 6 months, and none of the mothers achieved full functional status by 6 months. For many mothers, the first months after giving birth are fraught with personal and family stress (23). They often do not have the traditional supports from extended families that women had in previous generations (24). McVeigh also found that women not only assume primary responsibility for infant care, but also resume most aspects of role activities in which they engaged before delivery. This suggests that women are working harder after giving birth, not simply changing roles. In such a setting, it is not surprising that self-care may not be a priority. As health care providers, we need to be aware of these stresses faced by new mothers and incorporate social and emotional support for them along with support for diabetes care.

In summary, women participating in an intensive diabetes management program during pregnancy improve significantly from entry to delivery in diabetes self-management behaviors and glycemic control and retain some of these behaviors in the long term; however, this is not reflected in long-term maintenance of optimal glycemic control. This result may be explained by not continuing frequent self-monitoring of blood glucose, lack of follow-up support, and focus on the baby's health rather than the mother's health in women with young children. Future research should examine strategies to assist women to maintain their health, including excellent glycemic control, in the early postpartum years.

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