



CANADIAN *diabetes*

Moving Up a Level

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EDITORS' NOTE

Diabetes is characterized by insulin deficiency. In type 1 diabetes, loss of insulin production may be rapid and profound with life-threatening consequences. In type 2 diabetes, loss of insulin production is slower, but progressive and relentless (1). In type 1 diabetes with almost total loss of insulin production, intensive management with basal-bolus insulin or insulin pump therapy is recommended by the Canadian Diabetes Association clinical practice guidelines (2). At the time of diagnosis of type 2 diabetes, about 50% of maximal insulin-producing ability has been lost, and this loss continues at a rate of approximately 5% per year. When insulin production declines to approximately 20% of maximum (± 6 years from diagnosis), the individual with diabetes becomes metabolically unstable, glucose levels and glycated hemoglobin (A1C) start to rise into double digits, and insulin is required to restore control.

Unfortunately, in Canada we are reluctant to initiate insulin. In 2003, the Diabetes In Canada Evaluation (DICE) study (3) showed that the average length of time between diagnosis of diabetes and initiation of insulin therapy was over 10 years. In 2010, the SOLVE study showed that our behaviour had not improved in the ensuing 7 years, and it still takes an average of 10.2 years between onset of diabetes and insulin initiation (4). Unfortunately, our reluctance to initiate and titrate insulin therapy is one of the main reasons that only approximately 50% of persons with diabetes in Canada achieve a target of A1C $<7\%$ (3).

Dr. Alice Cheng discussed insulin initiation in the spring 2011 issue of *Canadian Diabetes* (5). She discussed how insulin initiation is safe and effective. The importance of starting insulin early when glucose control can no longer be achieved with oral agents and lifestyle was discussed. She also emphasized the need to keep adjusting the insulin dose as needed to achieve a fasting glucose target of 4 to 7 mmol/L.

This issue of *Canadian Diabetes* takes us past this point of insulin initiation to look at what we need to do when we have managed to achieve fasting glucose levels of 4 to 7 mmol/L, but A1C remains

above 7%. Dr. Stuart Ross leads us through the intensification of insulin. He points out that physiologic insulin secretion is biphasic; that is, there is a fairly steady background secretion of basal insulin throughout the day, with other peaks of insulin secretion associated with meals, referred to as bolus insulin. Initially, we are able to achieve glycemic control with basal insulin alone, but as insulin deficiency becomes progressively more profound due to ongoing beta-cell failure, we need to add mealtime insulin. As Dr. Ross points out, there are many different ways to provide for both basal and bolus needs (such as using pre-mixed insulin). Ultimately, with ongoing progressive pancreatic failure, we reach a point where we need basal-bolus insulin replacement, similar to that which is needed for individuals with type 1 diabetes. It may, therefore, be easier to make a logical transition from basal insulin alone to "basal plus" (with short-acting insulin at the largest meal of the day), and then progress to insulin at each meal with or without high glucose corrections, as needed.

While some of our patients with diabetes may have special needs and could benefit from compromises such as pre-mixed insulins; for the majority, it is better to progress to basal-bolus insulin because it gives the flexibility to adjust to progressively increasing insulin deficiency. We start intensification by adding a mealtime dose of short-acting insulin analog, aspart (NovoRapid), glulisine (Apidra) or lispro (Humalog) at the largest meal of the day. We may start at an arbitrary dose of 3 to 5 units with the meal, and then titrate up this mealtime dose until generally 4 hours later (at the next meal or bedtime) glucose levels have returned to the normal level (4 to 7 mmol/L). If despite this basal plus approach we still have not achieved the glycemic target of A1C $<7\%$, then we can add bolus insulin at the next meal and, ultimately, to the third meal. We can start the mealtime bolus dose from 3 to 5 units, then increase in 1 unit increments every few days

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until we achieve normal glucose values 4 hours after the meal (or before the next meal). If we have titrated up the bolus insulin dose at each meal and have still not reached an A1C target <7%, it may be necessary to add a high glucose correction for each meal to correct preprandial hyperglycemia. Alternatively we can use regular human insulin as the mealtime insulin; it has a cost advantage over the rapid acting analogues and, in type 2 diabetes where there is still some endogenous insulin production, it may provide adequate control. The problem with regular insulin is that it needs to be given about 30 minutes before a meal; it peaks about 2 to 4 hours after injection; so in an individual with severe insulin deficiency, it may not adequately cover the immediate postprandial period, and the peak effect may lead to hypoglycemia by 3 to 4 hours after injection.

While each person has different insulin sensitivity, a common glucose–correction algorithm is shown in Table 1.

Table 1. High/low glucose correction	
Preprandial glucose (mmol/L)	Action
<4.0	Subtract 2 units from the mealtime bolus
4.0–5.0	Subtract 1 unit from the mealtime bolus
5.1–7.0	Use planned mealtime bolus dose
7.1–8.0	Add 1 unit to the mealtime bolus
8.1–9.0	Add 2 units to the mealtime bolus
9.1–10.0	Add 3 units to the mealtime bolus
10.1–11.0	Add 4 units to the mealtime bolus
>11.0	Add 5 units to the mealtime bolus

When we reach this point, we are providing full basal-bolus insulin support, which is similar to what we do in type 1 diabetes. The reason for the intensification is that insulin production has continued to decline. In the absence of endogenous insulin production, basal-bolus insulin is required to mimic normal physiology. The insulin pump is one way of providing this basal-bolus support. In Canada, 20% to 30% of patients with type 1 diabetes use an insulin pump. Several Canadian provinces, including Ontario, Newfoundland, Quebec and British Columbia support the cost of insulin pump therapy, at least for pediatric patients, as this form of intensive therapy has been shown to achieve better glycemic control and results in a decreased toll to complications.

While the pump is only a device for the injection of insulin and does not function automatically to control glucose levels, it does offer some advantages compared to basal-bolus therapy with an insulin pen or syringe. The first advantage is the ability to have

different basal rates throughout the day. Basal insulin needs are often lowest during the early hours of sleep (10 PM to 4 AM), then dramatically increase during the early morning hours (4 to 8 AM) as growth hormone secretion peaks and the dawn phenomenon occurs. It is only with an insulin pump that we can provide for these different basal needs throughout the day. With most insulin pumps, a paired glucose meter may report wirelessly to the pump. One can then use mathematical formulae built into the pump to determine bolus or high glucose correction insulin needs. While the pump may do the calculations, there is still the need for the human interface to approve and start the insulin dosing.

Dr. Robyn Houlden has pointed out that pump use—particularly in type 1 diabetes—is increasing, so as physicians in the emergency room (ER) or in patient settings, we are inevitably going to deal with more patients with insulin pumps. Most people on insulin pump therapy become very capable of using these devices to precisely control glucose levels and are usually better than many healthcare professionals at running their pumps. In most circumstances, people with an insulin pump in an outpatient or inpatient setting can be permitted to do their own glucose monitoring and insulin adjustments, but it needs to be done in cooperation with hospital staff and a full interchange of information so that hospital staff know what the glucose results are and what action is being taken.

As these devices become more common, we need to have capable hospital staff familiar with insulin pumps, and have the proper procedures and policies in place to allow cooperative pump management. Usually, whatever the circumstances in hospital, the patient's normal basal rate can be continued and, if normal meals are being taken, then we can follow the patient's previously determined bolus and adjustment doses. If the patient is nil per os or on intravenous (IV) fluids (with no carbohydrate content), then only basal insulin is needed, though frequent monitoring still needs to be done, and high or low glucose corrections applied. If hypoglycemia occurs in an individual who cannot eat, we can suspend or give a temporary basal rate reduction until glucose levels return to normal.

With people on an insulin pump presenting to the ER with hypo- or hyperglycemic emergency, we need to have experienced staff who are trained in pump use on duty or rapidly available and adequate hospital policies to provide a framework for responsibilities of treatment. At the very least, emergency staff need to know how to react to pump patients—how to work back from their total daily dose (TDD—basal doses and usual meal boluses and corrections factors) to substitute basal bolus insulin for them if the

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patient is not well enough for self-care. For hypoglycemic emergencies, the pump is usually placed in a suspend mode while usual glucose-raising measures are taken of oral ingestion of carbohydrate where possible, or use of glucagon or IV glucose. We need to remember that the insulin pump delivers only rapid-acting insulin, so if the pump is not functioning or is suspended, then hyperglycemia and ketoacidosis can start very rapidly. As soon as the hypoglycemic emergency has been adequately treated, basal insulin delivery needs to be resumed through the pump or by injection.

In hyperglycemic emergencies, the first thing to do is to establish normal glucose levels by administering short-acting insulin analogues using a pen or syringe or use of IV regular insulin and fluids if very ill. Frequently, the cause of hyperglycemia is the failure of the pump to deliver insulin due to pump failure, blockage or disconnection, but because of the short space of time before ketoacidosis occurs, we should not waste time trying to troubleshoot the pump, but rather give the needed insulin. When glucose levels have returned to normal we can troubleshoot the problem with the assistance of the patient, who is often the most proficient in pump use.

Insulin pumps are a useful alternative for insulin administration in people with type 1 diabetes or advanced type 2 diabetes who have severely compromised insulin production. In most cases, people who have insulin pumps are well trained and can solve problems; however, there are circumstances where assistance is needed from trained hospital personnel. It is essential for us to have trained staff and policies in place to allow us to capably assist these people with diabetes in our modern healthcare institutions.

REFERENCES

1. Stratton IM, Adler AI, Neil HAW, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. *BMJ*. 2000;321:405-412.
2. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2008 clinical practice guidelines for the prevention and management of diabetes in Canada. *Can J Diabetes*. 2008;32(suppl 1):S1-S201.
3. Harris SB, Ekoe J, Zdanowicz Y, Webster-Bogaert S. Glycemic control and morbidity in the Canadian primary care setting. Results of the Diabetes In Canada Evaluation Study. *Diabetes Res Clin Pract*. 2005; 70:90-97.
4. Ross SA, Yale JF, Conway JR. SOLVE—a multinational, observational study to evaluate insulin detemir added to OADs in insulin-naïve patients with type 2 diabetes: baseline characteristics from the Canadian cohort. *Can J Diabetes*. 2010;34:272. Abstract 98.
5. Cheng AYY. The rules of 3's: insulin use in type 2 diabetes. *Can Diabetes*. 2011;24(1):3-9.

Insulin Therapy: Taking Care to the Next Level

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WHY BOTHER?

Why bother, indeed. As the decision to intensify management is being made, it must be remembered that diabetes is a progressive disease that can be managed by achieving well-established glucose targets. Recent major clinical trials have emphasized the importance of reaching these targets to help prevent the long-term vascular complications of diabetes. The United Kingdom Prospective Diabetes Study (UKPDS) (1) examined the benefit of intensive glucose management from the moment of diagnosis and provided some of the most valuable information we have on the long-term management of type 2 diabetes. Similarly, the Diabetes Control and Complications Trial (DCCT) (2) in type 1 diabetes emphasized the value of reaching glucose targets in preventing vascular complications. The subsequent long-term follow-up of these studies, the UKPDS legacy study (3) and the Epidemiology of Diabetes Interventions and Complications (EDIC) trial (4), both emphasized the benefit of early, aggressive management of both type 1 and type 2 diabetes in preventing or delaying vascular complications.

Subsequent long-term intensive glucose control studies, such as Action in Diabetes and Vascular Disease: Preterax and Diamicon MR Controlled Evaluation (ADVANCE) (5), Veterans Affairs Diabetes Trial (VADT) (6), and Action to Control Cardiovascular Risk in Diabetes (ACCORD) (7), all provided additional evidence on the benefits of intensive management of type 2 diabetes.

Despite the strength of the studies, it is apparent that the glucose targets that have been well described and published (8) are not being met. Data from the Diabetes In Canada Evaluation (DICE) study (9) demonstrated that not only are 50% of patients with type 2 diabetes not reaching the stated glycated hemoglobin (A1C) targets, but also that appropriate therapies are being delayed and often not used. These results were further substantiated by the Braga data (10), which also identified that intensive treatment programs were not being used in Canadian patients with type 2 diabetes and that glycemic targets were not being met. A recent study further emphasized the long delays in initiating insulin being observed in Canadian patients with type 2 diabetes. A mean 10.3-year delay was seen between the time of diagnosis and initiating insulin despite a mean A1C value of 9% at the time of commencing the insulin (11).

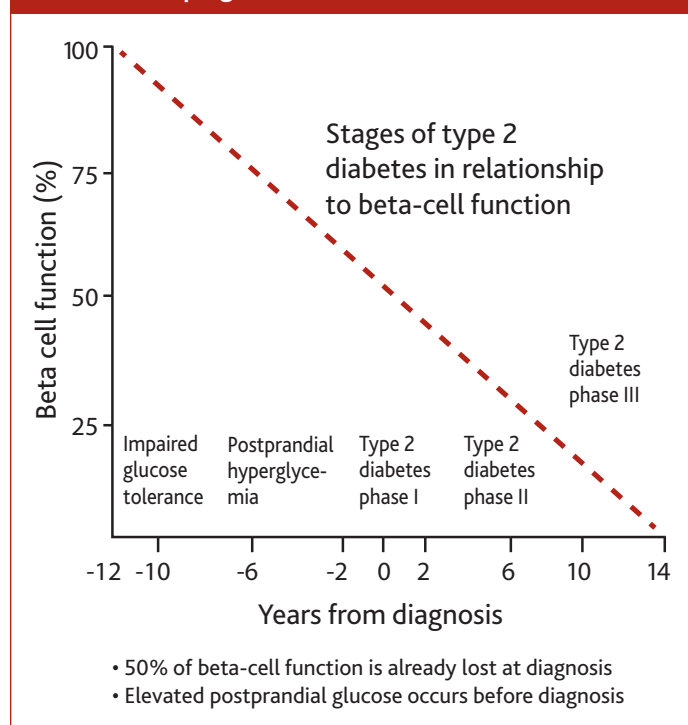
UNDERSTANDING THE CHANGES IN INSULIN SECRETION IN TYPE 2 DIABETES

In the person without diabetes, there is a constant secretion of insulin over a 24-hour period often referred to as basal insulin. This basal release of insulin acts as a platform for the release of bursts of insulin, which are released in response to food intake and help control glucose in the postprandial phase.

Type 2 diabetes, it must be recognized, is a progressive disease (1). It is estimated that when glucose levels rise to the point that diabetes is diagnosed (fasting plasma glucose [FPG] >7 mmol/L or postprandial glucose [PPG] >11.1 mmol/L [4]) that 50% of insulin-producing ability has been lost and this functional impairment continues at a rate of about 5% per year on average. When maximal insulin output has decreased to 15% or 20% of normal (6–8 years after diagnosis), glycemic control can no longer be achieved with oral hypoglycemic agents and metabolic instability occurs with increasing glucose levels. At this point, insulin supplementation is required to achieve control. In her article published in the spring 2011 issue of *Canadian Diabetes*, Dr. Alice Cheng described the initiation of insulin with basal (long-acting) insulin together with oral agents, but as insulin deficiency

continues to progress, a point is reached where glycemic control (A1C $\leq 7\%$) can no longer be maintained using basal insulin and oral agents (12). At this point, the introduction of rapid-acting insulin to meet insulin needs with meals is required. This article is concerned with the addition of rapid-acting insulin to cover meals when basal insulin alone is insufficient to achieve control.

Figure 1. Type 2 diabetes is characterized by insulin resistance and progressive beta-cell failure



Adapted with permission from Lebovitz HE. Insulin secretagogues: old and new. *Diabetes Review*. 1999;7:139-153.

As shown in Figure 1, loss of beta-cell function will continue, and within 10 years of diagnosis of type 2 diabetes, much of the beta-cell response has been lost (13). The physiologically normal basal levels of insulin will fall, and there will be an inadequate response to food ingestion. In addition, the traditional early, first-phase insulin response to food, which helps control PPG, will be lost.

The reduction in basal insulin will lead to a rise in FPG, and the inadequate response of insulin to food will lead to a rise in PPG. It must be remembered that the A1C measurement represents the contribution of both the FPG and the PPG (14). FPG is the major contributor to elevated A1C, but as the A1C value falls below 8%, PPG is the major contributor. Thus, based on the A1C value, we can select therapies that primarily affect either FPG or PPG levels to improve A1C control.

ACHIEVING GLYCEMIC TARGETS

The Canadian Diabetes Association clinical practice guidelines are quite clear as to the targets that should be strived for in diabetes management (8). Appropriate lifestyle changes should be immediately implemented at the time of diagnosis and reinforced at all times. If these measures fail and A1C targets are not met within 3 months of diagnosis, the guidelines recommend early intervention with oral antihyperglycemic agents and/or insulin. If oral antihyperglycemic agents do not achieve the appropriate A1C target, then insulin will be required. As recently reviewed, introduction of a basal insulin regimen can achieve a dramatic decrease in A1C values that may well reach the target of $\leq 7\%$ (12). Recent trials using the early administration of insulin in the disease process have emphasized both the ease of reaching glycemic targets and patient satisfaction with the insulin (15).

The introduction of basal insulin must represent the beginning of a more intensive approach to insulin therapy. With the decreasing beta-cell response, not only will basal insulins be required, but in addition, rapid-acting insulin prior to meals will be necessary to achieve both FPG and PPG control and, thus, a reduction in A1C.

WHY ARE GLUCOSE TARGETS NOT REACHED?

Barriers to commencing insulin or intensifying therapy exist on the part of both the healthcare provider and patient. Several potential barriers tend to dominate: the risk of hypoglycemia; weight gain; difficulty in initiating the insulin regimen; patient embarrassment at the potential need to administer insulin in public; and the concept that intensive management of diabetes is in some way dangerous. And yet, with appropriate education, modern insulins and simple insulin delivery systems, all these barriers can easily be overcome.

For the person with type 2 diabetes, one of the major barriers to reaching glucose targets remains hypoglycemia. Despite the fact that many patients with diabetes would experience less hypoglycemia with the newer insulin analogues, many remain on the older-type insulins. In addition, a reluctance to use glucose monitoring as a technique for prospectively planned insulin doses further leads to higher risk of hypoglycemia. While the target A1C remains $\leq 7\%$ for the person with type 2 diabetes, in some patients this is an unattainable goal because of other aspects of their disease. Thus, A1C targets must be set for each individual patient.

The role of education cannot be underestimated. If the patient is advised which insulins would be most advantageous and how

to use them, the issues of excessive weight gain and difficulties in managing their program can be reduced and even eliminated.

WHEN TO INTENSIFY INSULIN THERAPY

Step 1: Assessment

Basal insulin administration is designed to achieve the FPG glycemic target, which is 4 to 7 mmol/L. To reach this target, the basal insulin dose must be titrated. Once the FPG target has been attained, and if the A1C value remains elevated at >7%, then an assessment of the PPG values must be made. The goal will be a PPG <8 mmol/L. By measuring PPG 2 to 3 hours after a meal, it can quickly be determined if this target is being reached. These measurements will also establish after which meals the PPG value is elevated above the target. For example, PPG may be consistently elevated after the largest meal of the day, but not following other meals.

Step 2: Intensification—type 2 diabetes

Once the FPG target of 4 to 7 mmol/L has been reached using basal insulin, an assessment must be made of the PPG values throughout the day. Self-glucose monitoring measurements can be made 2 to 3 hours after meals to determine whether the largest meal of the day and/or other meals have glucose values above the target of 8 mmol/L.

Once it has been determined which meals are associated with an elevated PPG, then rapid-acting insulin can be introduced prior to the meal and titrated to achieve the target glucose value of <8 mmol/L. To simplify the titration for the person requiring intensification of insulin administration, the first dose of rapid-acting insulin can be introduced prior to the largest meal of the day. The dose can then be titrated to achieve the target value. Again, a simple assessment of PPG after the other meals can be used to quickly determine whether additional rapid-acting insulin will be required before those meals where the PPG is elevated.

If it is not practical for the patient to measure PPG, then the glucose level prior to the next meal will give a good indication of the presence of hyperglycemia, with a target glucose value of 4 to 7 mmol/L.

WHICH INSULINS?

Rapid-acting insulin analogues

The rapid-acting insulin analogues—insulin aspart, insulin lispro and insulin glulisine—provide several advantages over regular human insulin: they can be given immediately prior to a meal, with a meal or just after a meal, and provide a more dependable and faster action than regular human insulin.

Multiple clinical trials have been conducted in which rapid-acting insulin has been added to a basal regimen. The studies have demonstrated the ease of intensifying the insulin regimen to achieve glucose targets both safely and efficiently. In the Treating To Target in Type 2 diabetes (4-T) study (16), one of the treatment arms used the initial administration of a long-acting basal insulin, insulin detemir (Levemir), which was then followed by intensification with insulin aspart. Investigators achieved a decrease in A1C of 1.2% and a median A1C of 6.9%. In all, 63% of the participants attained an A1C below 7% but only 0.9% experienced major hypoglycemia. Similarly, in the TITRATE study (17) an intensive treat-to-target protocol safely and effectively achieved A1C targets in the majority of participants. Other studies using glulisine or lispro have provided insulin algorithms that allow for the development of simple clinical programs to intensify bolus insulin regimens (18,19).

One such program is the Stepwise approach (20). This method uses a simple titration regimen that allows a patient to individually titrate the insulin dose to achieve glucose targets (Table 1):

Table 1. Adding rapid-acting insulin to a basal regimen (20)

- Titrate basal insulin to achieve FPG <7 mmol/L.
- Start 4 units of rapid-acting insulin before the largest meal of the day.
- Titrate dose to achieve a glucose value of 4–7 mmol/L before the next meal or bedtime.
- Add 4 units of rapid-acting insulin before the second-largest meal of the day if A1C remains elevated or glucose value before next meal is >7mmol/L.
- Titrate dose to achieve a glucose value of 4–7 mmol/L before the next meal.
- Add 4 units of rapid-acting insulin before the third meal of the day if A1C remains elevated or glucose value before next meal is >7mmol/L.
- Titrate dose to achieve a glucose value of 4–7 mmol/L before the next meal.

- Step 1: 4 units of rapid-acting insulin is given immediately prior to the largest meal of the day.
- Step 2: Using self-glucose monitoring, the plasma glucose prior to the next meal, or before bed if insulin is given before evening meal, is then measured. If the glucose value is >7 mmol/L, then 1 unit of rapid-acting insulin is added to the dose the following day, before the meal. If the glucose value is <4 mmol/L, then the insulin dose is reduced by 1 unit the next day. The titration continues until the target glucose has been met.

- Step 3: After the first bolus dose has been optimized, but the A1C remains elevated, then a second bolus is added before the second-largest meal of the day, commencing with 4 units before the meal and measuring glucose prior to the next meal. Titration of the insulin will be continued, as described with the first bolus.
- Step 4: After the second bolus dose has been optimized, but the A1C value remains elevated, then the third bolus can be added before the third meal and titration continues as described.

Premixed insulins

These insulins allow the patient to have the benefit of a longer-acting insulin as well as a faster-acting insulin combined in one injection. Good glucose control can be obtained over a 24-hour period using the premixed insulins twice a day. The premixed insulins are available in a human insulin formulation—human regular/NPH insulin—as well as an insulin analogue formulation. The major disadvantage of the human insulin formulations is the risk of hypoglycemia related to the longer action of the regular insulin and a lack of predictability of the action of the NPH insulin.

Premixed insulin analogues offer some advantage because of their predictable time-action and reduced risk of hypoglycemia. Several formulations are available including premixed insulin lispro with 25% rapid-acting lispro and 75% intermediate-acting Protamine (Humalog Mix 25), insulin lispro 50/50 (Humalog Mix 50), and biphasic insulin aspart 30 (NovoMix 30) with 30% rapid-acting insulin aspart and 70% intermediate protaminated aspart. Clinical trials have demonstrated that a patient can be initiated on the premixed insulins commencing as an add-on to oral drug therapy or by substituting for a basal insulin (21). The safety and effectiveness of biphasic insulin aspart 30/70 (NovoMix 30) when switching from human premix insulin in patients with type 2 diabetes was examined in a subgroup analysis of the 6-month observational study of safety and effectiveness of NovoMix 30 for the treatment of diabetes (IMPROVE) (22). This study demonstrated that patients could be transferred from human premixed insulin to a premixed analogue insulin with significant improvements in glycemic control combined with a reduced risk of hypoglycemia. Algorithms are available to allow easy and safe titration of the premixed insulin to achieve established glucose targets (23, 24). A convenient and safe regimen is to commence with 10 units of the premixed insulin before breakfast and before

supper (Table 2). The prebreakfast insulin dose will affect the presupper glucose value and can be adjusted to achieve a presupper glucose value of <7 mmol/L. Similarly, the presupper glucose can be adjusted to provide target glucose values before breakfast. Hypoglycemic events are decreased with the premixed analogue insulins compared to human premixed insulin. Glucose monitoring can be kept to a minimum, measuring mainly at the key insulin adjustment time periods of prebreakfast and presupper. However, because of the rapid-acting component of premixed insulins, it is valuable to monitor glucose values prior to lunch and bedtime, to ensure that glucose values are not demonstrating the presence of hypoglycemia. If hypoglycemia is a problem at these times, then the morning insulin may need to be reduced and on occasions either a rapid-acting insulin or a small dose of the premixed insulin added at lunchtime to help prevent prelunch hypoglycemia with associated achievement of target glucose at suppertime.

Table 2. Initiating premixed insulin (23,24)

Initiating premixed insulin therapy in an insulin-naïve patient

- **Step 1:** Commence with 10 units of premixed insulin before breakfast and before supper.
- **Step 2:** Increase the prebreakfast insulin dose by 2 units every 2–3 days until presupper glucose is <7 mmol/L.
- **Step 3:** Increase the presupper insulin dose by 2 units every 2–3 days until prebreakfast glucose is <7 mmol/L.
- **Step 4:** Keep glucose monitoring requirements to a minimum measuring specifically before breakfast and before supper. It is valuable to occasionally check the prelunch and prebedtime glucose levels to ensure there is no evidence of hypoglycemia.

Initiating premixed insulin in a patient using basal insulin

- **Step 1:** Stop the basal insulin dose.
- **Step 2:** Divide the total basal insulin dose, giving half the dose as premixed insulin before breakfast and half the dose before supper.
- **Step 3:** Titrate premixed insulin doses before breakfast and before supper as described above.

INSULIN PUMP THERAPY

The development of highly sophisticated insulin pumps has provided the possibility of insulin pump therapy being available to patients with type 1 or type 2 diabetes. Continuous glucose-monitoring systems have further enhanced the ability to achieve

close to perfect glucose control throughout the 24-hour period. For a patient to be considered for pump therapy, it is important to establish that they fit certain criteria:

- Be knowledgeable about their diabetes management.
- Understand the concepts of insulin titration.
- Be prepared to do multiple glucose-monitoring tests throughout the day and to interpret these values.
- Understand the concepts of nutrition, particularly carbohydrate counting.
- Be relatively independent in their diabetes management.

Insulin requirements tend to be much higher in the insulin-resistant patient with type 2 diabetes and, thus, insulin algorithms need to be appropriately adjusted to achieve euglycemia.

ADJUSTMENT OF ORAL ANTIHYPERGLYCEMIC AGENTS

Many patients remain on combinations of oral antihyperglycemic drugs, such as metformin and sulfonylureas, when on basal insulin therapies. Once intensification using rapid-acting insulin has commenced, there is little need to continue with sulfonylurea therapies. Metformin can be continued at its current dose.

IS INTENSIVE MANAGEMENT SAFE?

While intensive glucose management has proven to be successful in reducing microvascular complications, the results are not so clear as relates to macrovascular disease. The ACCORD trial (7) attempted to rapidly reduce the A1C level to below 6%, but the intensive glucose-control arm of the study was terminated before the trial was completed because of higher all-cause mortality in this group. Fears were raised that even lowering A1C below 7% maybe harmful to patients with type 2 diabetes.

Further analysis of the data revealed that the increased mortality in ACCORD occurred mainly in patients who had responded poorly to intensive treatment, had higher A1C levels, were older, and had significant cardiovascular risk factors. Patients who commenced the study with lower A1C or quickly responded to intensive treatment appeared to be at less risk. Thus, an acceptable approach would be to identify patients who have poor glycemic control, who are older, and who have previously failed to respond to more intensive treatment. These patients would benefit from a more individualized approach and less aggressive glycemic targets. However, the data from ACCORD should not be used as an excuse to allow patients to remain in poor control or to not receive early, aggressive therapy, when appropriate.

NUTRITION

A thorough review of nutritional concepts is required before commencing insulin. Many patients may not, in fact, have had a recent review of their nutritional requirements, and with the commencement of insulin therapy, issues such as adjustment of food for activities, illness and changing insulin doses, must all be considered. Carbohydrate counting can be most useful in predicting the quantities of insulin that will be required for any particular meal. Some patients, however, are reluctant to go through the process of carbohydrate counting, but by using information gathered from PPG measurement, how much insulin is required for any specific type of food can be quickly established. Most patients will become quite proficient at assessing the quantity of insulin to be taken prior to a meal, given the type of food and activities planned after the meal.

EDUCATION

An effective educational program is essential before commencing insulin. Once the patient has learned the techniques of insulin injection, understanding the concepts of insulin adjustments will enable the patient to remain confident in making appropriate insulin dose changes to fit their varied lifestyle. Establishing a process of follow-up further enables the patient to learn the appropriate techniques of insulin adjustment and become increasingly independent in this self-management. Follow-up can be arranged by visits to the diabetes educator, but simple techniques—such as telephone calls and faxed information—permit easy interaction between patient and educator. Recently, the use of Internet data transfer has proved to be most successful in lowering A1C and keeping the time commitment of both patient and educator to a minimum (25).

With the increasing number of patients who will require insulin therapy, the development of effective, time-efficient educational programs with comprehensive follow-up can prove to be most beneficial.

SUMMARY

It is clear that there have been many barriers preventing patients from reaching established glycemic targets. Recent research emphasizes the importance of early, aggressive management, and this will certainly require the use of insulin. Early introduction of insulin therapy will make a difference to glucose control in the patient with type 2 diabetes. While basal insulin therapy will provide good glucose control early in the disease, with the progressive nature of type 2 diabetes, intensification of insulin will be required. The large selection of insulins and insulin algorithms available

to the healthcare provider ensures that good glucose control is possible in patients with type 2 diabetes and that glycemic targets can be met. While it is difficult to fully understand the delays that appear to take place in intensifying insulin therapy, there are now few barriers to prevent success.

When considering a patient for intensification of insulin, the answer now is quite clear: just do it!

REFERENCES

1. Stratton IM, Adler AI, Neil HAW, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. *BMJ*. 2000;321:405-412.
2. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med*. 1993;329:977-986.
3. Holman RR, Paul SK, Bethel MA, et al. 10-year follow-up of intensive glucose control in type 2 diabetes. *N Engl J Med*. 2008;359:1577-1589.
4. Writing Team for the Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Research Group. Effect of intensive therapy on the microvascular complications of type 1 diabetes mellitus. *JAMA*. 2002;287:2563-2569.
5. Patel A, ADVANCE Collaborative Group. Effects of a fixed combination of perindopril and indapamide on macrovascular and microvascular outcomes in patients with type 2 diabetes mellitus (the ADVANCE trial): a randomized controlled trial. *Lancet*. 2007;370:829-840.
6. Duckworth W, Abraira C, Moritz T, et al. VADT. Glucose control and vascular complications in veterans with type 2 diabetes. *N Engl J Med*. 2009;360:129-139.
7. Action to Control Cardiovascular Risk in Diabetes Study Group, Gerstein HC, Miller ME, et al. Effects of intensive glucose lowering in type 2 diabetes. *N Engl J Med*. 2008;358:2545-2559.
8. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2008 clinical practice guidelines for the prevention and management of diabetes in Canada. *Can J Diabetes*. 2008;32(suppl 1):S1-S201.
9. Harris SB, Ekoe J, Zdanowicz Y, Webster-Bogaert S. Glycemic control and morbidity in the Canadian primary care setting. Results of the Diabetes In Canada Evaluation study. *Diabetes Res Clin Pract*. 2005; 70:90-97.
10. Braga M, Casanova A, Teoh H, et al; Diabetes Registry to Improve Vascular Events (DRIVE) Investigators. Treatment gaps in the management of cardiovascular risk factors in patients with type 2 diabetes in Canada. *Can J Cardiol*. 2010;26:297-302.
11. Ross SA, Yale JF, Conway JR. SOLVE—a multinational, observational study to evaluate insulin detemir added to OADs in insulin-naïve patients with type 2 diabetes: baseline characteristics from the Canadian cohort. *Can J Diabetes*. 2010;34:272. Abstract 98.
12. Cheng AYY. The rules of 3's: insulin use in type 2 diabetes. *Can Diabetes*. 2011;24(1):3-9.
13. Lebovitz HE. Insulin secretagogues: old and new. *Diabetes Reviews*. 1999;7:139-153.
14. Monnier L, Lapinski H, Colette C. Contributions of fasting and postprandial plasma glucose increments to the overall diurnal hyperglycemia of type 2 diabetic patients: variations with increasing levels of HbA(1c). *Diabetes Care*. 2003;26:881-885.

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Self-Monitoring of Blood Glucose in People with Type 2 Diabetes

Self-management of diabetes remains one of the cornerstones of diabetes self-care. As such, Self-Monitoring of Blood Glucose (SMBG) is an important and essential tool for people living with diabetes, and should be individualized for each patient.

The Canadian Diabetes Association has developed three SMBG tools—one for healthcare providers and two for people living with diabetes—to not only identify SMBG recommendations

and pattern management for healthcare providers, but to provide essential information and education for patients for optimal self-management.

Building these tools into your practice and working with your patients on their individual needs for SMBG will ensure that they receive the best support and enable them to take effective action on their SMBG results.

For more information about SMBG and to download these tools, visit www.diabetes.ca/SMBG.

A Practical Guide to Insulin Pump Management in Adults In and Around Hospital

Jia Jia Ren MD, Robyn L. Houlden MD FRCPC

Insulin pumps have become increasingly more prevalent in the management of diabetes in recent years. Currently in North America, about 20% to 30% of patients with type 1 diabetes mellitus are pump users (1). As a result, non-diabetes specialists are encountering these patients throughout the healthcare system, including the inpatient setting. Ideally, hospital personnel knowledgeable in insulin pump therapy should be available to assist patients, and medical and nursing staff (2). However, many institutions currently lack this resource. This article is designed to help non-diabetes specialists manage patients on pump therapy in and around hospital.

THE BASICS OF INSULIN PUMP THERAPY

The insulin pump is a small, programmable, external battery-powered device that delivers rapid-acting insulin in tiny continuous amounts (basal doses) and in larger amounts for meals (bolus doses). Several different models of insulin pump are available. Most attach to the patient by an infusion set consisting of long, thin flexible tubing with a needle or catheter on the end that is inserted subcutaneously. Recently, a pump has become available where the pump with a very short infusion catheter both sit on the skin surface, held by an adhesive; this model of pump is controlled by a wireless controller.

The patient programs and operates the pump to deliver insulin doses that match their individual needs. The **total daily dose (TDD)** of insulin is typically 20% to 25% lower when taking insulin pump therapy compared with multiple daily injections. Of the reduced TDD, 40% to 50% is usually given as basal insulin and 50% to 60% as mealtime boluses. A target blood glucose range is programmed into the pump (e.g. 5.5 ± 1 mmol/L). The pump user either directly enters their current blood glucose value into the pump or has a glucose meter that remotely transmits the value into the pump.

The **basal dose** is initially developed by taking 50% of the estimated TDD divided by 24 to get an mean hourly rate, and fine tuned in response to blood glucose monitoring results. Many patients require a slightly lower basal rate in the early nocturnal

period, and a slightly higher rate in the early morning due to the dawn phenomenon.

The **mealtime bolus insulin dose** is usually calculated based on the carbohydrate content of the meal and the insulin-to-carbohydrate ratio of the patient. The insulin-to-carbohydrate ratio is the amount of carbohydrate in grams that is handled by a 1-unit dose of rapid-acting insulin. A common insulin-to-carbohydrate ratio is 1:10, which means that 1 unit of insulin will cover 10 grams of ingested carbohydrate. For example, the carbohydrate content of a single slice of bread is roughly 15 g, a medium-sized apple is about 25 g, and 250 mL (1 cup) of milk is about 12 g. Thus, a lunch of a sandwich, an apple and a glass of milk would be about $(15 \times 2) + 25 + 12 = 67$ g of carbohydrate. The insulin-to-carbohydrate ratio varies for different pump users, but is typically calculated initially as 500 divided by TDD. Ideally, blood glucose will increase by 2 to 4 mmol/L from before the meal to the postprandial peak and return to preprandial levels by 4 hours postprandial. The accuracy of the insulin-to-carbohydrate ratio can be evaluated by measuring blood glucose preprandial and at 2 and 4 hours postprandial. A person may use more than one insulin-to-carbohydrate ratio (e.g. a ratio of 1:10 for breakfast, 1:12 for lunch and 1:15 for dinner) based on physical activity and other variables.

Pump users also administer **correction doses** of insulin for blood glucose levels above their target using an insulin sensitiv-

ity factor (ISF). The ISF is the expected change in blood glucose from administering 1 unit of rapid-acting insulin. Similar to the insulin-to-carbohydrate ratio, the ISF varies for different pump users and typically ranges from 1 unit/0.5 mmol/L to 1 unit/4.0 mmol/L. The ISF can be calculated initially as 100 divided by the TDD. Once the ISF is programmed into the pump, the pump calculates the dose of insulin needed to normalize the current blood glucose level to the target range and displays the recommended correction bolus, which the patient then accepts or modifies. The accuracy of the ISF can be evaluated by tracking blood glucose 4 hours after a correction bolus, at a time during which no additional food or insulin is taken, by which time the expected blood glucose should be at the target level. In an inpatient setting, the ISF can be ordered as an insulin correction scale using the known ISF for that patient. For example, if the ISF equals 2, then for each 2 mmol/L above the target range, the patient would receive 1 extra unit of rapid-acting insulin (e.g. if the target range in hospital is 5 to 10 mmol/L and the patient's preprandial blood glucose is 14 mmol/L, they would receive an extra 2 units of insulin added to the meal bolus). Patients in hospital may frequently have greater insulin requirements due to increases in circulating concentrations of stress hormones, decreased physical activity, medications (e.g. glucocorticoids), or total or parenteral nutrition, and the ISF may have to be decreased. Table 1 summarizes the basic insulin pump settings.

SELF-MANAGEMENT

Patients on insulin pump therapy do not necessarily need to discontinue this type of therapy while hospitalized. They are often more knowledgeable than their healthcare providers about diabetes management and should be encouraged to self-manage their diabetes during hospitalization (3). However, to promote a collaborative relationship between the hospital staff and patient, and to ensure patient safety, hospitals should have clear policies and procedures in place to guide the continued use of insulin pumps in the inpatient setting (4).

COMPETENCY

Any patient admitted to hospital using an insulin pump should be assessed for their physical and mental competency to continue using their device. In addition, the patient should also have adequate insulin pump supplies, including infusion sets, reservoirs and batteries. If the patient is not deemed competent or does not have adequate supplies, the insulin pump should be discontinued and the patient placed on a subcutaneous insulin regimen or intravenous insulin infusion.

Occasionally, some patients may be dependent on family members to manage their insulin pump due to vision or coordination issues. These patients may be considered for continuation of insulin pump therapy in hospital as long as knowledgeable family

Target glucose range e.g. 5.0–6.5 mmol/L (some pumps display as 5.5 ± 1 mmol/L)	Most people on pumps program 1 target blood glucose range for an entire 24-h period. However, they can program different target ranges for different times of the day (e.g. they may set a higher target range for overnight periods).
Basal rate e.g. 24–04 h = 0.6 units/h 04–07 h = 0.9 units/h 07–18 h = 0.8 units/h 18–24 h = 0.7 units/h	Can be set for up to hourly changes in the infusion rate. Most people on pumps use 1 to 4 different basal rates per day. The total 24-h basal rate can be calculated and displayed on the pump. Ask the patient to show you this information.
Meal bolus settings e.g. 24–06 h = 1 unit/12 g CHO 06–10 h = 1 unit/7 g CHO 10–15 h = 1 unit/8 g CHO 15–21 h = 1 unit/7 g CHO 21–24 h = 1 unit/12 g CHO	May be the same all day or vary with different meals. Using the example settings, If 28 g CHO breakfast, dose = 4 units If 32 g CHO lunch, dose = 4 units If 63 g CHO supper, dose = 9 units
Insulin sensitivity factor or correction dose e.g. 24–06 h = 1 unit/3 mmol/L 06–10 h = 1 unit/1.5 mmol/L 10–24 h = 1 unit/2 mmol/L	Can be set by sections of the day. Using the example settings, If glucose 12 mmol/L before breakfast, 3.7 units added to correct to 6.5 mmol/L.

CHO = carbohydrate

members remain constantly in the hospital.

Pump manufacturers provide 24-hour help lines that the patient can contact for device-related problems. The telephone number can usually be found on the back of the pump.

CONTRAINDICATIONS

Contraindications to remaining on insulin pump therapy while in hospital include (5):

- Impaired level of consciousness. (One exception is that insulin pump therapy can be continued during anesthesia, as long as the anaesthetist is aware of and willing to manage the pump during anesthesia.)
- Critical illness requiring intensive care.
- Psychiatric illness that interferes with the patient's ability to self-manage their diabetes or places the patient at risk for suicide.
- Diabetic ketoacidosis.
- Refusal or unwillingness to participate in self-care.

Cessation of insulin pump therapy will result in the patient becoming relatively insulin deficient within 1 hour and absolutely insulin deficient within 4 hours. There is a major risk of severe hyperglycemia and diabetic ketoacidosis occurring within hours following discontinuation of therapy. **If the insulin pump must be discontinued, the patient should be placed on a subcutaneous basal/bolus insulin program prior to pump withdrawal or an intravenous insulin infusion immediately upon pump withdrawal.**

It is helpful for the patient if information about carbohydrate content is provided with each meal to allow accurate calculation of meal boluses. For patients able to eat, the usual basal rates should be continued, and the patient should bolus for meals and correct for higher or lower blood glucose readings, as usual. For patients who are NPO, the usual basal rates should be continued; however, they should bolus only for high blood glucose levels typically at 4 to 6 hourly intervals. If they experience hypoglycemia, the basal rate can be reduced by 50% for several hours, or suspended with severe hypoglycemia.

PATIENTS UNABLE TO REMAIN ON INSULIN PUMP THERAPY

If patients cannot manage their pump, they should be switched to subcutaneous insulin. The 24-hour basal dose of insulin delivered by the pump should be replaced with an injection of glargine or detemir divided into once- or twice-daily injections. In hospital, it is often easier to eventually adjust back to insulin

pump therapy if the dosing of long-acting basal insulin is twice daily. The insulin pump should be discontinued 2 hours after the first injection of basal insulin. Mealtime insulin should be provided with subcutaneous rapid-acting insulin. The dose can be calculated as half the patient's usual TDD divided by 3 and given before each meal. For example, for a patient taking a usual TDD of insulin of 28 units, give, $[(28 \text{ units} \div 2) \div 3] = 5$ units of rapid-acting insulin before each meal. Additional points to take into consideration include the following:

- A correction (supplemental) scale of rapid-acting insulin should be ordered for high and low blood glucose levels.
- The pump should be resumed when the patient is able to resume responsibility.
- Critically ill patients should be started on intravenous insulin. Guidelines for switching a patient from insulin pump therapy to multiple daily injections are shown in Table 2.

INSULIN PUMPS IN THE EMERGENCY DEPARTMENT

Diabetic ketoacidosis

Insulin pump failure can lead to diabetic ketoacidosis. Pump failure may be related to blockage or leakage in the reservoir (syringe) or the infusion set or connectors, causing an interruption of infusion flow or mechanical failure. Because the subcutaneous depot of insulin is very small with pump therapy, any interruption in the continuous flow of insulin quickly leads to hypoinsulinemia, hyperglycemia and possibly diabetic ketoacidosis. Often, the patient will be unaware that their pump has stopped administering insulin.

When diabetic ketoacidosis occurs, the pump must be discontinued and the patient should be treated according to guidelines, such as the 2008 Canadian Diabetes Association clinical practice guidelines (6). The patient may be transitioned back to the pump after resolution of the diabetic ketoacidosis. Typically, intravenous insulin is continued for the first 2 hours of the pump restart to allow the formation of a subcutaneous depot of insulin.

Patient presenting with hyperglycemia (not in diabetic ketoacidosis)

As patients using insulin pump therapy can develop diabetic ketoacidosis faster than patients taking subcutaneous injections, education about the management of high blood glucose levels is a critical component of initial pump training. If a patient presents to the emergency department with hyperglycemia and is not found to

Table 2. How to switch a patient from insulin pump therapy to multiple daily injections

Step	Example																				
Determine typical TDD of insulin on pump. Ask patient to display TDD for past few days on the pump.	TDD = 44 units																				
Calculate dose of SC basal insulin. Divide TDD by 1/2 and administer as long-acting basal insulin (glargine or levemir) given once daily or as a divided dose twice daily (it is easier to eventually adjust back to insulin pump therapy if the dosing is twice daily).	44 units ÷ 2 = 22 units. Administer as long-acting insulin 22 units once daily or 11 units twice daily.																				
Calculate mealtime bolus insulin. Divide TDD by 1/2 and administer as 1/3 before each meal. Or Ask patient to select dose of mealtime insulin using their usual insulin-to-carbohydrate ratio.	42 units ÷ 2 = 22 units. Administer 1/3 of 22 units (7 units) as rapid-acting insulin before each meal. If usual insulin-to-carbohydrate ratio is 1:10 g CHO, and patient consumes a 60 g CHO meal, they should take 6 units of rapid-acting insulin before the meal.																				
Create a correction dose scale of rapid-acting insulin. Ask patient for their usual ISF and write an appropriate scale.	If usual ISF is 1 unit/2 mmol/L, then for each 2 mmol/L above the target range, the patient should receive 1 extra unit of rapid-acting insulin. For in-hospital blood glucose target range of 6–10 mmol/L: <table border="0"> <tr> <td>Blood glucose AC meals:</td> <td>Action:</td> </tr> <tr> <td><4.0 mmol/L</td> <td>Notify MD, treat hypoglycemia by medical directive (if available) and reduce mealtime rapid-acting insulin by 2 units SC</td> </tr> <tr> <td>4.0–6.0 mmol/L</td> <td>Reduce mealtime rapid-acting insulin by 1 unit SC</td> </tr> <tr> <td>6.1–10.0 mmol/L</td> <td>Give ordered bolus dose without correction</td> </tr> <tr> <td>10.1–12.0 mmol/L</td> <td>1 unit rapid-acting insulin SC</td> </tr> <tr> <td>12.1–14.0 mmol/L</td> <td>2 units rapid-acting insulin SC</td> </tr> <tr> <td>14.1–16.0 mmol/L</td> <td>3 units rapid-acting insulin SC</td> </tr> <tr> <td>16.1–18.0 mmol/L</td> <td>4 units rapid-acting insulin SC</td> </tr> <tr> <td>18.1–20.0 mmol/L</td> <td>5 units rapid-acting insulin SC</td> </tr> <tr> <td>>20.0 mmol/L</td> <td>6 units rapid-acting insulin SC and notify MD</td> </tr> </table>	Blood glucose AC meals:	Action:	<4.0 mmol/L	Notify MD, treat hypoglycemia by medical directive (if available) and reduce mealtime rapid-acting insulin by 2 units SC	4.0–6.0 mmol/L	Reduce mealtime rapid-acting insulin by 1 unit SC	6.1–10.0 mmol/L	Give ordered bolus dose without correction	10.1–12.0 mmol/L	1 unit rapid-acting insulin SC	12.1–14.0 mmol/L	2 units rapid-acting insulin SC	14.1–16.0 mmol/L	3 units rapid-acting insulin SC	16.1–18.0 mmol/L	4 units rapid-acting insulin SC	18.1–20.0 mmol/L	5 units rapid-acting insulin SC	>20.0 mmol/L	6 units rapid-acting insulin SC and notify MD
Blood glucose AC meals:	Action:																				
<4.0 mmol/L	Notify MD, treat hypoglycemia by medical directive (if available) and reduce mealtime rapid-acting insulin by 2 units SC																				
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14.1–16.0 mmol/L	3 units rapid-acting insulin SC																				
16.1–18.0 mmol/L	4 units rapid-acting insulin SC																				
18.1–20.0 mmol/L	5 units rapid-acting insulin SC																				
>20.0 mmol/L	6 units rapid-acting insulin SC and notify MD																				
Adjust insulin doses based on daily review of capillary blood glucose monitoring results.																					
Transition back to insulin pump when patient competent.																					

CHO = carbohydrate

SC = subcutaneous

ISF = insulin sensitivity factor

TDD = total daily dose

be in diabetic ketoacidosis, emergency room (ER) personnel can review with the patient management of hyperglycemia and refer the patient back to their diabetes education team for reinforcement of the teaching (Table 3). As with anyone who has diabetes and presents with poor glucose control, an underlying illness or error in insulin dosing may be present and should be ruled out

before the patient is discharged.

If a patient presents with hyperglycemia that has not responded to 2 or more correction boluses for high glucose given with the pump, then it should be assumed that there is a problem with insulin delivery. Use the patient's ISF to treat hyperglycemia, but give the insulin dose by insulin pen or syringe until normal glu-

Table 3. Management of hyperglycemia on insulin pump therapy

If blood glucose is >14 mmol/L, patients on pump therapy should check for urine or capillary ketones.

If ketones are negative, the patient should:

- Take a correction bolus of insulin with their pump.
- Recheck their blood glucose in 1 hour. If blood glucose has started to decrease, the patient should continue to monitor their blood glucose until it is in the target range.
- If the patient's blood glucose has not started to decrease 1 hour after the first correction dose, they should take a correction dose of rapid-acting insulin using a syringe or insulin pen. They should change their infusion set, tubing, reservoir and insulin. They should continue to check their blood glucose until it is in the target range.

If ketones are positive, the patient should:

- take a correction dose of rapid-acting insulin using a syringe or insulin pen
- change their infusion site, infusion set, reservoir and insulin
- check their blood glucose every 1 to 2 hours and continue to take correction insulin as needed using a syringe or insulin pen until their blood glucose is in the target range
- drink plenty of water or noncarbohydrate fluids.

If their blood glucose continues to rise or if they have moderate-to-high ketones, nausea, vomiting or difficulty breathing, they should go to the ER.

glucose levels are achieved, at which point the patient may be able to help resolve the pump delivery problem. The most common cause of delivery failure is a plugged, obstructed or disconnected infusion site. If the pump does not seem to be delivering insulin, the reservoir, tubing and infusion set should be replaced.

Patient presenting with severe hypoglycemia

For patients on pump therapy who present with severe hypoglycemia (i.e. confusion, loss of consciousness or seizure), the insulin pump should be suspended or disconnected and the hypoglycemia corrected with intravenous dextrose 50% in water (D50W). Pump programming is quite intuitive, so that when the screen is on, the option of "basal suspend" is usually easy to find. Additionally, the pump can often be disconnected from the catheter connection or the battery removed if the "pump suspend" command cannot be found by ER staff. The patient should be restarted on their insulin pump once hypoglycemia has been treated, as cessation of insulin pump

therapy will result in the patient quickly becoming insulin deficient and rebound hyperglycemia will occur. The cause of hypoglycemia should be identified (i.e. too high a basal rate for background insulin needs, taking more insulin than needed for food or to correct high blood glucose, exercising without setting a temporary basal rate or drinking alcoholic beverages without eating carbohydrate-containing food). The patient should be instructed to contact their diabetes care team to discuss strategies to avoid severe hypoglycemia in the future. In the interim, they should be encouraged to run a temporary basal with a reduced rate of 30% to 50% until they are certain that they will not continue to have hypoglycemia, and to permanently decrease the basal rate at the time that the severe hypoglycemia occurred by 10% to 20%. Family members should be instructed on the management of hypoglycemia, including administration of glucagon.

Patient presenting with infusion site abscess or infection

Infusion site infections can occur because of poor insertion technique or leaving the infusion set in place for too long. Infusion sets should be changed every 2 to 3 days or sooner if redness, swelling or tenderness develops. Most skin infections associated with pump therapy are cellulitis secondary to *Staphylococcus aureus* bacteria (7). The infusion set and reservoir must be removed and discarded and another infusion site used until the infection has cleared. Treatment with oral antibiotics is needed, potentially with activity against methicillin-resistant *Staphylococcus aureus* (MRSA) in high prevalence areas; although if the patient is not allergic to penicillin, cloxacillin will often work. Skin abscesses should undergo incision and drainage, and debrided material sent for culture and susceptibility testing.

INSULIN PUMP THERAPY AND SURGERY

General principles

Elective surgery should be planned in advance in consultation with the patient's usual endocrinologist or diabetes specialist. The infusion site should be placed in a location away from the area where surgery will occur. Consideration should be given to where a diathermy pad may be placed. The patient must replace a metal insertion cannula with a plastic one before any surgical procedure that may involve diathermy. Insulin pumps should not be worn for procedures that involve exposure to radiation due to the strong electromagnetic field. The anesthetist must have access to the insulin pump during surgery to enable it to be turned off or disconnected, if necessary.

For minor elective surgery

If surgery is in the morning

The patient should administer their usual basal, bolus and correction insulin until midnight the night before surgery. They should then continue their usual basal infusion rates for the rest of the night. At the initiation of surgery, a temporary basal rate of 80% of the usual rate should be commenced. Capillary blood glucose level should be checked hourly.

Once the patient is able to eat or drink, intravenous fluids can be discontinued, the patient can resume their usual basal rates as well as bolus insulin using their usual pump settings. Patients should check their capillary blood glucose more frequently in the 1 to 2 days after surgery.

If surgery is in the afternoon

The procedure is similar to that followed above for morning surgery except that if the patient can eat a light breakfast, the preprandial capillary blood glucose should be entered into the pump and preprandial insulin administered per the patient's usual pump settings.

For major elective surgery

Discontinuation of the insulin pump and commencement of intravenous insulin therapy is recommended for major elective surgery. The pump should be discontinued half an hour after intravenous insulin and fluids are commenced.

Transition back to subcutaneous insulin in the postoperative period should be determined on an individual basis and will vary depending on the patient's usual insulin regimen and ability to tolerate an oral diet. It is possible to recommence insulin pump therapy in the postoperative period, even if the patient is being kept NPO, with administration of the usual basal rates and correction boluses. Mealtime boluses are not given, as the patient is not eating.

Other circumstances

The insulin pump may need to be temporarily discontinued during hospitalization in a number of other circumstances. These include:

- any radiographic procedure (pump must be removed)
- CT scan (pump must be removed)
- MRI scan (pump must be removed, including metal cannula).

The physician should order a one-time dose of rapid-acting insulin if the pump is expected to be off for longer than 60 minutes. This should be calculated as the usual basal rate the patient would have received during this time interval. For example, if a

patient usually receives 1.0 unit/hour and will be off the pump for 3 hours, they should receive a subcutaneous injection of 3 units of rapid-acting insulin.

REFERENCES

1. Grunberger G, Bailey T, Cohen AJ, et al. Statement by the American Association of Clinical Endocrinologists Consensus Panel on insulin pump management. *Endocr Pract.* 2010;16:746-762.
2. Bailon RM, Partlow BJ, Miller-Cage V, et al. Continuous subcutaneous insulin infusion (insulin pump) therapy can be safely used in the hospital in select patients. *Endocr Pract.* 2009;15:24-29.
3. Noschese M, Donihi A, Ruppert K, et al. A guideline for diabetes self management in the hospital: experience with 50 patients using continuous insulin infusions. Paper presented at: 67th Scientific Sessions of the American Diabetes Association. June 22–27, 2007; Chicago, IL. Abstract 0845-P.
4. Bailon RM, Partlow BJ, Miller-Cage V, et al. Continuous subcutaneous insulin (insulin pump) therapy can be safely used in the hospital in select patients. *Endocr Pract.* 2009;15:25-29.
5. Cook C, Boyle ME, Cisar NS, et al. Use of continuous subcutaneous insulin infusion (insulin pump) therapy in the hospital setting: proposed guidelines and outcomes measure. *Diabetes Educ.* 2005;31:849-857.
6. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2008 clinical practice guidelines for the prevention and management of diabetes in Canada. *Can J Diabetes.* 2008;32(suppl 1):S65-S69.
7. Mecklenburg RS, Benson EA, Benson JW, et al. Acute complications associated with insulin infusion pump therapy. Report of experience with 161 patients. *JAMA.* 1984;252:3265-3269.

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- clinique 2008 de l'Association canadienne du diabète pour la prévention et le traitement du diabète au Canada. *Can J Diabetes.* 2008;32 (suppl. 2) : S1 à S225.
3. Harris SB, Ekoe J, Zdanowicz Y, Webster-Bogaert S. Glycemic control and morbidity in the Canadian primary care setting. Results of the Diabetes In Canada Evaluation Study. *Diabetes Res Clin Pract.* 2005; 70:90-97.
 4. Ross SA, Yale JF, Conway JR. SOLVE—a multinational, observational study to evaluate insulin detemir added to OADs in insulin-naïve patients with type 2 diabetes: baseline characteristics from the Canadian cohort. *Can J Diabetes.* 2010;34:272. Abstract 98.
 5. Cheng AYY. The rules of 3's: insulin use in type 2 diabetes. *Can Diabetes.* 2011;24(1):3-9.

INSULIN THERAPY...CONTINUED FROM PAGE 10

15. Gerstein HC, Yale JF, Harris SB, et al. A randomized trial of adding insulin glargine vs. avoidance of insulin in people with Type 2 diabetes on either no oral glucose-lowering agents or submaximal doses of metformin and/or sulphonylureas. The Canadian INSIGHT (Implementing New Strategies with Insulin Glargine for Hyperglycaemia Treatment) Study. *Diabet Med.* 2006;23:736-742.
16. Holman RR, Thorne KI, Farmer AJ, et al; 4-T Study Group. Addition of biphasic, prandial, or basal insulin to oral therapy in type 2 diabetes. *N Engl J Med.* 2007;357:1716-1730.
17. Blonde L, Merilainen M, Karwe V, Raskin P; TITRATE Study Group. Patient-directed titration for achieving glycaemic goals using a once-daily basal insulin analogue: an assessment of two different fasting plasma glucose targets – the TITRATE study. *Diabetes Obes Metab.* 2009;11:623-631.
18. Lankisch MR, Ferlinz KC, Leahy JL, Scherbaum WA, on behalf of the Orals Plus Apidra and LANTUS (OPAL) Study Group. Introducing a simplified approach to insulin therapy in type 2 diabetes: a comparison of two single-dose regimens of insulin glulisine plus insulin glargine and oral antidiabetic drugs. *Diabet Obes Metab.* 2008;10:1178-1185.
19. Rosenstock J, Ahmann AJ, Colon G, et al. Advancing insulin therapy in type 2 diabetes previously treated with glargine plus oral agents: prandial premixed (insulin lispro protamine suspension/lispro) versus basal/bolus (glargine/lispro) therapy. *Diabetes Care.* 2008;31:20-25.
20. Meneghini L, Mersebach H, Kumar S, et al. Comparison of 2 intensification regimens with rapid-acting insulin aspart in type 2 diabetes mellitus inadequately controlled by once-daily insulin detemir and oral antidiabetes drugs: the step-wise randomized study. *Endocr Pract.* 2011;17:727-736.
21. Shah S, Benroubi M, Borzi V, et al, on behalf of the IMPROVE Study Group Expert Panel. Prandial premixed insulin analogue regimens versus basal insulin analogue regimens in the management of type 2 diabetes: an evidence-based comparison. *Clin Ther.* 2007;29(6 pt 1): 1254-1270.
22. Shah S, Benroubi M, Borzi V, et al, on behalf of the IMPROVE Study Group Expert Panel. Safety and effectiveness of biphasic insulin aspart 30/70 (NovoMix 30) when switching from human premix insulin in patients with type 2 diabetes: subgroup analysis from the 6-month IMPROVE observational study. *Int J Clin Pract.* 2009;63:574-582.
23. Buse JB, Wolffenbittel BH, Herman WH, et al. The DURABILITY of Basal versus Lispro mix 75/25 insulin Efficacy (DURABLE) trial: comparing the durability of lispro mix 75/25 and glargine. *Diabetes Care.* 2011;34: 249-255.
24. Hirsch IB, Bergenstal RM, Parkin CG, et al. A real-world approach to insulin therapy in primary care practice. *Clin Diabetes.* 2005;23:78-86.
25. Tildesley HD, Mazanderani AB, Ross SA. Effect of Internet therapeutic intervention on A1C levels in patients with type 2 diabetes treated with insulin. *Diabetes Care.* 2010;33:1738-1740.

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NOTE DE LA RÉDACTION... SUITE DE LA PAGE 20

question de l'intensification de l'insulinothérapie. Il fait remarquer que la sécrétion physiologique d'insuline comporte deux phases, soit une sécrétion d'insuline relativement constante pendant toute la journée (insuline basale) et des pics sécrétoires associés aux repas (insuline bolus). Au départ, l'insuline basale permet à elle seule de contrôler la glycémie, mais quand la carence insulinique s'aggrave en raison de la défaillance continue des cellules bêta des îlots de Langerhans du pancréas, il devient nécessaire d'injecter de l'insuline au moment des repas. Le Dr Ross fait remarquer qu'il y a diverses façons de combler les besoins en insuline basale et prandiale (comme l'injection d'insuline prémélangée), mais qu'avec l'aggravation progressive de l'insuffisance pancréatique, une insulinothérapie basale-bolus finit par être nécessaire, un peu comme en présence de diabète de type 1. Pour faciliter les choses, il pourrait donc être plus logique de passer de l'injection d'insuline basale seule à celle d'insuline basale et d'insuline à courte durée d'action au moment du plus gros repas de la journée, puis à l'injection d'insuline à chaque repas, avec ou sans facteur de correction des hyperglycémies qui surviennent.

Chez certains de nos patients diabétiques, en raison de besoins particuliers, des compromis pourraient être avantageux, par exemple l'utilisation d'insuline prémélangée, mais dans la majorité des cas, il est préférable d'adopter l'insulinothérapie basale-bolus, car celle-ci est assez souple pour être adaptée à une aggravation de la carence insulinique. Quand l'insulinothérapie doit être intensifiée, on commence par ajouter une injection d'un analogue de l'insuline à courte durée d'action, soit l'insuline aspart (NovoRapid), glulisine (Apidra) ou lispro (Humalog), au plus gros repas de la journée. Au départ, on peut arbitrairement fixer la dose à 3 à 5 unités au moment du repas, puis augmenter cette dose jusqu'à ce que quatre heures plus tard (au repas suivant ou au coucher), la glycémie soit en général normale (d'entre 4 et 7 mmol/L). Si malgré cette démarche le taux d'HbA_{1c} n'est toujours pas inférieur à 7 %, on peut ajouter un bolus d'insuline au repas suivant et, finalement, au troisième repas. Le bolus prandial peut au départ être de 2 à 5 unités, puis être augmenté d'une unité à la fois à quelques jours d'intervalle jusqu'à ce que la glycémie soit normale quatre heures après le repas (ou avant le repas suivant). Si le taux d'HbA_{1c} est toujours supérieur à 7 % malgré l'augmentation de la dose d'insuline à chaque repas, il peut être nécessaire d'utiliser un facteur de correction à chaque repas pour corriger une hyperglycémie préprandiale. On peut aussi utiliser l'insuline humaine régulière comme insuline prandiale, car elle est moins coûteuse que les analogues de l'insuline à action rapide et, en présence

de diabète de type 2, quand il y a une certaine insulinosécrétion résiduelle, elle peut produire un bon contrôle. Toutefois, parce que l'insuline régulière doit être injectée environ 30 minutes avant le repas et que son action est maximale environ 2 à 4 heures plus tard, quand la carence insulinique est grave, elle peut ne pas couvrir convenablement la période qui suit immédiatement le repas et produire une hypoglycémie 3 à 4 heures après l'injection.

La sensibilité à l'insuline diffère d'une personne à l'autre, mais l'algorithme présenté au tableau 1 est couramment utilisé pour corriger la glycémie.

Tableau 1. Correction de l'hyper- et de l'hypoglycémie

Glycémie préprandiale (mmol/L)	Mesure
< 4,0	Soustraire 2 unités du bolus prandial
4,0 à 5,0	Soustraire 1 unité du bolus prandial
5,1 à 7,0	Prenez le bolus prandial planifié
7,1 à 8,0	Ajouter 1 unité au bolus prandial
8,1 à 9,0	Ajouter 2 unités au bolus prandial
9,1 à 10,0	Ajouter 3 unités au bolus prandial
10,1 à 11,0	Ajouter 4 unités au bolus prandial
> 11,0	Ajouter 5 unités au bolus prandial

À ce stade, l'insulinothérapie basale-bolus comble tous les besoins en insuline, un peu comme en présence de diabète de type 1. L'intensification de l'insulinothérapie est nécessaire parce que la sécrétion d'insuline continue de baisser. En l'absence de production endogène d'insuline, l'insulinothérapie basale-bolus prend la relève. La pompe à insuline est une des façons d'administrer une insulinothérapie basale-bolus. Au Canada, de 20 à 30 % des patients atteints de diabète de type 1 utilisent une pompe à insuline. Dans plusieurs provinces canadiennes, dont l'Ontario, Terre-Neuve, le Québec et la Colombie-Britannique, le coût des pompes à insuline est remboursé, au moins chez les enfants, car on a démontré que c'était une forme de traitement intensif qui produisait un meilleur contrôle de la glycémie et qui réduisait le fardeau des complications.

Même si la pompe ne fait qu'injecter l'insuline et ne contrôle pas automatiquement la glycémie, elle a certains avantages sur l'insulinothérapie basale-bolus administrée au moyen d'un stylo ou d'une seringue. Le premier est qu'elle permet d'administrer des doses d'insuline basale différentes à divers moments de la journée. Les besoins en insuline basale sont souvent les plus faibles pendant la première partie de la nuit (entre 22 heures et 4 heures du matin), puis augmentent considérablement au petit matin (entre 4 et 8

heures), au moment du pic de sécrétion d'hormones de croissance et du phénomène de l'aube. Seule une pompe à insuline permet de combler les différents besoins en insuline basale au cours de la journée. La plupart des pompes à insuline sont jumelées à un indicateur de glycémie, qui transmet sans fil les données à la pompe. On peut utiliser les formules mathématiques intégrées à la pompe pour déterminer la dose d'insuline bolus ou pour corriger la dose en fonction d'une hyperglycémie. La pompe effectue le calcul, mais le patient doit approuver la dose et en amorcer l'administration.

La D^{re} Robyn Houlden a fait remarquer que comme l'utilisation de la pompe à insuline se répand, surtout chez les patients atteints de diabète de type 1, les médecins des services des urgences ou d'autres milieux devront inévitablement traiter davantage de patients portant une pompe à insuline. La plupart des porteurs d'une pompe à insuline parviennent à utiliser l'appareil pour contrôler précisément leur glycémie et connaissent habituellement leur pompe mieux que de nombreux professionnels de la santé. Dans la plupart des cas, on peut permettre à un patient interne ou externe qui porte une pompe à insuline de surveiller sa glycémie et d'adapter ses doses d'insuline, mais il doit le faire en collaboration avec le personnel hospitalier et donner à celui-ci tous les renseignements nécessaires pour qu'il connaisse sa glycémie et les mesures prises.

Comme les pompes à insuline sont de plus en plus souvent utilisées, il nous faut du personnel hospitalier qui connaît bien ces pompes et des processus et politiques convenables pour permettre une gestion coopérative des pompes. En général, quelle que soit la situation d'un patient à l'hôpital, il peut continuer de recevoir sa dose habituelle d'insuline basale et, s'il prend des repas normaux, on peut lui administrer les bolus d'insuline et procéder aux ajustements déjà déterminés. Si le patient ne peut rien prendre par voie orale ou s'il reçoit par voie intraveineuse des liquides qui ne contiennent pas de glucides, il ne doit recevoir que de l'insuline basale, mais sa glycémie doit quand même être souvent mesurée et on doit appliquer les facteurs de correction de l'hyper- et de l'hypoglycémie. En cas d'hypoglycémie chez un patient qui ne peut pas manger, on peut soit ne pas administrer d'insuline basale, soit réduire la dose d'insuline basale jusqu'à la normalisation de la glycémie.

Quand un porteur d'une pompe à insuline est amené au service des urgences en raison d'une urgence hypo- ou hyperglycémique, du personnel expérimenté qui sait utiliser une pompe à insuline doit être de garde ou pouvoir se rendre rapidement sur place et l'hôpital doit avoir des politiques convenables pour encadrer les responsabilités en matière de traitement. Le personnel du service des urgences doit à tout le moins savoir quoi faire quand un patient

porte une pompe à insuline, c'est-à-dire comment, à partir de la dose quotidienne totale du patient (doses d'insuline basale, bolus prandiaux habituels et facteurs de correction), substituer une insulinothérapie basale-bolus si le patient ne peut s'occuper de lui-même. En cas d'urgence hypoglycémique, la pompe est en général placée en mode d'attente pendant qu'on prend les mesures habituelles pour faire augmenter la glycémie (glucides par voie orale, si possible, glucagon ou glucose par voie i.v.). Il ne faut pas oublier que comme la pompe à insuline n'administre que de l'insuline à action rapide, si elle ne fonctionne pas ou si elle est placée en mode d'attente, une hyperglycémie ou une acidocétose peuvent survenir très rapidement. Dès que l'urgence hypoglycémique a été convenablement traitée, il faut recommencer à administrer de l'insuline basale au moyen de la pompe ou par injection.

En cas d'urgence hyperglycémique, il faut d'abord normaliser la glycémie en administrant un analogue de l'insuline à action rapide au moyen d'un stylo ou d'une seringue ou, chez les patients gravement malades, de l'insuline régulière et des liquides par voie intraveineuse. Souvent, l'hyperglycémie vient du fait que la pompe n'a pas administré l'insuline parce qu'elle est déficiente, bloquée ou débranchée. Comme le délai de survenue d'une acidocétose est court, il ne faut pas perdre de temps à rechercher la cause du problème, mais plutôt administrer au patient l'insuline dont il a besoin. Une fois la glycémie normalisée, on peut rechercher la cause du problème avec l'aide du patient, qui est souvent celui qui connaît le mieux la pompe.

La pompe à insuline est une solution de rechange utile pour l'administration d'insuline chez les patients atteints de diabète de type 1 ou chez les patients atteints de diabète de type 2 avancé chez qui la production d'insuline est très réduite. La plupart des porteurs d'une pompe à insuline sont bien formés et savent régler les problèmes, mais dans certaines situations, ils ont besoin de l'aide de personnel hospitalier ayant reçu la formation voulue. Nos établissements de santé modernes doivent donc absolument disposer du personnel et des politiques nécessaires pour que les patients diabétiques puissent y obtenir une aide compétente.

RÉFÉRENCES

1. Stratton IM, Adler AI, Neil HAW, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. *BMJ*. 2000;321:405-412.
2. Comité d'experts des Lignes directrices de pratique clinique de l'Association canadienne du diabète. Lignes directrices de pratique

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De l'intensification de l'insulinothérapie

J. Robin Conway, MD, et Sarah Capes, MD, FRCPC

NOTE DE LA RÉDACTION

Le diabète est caractérisé par une carence insulinique. En présence de diabète de type 1, la baisse de la production d'insuline peut être rapide et marquée, ce qui peut menacer le pronostic vital. En présence de diabète de type 2, la baisse de la production d'insuline est plus lente, mais progressive et implacable¹. Contre le diabète de type 1, dans lequel la perte de la production d'insuline est presque totale, les lignes directrices de pratique clinique de l'Association canadienne du diabète préconisent un traitement intensif, soit une insulinothérapie basale-bolus ou l'utilisation d'une pompe à insuline². Au moment du diagnostic de diabète de type 2, la production d'insuline correspond à environ 50 % de la production maximale; la production d'insuline continue par la suite de baisser au rythme d'environ 5 % par année. Quand la production d'insuline n'est plus que d'environ 20 % de la production maximale (environ 6 ans après le diagnostic), le métabolisme de la personne diabétique devient instable, la glycémie et le taux d'hémoglobine glycosylée (HbA_{1c}) dépassent le cap des 10 % et une insulinothérapie s'impose pour rétablir l'équilibre.

Au Canada, on hésite malheureusement à recourir à l'insulinothérapie. En 2003, l'étude DICE³ (*Diabetes In Canada Evaluation*) a démontré qu'en moyenne, plus de dix ans s'écoulaient

entre le diagnostic de diabète et la mise en route de l'insulinothérapie. En 2010, l'étude SOLVE a révélé que notre comportement ne s'était pas amélioré depuis 2003 puisqu'il s'écoulait toujours en moyenne 10,2 ans entre le diagnostic de diabète et la mise en route de l'insulinothérapie⁴. Malheureusement, notre hésitation à mettre en route et à adapter l'insulinothérapie est une des principales raisons pour lesquelles au Canada, seulement environ 50 % des personnes diabétiques obtiennent un taux d'HbA_{1c} de moins de 7 %³.

Dans un article paru dans le numéro du printemps 2011 de *Le diabète au Canada*⁵, la D^{re} Alice Cheng parlait de l'innocuité et de l'efficacité de la mise en route de l'insulinothérapie. Dans cet article, il était question de l'importance d'amorcer rapidement l'insulinothérapie quand les antidiabétiques oraux et les changements du mode de vie ne permettaient plus de contrôler la glycémie. La D^{re} Cheng insistait aussi sur le besoin d'adapter les doses d'insuline pour obtenir une glycémie à jeun d'entre 4 et 7 mmol/L.

Le présent numéro de *Le diabète au Canada* porte sur les mesures à prendre après la mise en route de l'insulinothérapie, quand la glycémie à jeun est d'entre 4 et 7 mmol/L, mais que le taux d'HbA_{1c} demeure supérieur à 7 %. Le D^r Stuart Ross aborde la

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