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Diabetes management and monitoring

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Learning objectives

Upon successful completion of this lesson, you will be able to do the following:

1. Be familiar with blood glucose targets and the complications of high blood glucose levels
2. Explain how lifestyle factors can affect the development and progression of diabetes
3. Review symptoms of hypoglycemia and appropriate management strategies
4. Outline basic features of the oral antihyperglycemic agents and the types of insulin used
5. Become familiar with various blood glucose monitors, test strips and insulin devices available on the market
6. Describe ways that registered pharmacy technicians can assist in the management of patients with diabetes

Overview

Diabetes mellitus is a metabolic disease characterized by increased blood glucose levels as a result of impaired glucose metabolism. Normally, the pancreas produces a hormone called insulin that regulates glucose in the blood by inducing glucose uptake by cells in the body. There are several types of diabetes. Prediabetes is a condition where blood glucose levels are higher than normal, but hav-

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en't reached the level required for a diagnosis of type 2 diabetes.

Type 1 diabetes is an autoimmune disease where a patient's pancreas is destroyed by self-antibodies, leading to the inability to produce insulin. Type 2 diabetes is a metabolic disorder characterized by the pancreas' inability to produce enough insulin and/or the body's inability to effectively use the insulin that is produced.[1-3] Gestational diabetes is a temporary condition that occurs in a small number of pregnancies.[1-3] Finally, latent autoimmune diabetes is characterized by the slow failure of beta cells in the pancreas.

This lesson will focus on type 1 and type 2 diabetes. Canadian healthcare spending has reached an estimated 14 billion annually on patients with diabetes, as these patients generally utilize family physicians, specialists and hospital resources more often than the general public.[1] Being the most accessible healthcare professionals, pharmacists and pharmacy technicians are ideally positioned within the healthcare system to care for this growing patient population.

Epidemiology

Diabetes continues to be a growing problem, both in Canada and on a global scale. The World Health Organization (WHO) estimates that diabetes is the third-highest risk factor for premature death, behind only high blood pressure and tobacco use.[1] Best available data from 2015 estimated that approximately 3.4 million, or 9.3% of Canadians, were living with diabetes. This figure is expected to increase to five million Canadians by 2025.[4] This increased prevalence is expected to put additional strain on the Canadian healthcare system. By 2025, a 25% increase in costs is expected in order to adequately care for the increased number of patients with diabetes.[4] Indigenous communities in Canada are at highest risk for associated complications as diabetes rates are three to five times higher in these populations.[1]

What is Diabetes?

Type 1 Diabetes

Type 1 diabetes is an autoimmune disorder in which a patient's own antibodies target insulin-secreting cells (beta cells) of the pancreas and lead to insufficient secretion of insulin. This type of diabetes is most commonly diagnosed in children, but in some cases, it may present later in life. As this is an autoimmune disorder, there is currently no cure or prevention strategies known for type 1 diabetes.[1-3] Lifelong insulin administration is critical for these patients to maintain proper glucose control and prevent long-term complications. A method called the Edmonton Protocol exists, where pancreatic islets are transplanted from a deceased donor pancreas to help with type 1 diabetes; however this is not as common.[5]

Type 2 Diabetes

Type 2 diabetes is a metabolic disorder characterized by a reduced response to insulin. It is typically diagnosed in adulthood and represents approximately 90% of all cases of diabetes in Canada.[3] Type 2 diabetes can be preventable. Poor diet, lack of exercise, being overweight and smoking are some of the factors that can cause high blood glucose levels which over the long term can lead to type 2 diabetes. Lifestyle interventions such as healthy eating and regular physical activity can significantly minimize the risk of developing type 2 diabetes.[1-3]

Secondary Complications

Cardiovascular disease is the most common complication that can arise from poorly controlled diabetes. Consistently elevated blood glucose levels increase the risk of stroke, myocardial infarction, coronary artery disease, heart failure and peripheral vascular disease.[1] In addition, patients with diabetes are at increased risk of microvascular complications such as retinopathy (damage to the blood vessels in the eye), nephropathy (damage to the blood vessels in the kidneys) and neuropathy (nerve cell damage).[1] In fact, diabetes is the leading cause of blindness, end stage renal disease (ESRD) and non-traumatic amputation in Canadian adults. [1] Specific blood-glucose-lowering agents and/or other medication classes are routinely prescribed along with initial antihyperglycemic medication to further lower a patient's risk of developing these complications or slow down their progression.[1-3] Target blood glucose levels are presented later on and are used to minimize the risk of patients progressing to these complications.

Blood Glucose/ Glycated Hemoglobin Targets

Blood glucose concentrations and glycated hemoglobin (A1C) are the two main tests used to monitor diabetes. A1C is used to describe a patient's average blood glucose levels in the previous three to four months.[1] Patients most commonly measure blood glucose concentrations by pricking their finger using a lancet to generate a small sample of blood. The sample is applied to a test strip that is read using a home blood glucose monitor (known as self-monitoring of blood glucose or SMBG). Continuous glucose monitoring devices are also available, which will be discussed in a later section. Patients are generally encouraged to test at least once daily when they are on oral antihyperglycemic medications that have an increased risk of hypoglycemia (low blood sugar) such as sulfonylureas or using long-acting (basal) insulin. Patients on multiple daily injections of both basal and rapid-acting (mealtime) insulin should test before every insulin injection. Frequent self-monitoring of blood glucose is also recommended for pregnant women with diabetes or those planning pregnancy. These testing regimens help prevent hypoglycemia and aid in monitoring efficacy of therapy.[1,2] Recommended blood glucose targets for diabetes patients are shown in Table 1. For patients on insulin therapy, insulin should be titrated until three consecutive fasting blood glucose readings are within the recommended range.[1] Although standard target ranges have been developed, blood glucose targets can be modified based on the patient's age, comorbidities and whether they are prone to hypoglycemia or experience asymptomatic low blood sugars.[1,2]

A1C is normally measured by venous sample in a laboratory; however, home A1C monitors are now available and only require a finger prick for testing. Some pharmacies may also offer point-of-care (POC) testing services for their patients. This represents a great opportunity for pharmacists and pharmacy technicians to be involved in the

TABLE 1 - Standard Self-Monitoring of Blood Glucose Target Ranges[1,2]

	Standard Target Range (mmol/L)
Fasting	4–7
Before Meals	4–7
2 Hours After Start of Meal (postprandial)	5–10 (5–8 if A1C targets are not met)

patient's care. Unlike SMBG, A1C testing is not time-sensitive, and can be done at any time of the day. A patient's A1C represents glycemic control over the previous three to four months and does not directly translate to blood glucose levels.[6] The term "prediabetes" is used to describe patients with impaired fasting glucose, impaired glucose tolerance or an A1C between 6.0 and 6.4%.[1] This places these individuals at greater risk to develop diabetes and associated complications.[1] Patients will be diagnosed with diabetes when A1C ≥ 6.5%.[1] Fasting blood glucose ≥7.0 mmol/L or a 2-hour plasma glucose in a 75g oral glucose tolerance test of ≥ 11.1mmol/L may also be used for diagnosis.[1]

For the majority of patients with diabetes, the target A1C is below 7%, but as with SMBG, some patients may benefit from a higher or lower A1C target.[1,2] Patients with recurrent hypoglycemia or hypoglycemia unawareness, or elderly patients with significant co-morbidities, limited life expectancy and/or high functional dependency are examples where A1C targets may range between 7.1%–8.5%.[1,2] Patients are generally encouraged to get their A1C tested every three months; however, well-controlled patients with stable blood glucose levels may test less often.[1]

Hypoglycemia

Hypoglycemia is defined as blood glucose levels less than 4 mmol/L. Symptoms may include one or more of the following: trembling, sweating, hunger, vision impairment, confusion, dizziness and drowsiness.[1,2] Severe hypoglycemia can lead to unconsciousness, with potential neurologic symptoms including paresis, convulsions and brain damage.[1] All diabetes medications have the potential to cause hypoglycemia, although some medications have a greater risk. Insulin and sulfonylureas (e.g., glyburide, glimepiride) have the largest risk of causing hypoglycemia.[1] Gliclazide has the lowest risk of hypoglycemia within the sulfonylureas, however regular monitoring should still be encouraged. In addition, skipping meals, consuming alcohol and engaging in physical activity can also lead to hypoglycemia. Other non-diabetes medications may also increase the risk of hypoglycemia, including beta-blockers, pentamidine injections, quinine/quinidine and tramadol.[2] Because of this, it is important to ask the pharmacist to assess all medications when a patient reports hypoglycemia.

TABLE 2 - Treatment of mild-to-moderate hypoglycemia in conscious patients[1]

	Actions
Step 1	Consume 15 grams of rapidly absorbed sugar. Examples include: - 150 mL of regular pop or juice - 3 Glucose tablets (5g each) - 6 Lifesavers candies - 1 tablespoon of honey
Step 2	Wait 15 minutes and test blood glucose levels again. - If still under 4.0 mmol/L, repeat step 1 - If over 4.0 mmol/L, proceed to step 3
Step 3	If next scheduled meal is within an hour of the hypoglycemic event, proceed with next meal as scheduled. If next scheduled meal is more than an hour away, a snack containing carbohydrates and protein should be eaten. Examples include: - toast with peanut butter - cheese with crackers

TABLE 3 - Examples of Food Glycemic Index Ratings[1]

Low GI Rating (preferred in diabetes)	High GI Rating
Rye bread	White bread
Pumpernickel bread	Whole wheat bread
Barley	Potatoes
Oats	Corn flakes
Apples	Pineapple

Patient education about how to treat mild-to-moderate hypoglycemia is essential in diabetes management. Three steps should be followed, as shown in Table 2. For severe hypoglycemic events in unconscious patients, a 1-mg glucagon injection should be administered by a bystander.[1] Family and friends should be trained how to administer glucagon if necessary.

Lifestyle Interventions

Dietary Recommendations

Patients with diabetes have very similar dietary recommendations as those without diabetes when it comes to macronutrient (carbohydrates, fats and protein) consumption. Focus should instead be on the glycemic index (GI) of foods consumed. Foods are rated by the GI based on how quickly they increase a patient's blood glucose levels, as well as the magnitude of this increase. Therefore, lower GI foods result in smaller blood glucose increases.[1] Examples of relative GI ratings can be found in Table 3.

Physical Activity and Weight Loss

Moderate intensity exercise has been shown to reduce the risk of cardiovascular disease, slow the progression of peripheral neuropathy and increase glycemic control in patients with diabetes.[1] To achieve these outcomes and sustained weight loss, 150 minutes of aerobic exercise weekly and resistance training twice weekly is recommended.[1,2] Patients should start slowly and gradually increase their exercise level to the recommended regimen. It is also important to educate patients that brief intense exercise can actually cause glucose levels to rise transiently. Insulin-dependent patients with type 1 diabetes can address this by administering a small bolus of rapid-acting insulin.[1]

Alcohol Consumption

Complete alcohol avoidance is not necessary for patients with diabetes; however, caution should be used as it has a delayed hypoglycemic effect and can contribute to weight gain. Food consumption while drinking alcohol can minimize the risk of hypoglycemia. In addition, moderation is recommended, with a maximum alcohol intake of three standard drinks per day and less than 15 weekly for men, and two standard drinks per day and less than 10 drinks weekly for women.[1]

Smoking Cessation

Although smoking does not directly impact blood glucose levels, it can negatively affect patients with diabetes. High blood glucose levels and smoking promotes blood vessel hardening, which can promote cardiovascular complications at a younger age than in non-smoking patients with diabetes.[7] All

patients who smoke should be counselled on these effects, and smoking cessation should be offered when appropriate.

Pharmacological Management

Type 1 Diabetes

Insulin continues to be the mainstay of treatment for type 1 diabetes. These patients are capable of normal response to insulin but produce little to no insulin; therefore, most oral agents are neither effective nor indicated. Metformin can be used off-label at times in type 1 diabetes to enhance the body's responsiveness to insulin and induce weight loss; however, this is not a standard of practice.[1]

Basal and rapid-acting insulin are used in type 1 diabetes. Basal insulin is typically given once daily at bedtime to provide patients with a consistent level of insulin throughout the day and is the main regulator of fasting blood glucose levels. Long-acting insulin is generally recommended over intermediate-acting insulin as a basal insulin, as it provides patients with a more consistent level of insulin throughout the day, with a lesser peak and a longer duration of action. The newest long-acting insulin to come to market is insulin degludec. It works very similarly to insulin detemir and insulin glargine; however, it has a longer duration of action and has been shown to have a lower risk of night-time hypoglycemia in clinical trials.[7] At this time, switching well-controlled patients to insulin degludec is not recommended; however, this agent may be a good option for patients where nocturnal hypoglycemia is a concern.

Mealtime insulin is used to manage spikes in glucose levels. To work effectively, mealtime insulin is usually administered within 15 minutes of starting a meal and remains active for only a few hours. Rapid-acting insulin is typically favoured over short-acting insulin because it more closely resembles endogenous insulin production.[1] It also has a quicker onset, making it more convenient to use prior to meals as well as a shorter duration of action and, therefore, lower risk of hypoglycemia.[1] Main insulin types are detailed in Table 4.

TABLE 4 - Main Insulin Types and Time Profiles[1, 2]

Type of Insulin	Examples	Onset of Action	Time of Peak Effect	Duration of Action
Rapid-Acting Insulin (Mealtime)	Insulin aspart	10–15 minutes	1–1.5 minutes	3-5 hours
	Insulin glulisine	10–15 minutes	1–1.5 minutes	3-5 hours
	Insulin lispro	10–15 minutes	1–2 hours	3.75-4.75 hours
Short-Acting Insulin	Regular insulin	30 minutes	2–3 hours	6.5 hours
Intermediate-Acting Insulin	Insulin NPH	1–3 hours	5–8 hours	18 hours
Long-Acting Insulin (Basal)	Insulin detemir	90 minutes	N/A	16-24 hours
	Insulin glargine	90 minutes	N/A	24 hours
	Insulin degludec	60 minutes	N/A	42 hours

N/A: not applicable

Type 2 Diabetes

Managing type 2 diabetes can be very complex and often requires multiple agents targeting different mechanisms that contribute to the disease. The main classes of antihyperglycemic medications are presented in Table 5. First-line therapy is based on the A1C level at diagnosis. This may include one or two medications, and even insulin, depending on blood glucose levels and presenting symptoms. Additional consideration is given to patient-specific factors, including contraindications, cardiovascular risk, renal status, comorbidities and financial barriers. For example, empagliflozin, canagliflozin or liraglutide are recommended as add-on therapy for patients with significant risk factors or a history of cardiovascular disease because of their additional cardiovascular benefits shown in clinical trials.[8] Another example would be to generally avoid the use of sulfonylureas in patients already on mealtime insulin due to the increased risk of hypoglycemia with concomitant use.[1] Technicians should keep in mind that several products contain combinations of medications from different classes which can help simplify dosing regimens. Technicians should also feel comfortable asking patients about any side effects they may be experiencing from their medication and refer them to the pharmacist if necessary. Refer to Table 5 for relevant questions you may wish to incorporate into your practice.

As discussed earlier, type 2 diabetes is a progressive disease with many patients no longer capable of producing sufficient insulin to manage their blood glucose levels over time. In these later stages, patients usually require insulin injections as outlined in the previous section. However, earlier initiation is also a possibility.[1,2]

Other medications

As mentioned earlier, patients with diabetes are routinely prescribed certain additional medications to help prevent secondary cardiovascular complications. These preventive medications include: statins (e.g., rosuvastatin) to reduce cholesterol, angiotensin-converting enzyme (ACE) inhibitors (e.g., perindopril) to prevent cardiovascular complications in patients 55 years and older with risk factors and to protect the kidneys from long-term damage, as well as low-dose acetylsalicylic acid (ASA) to prevent major cardiovascular events in patients who have a cardiac history. Angiotensin-receptor blockers (e.g., candesartan) may be used if the patient cannot tolerate an ACE inhibitor, and clopidogrel can be used instead of low-dose ASA if not tolerated.[1,2] This is a very important counselling point for patients, as they may not understand why they are on so many medications when they do not have comorbidities such as high blood pressure or cholesterol.

Registered Pharmacy Technician's Role

Screening Patients at Risk of Diabetes

Registered pharmacy technicians are ideally positioned to screen patients for diabetes. These patients may not be experiencing any symptoms or are unaware of their condition; however, screening can help identify them as at-risk patients. The earlier patients are diagnosed with diabetes or prediabetes (A1C 6.0-6.4%), the quicker they can take action. For example, patients over the age of 40 are at increased risk of diabetes and should be tested every three years.[1]

TABLE 5 - Antihyperglycemic Agents[1,2]

Medication Class	Examples and Route of Administration	Mechanism of Action	Side Effects	Questions to Ask
Biguanides	Metformin (oral)	Decreases glucose production in the liver and increases sensitivity to insulin in muscle and fat cells	Nausea, vomiting, diarrhea, lactic acidosis	Have you experienced any stomach pains or diarrhea while using this medication?
Sodium-Glucose Co-Transporter 2 (SGLT2) Inhibitors	Empagliflozin Canagliflozin Dapagliflozin Ertugliflozin (oral)	Prevents glucose reabsorption from urine, increasing urinary glucose excretion	Increased urinary frequency, hypotension, increased urinary tract infections (UTIs)	Have you noticed any increased urination or UTIs? Have you experienced any dizziness?
Sulfonylureas	Gliclazide Glyburide Glimepiride (oral)	Stimulates insulin secretion from the pancreas	Hypoglycemia	Have you felt, or woken up feeling, unwell, sweaty, jittery, shaky?
Dipeptidyl Peptidase-4 (DPP-4) Inhibitors	Linagliptin Saxagliptin Sitagliptin Alogliptin (oral)	Inhibits DPP-4 enzyme from degrading hormones that stimulate insulin release from the pancreas after meals	Diarrhea, constipation	Have you experienced any stomach pains or diarrhea while using this medication?
Glucose-Like Peptide-1 (GLP-1) Agonists	Dulaglutide Exenatide Liraglutide Semaglutide (Subcutaneous injection)	Synthetic hormones that stimulate insulin release from the pancreas after meals. Also reduce glucagon secretion	Headache, nausea, diarrhea, vomiting, constipation	Have you experienced any stomach pains, diarrhea or constipation while using this medication? Have you experienced any headaches?

Additional factors such as a family history of diabetes, being overweight, or gestational diabetes all increase their risk of developing diabetes.[1] The Canadian Diabetes Risk (CANRISK) calculator is a great tool that can be used for screening.[9] Have some printouts available at the pharmacy to educate patients to be aware of their risk level.

Selection of Insulin Devices

Insulin has become a much less daunting medication for patients over the years thanks to improvements in drug storage and delivery. Pre-filled insulin pens and reusable pens with cartridges provide patients with a quicker and easier way to inject insulin. In addition, needle tips used today are relatively painless when used correctly. Despite these advances in technology, many patients remain hesitant when it comes to insulin. Pharmacists and pharmacy technicians are in a prime position to help ease some of these concerns when they are dispensing these products.

Pre-filled pens offer convenience, as they are disposable when empty. Reusable pens simply require patients to remove empty cartridges and insert new ones. Technicians can assist patients in choosing the most suitable insulin device for them. Patient preference is the most important factor when choosing an insulin pen as this may dictate future adherence. Pre-filled pens, for instance, may be more desirable for patients with cognitive or coordination impairment due to the simplicity and convenience of use.

Needle tips for insulin pens are also available in a number different lengths: 4, 5, 6, 8 and 12 mm. Needle tips measuring 4–6 mm are generally recommended for most patients as they carry less risk of reaching the muscle and have been shown to be just as effective as longer needles regardless of age, sex, ethnicity and BMI.[10] Younger patients (< 6 years old) and extremely thin patients (BMI < 19) should be recommended 4 mm needles to prevent the risk of intramuscular injection.[10] Patients who require larger insulin doses may benefit from 8 mm needle tips in order to handle greater volumes; however, needle tips longer than 8 mm are generally not recommended.[10] No matter the needle size, ensure the patient has good technique and is comfortable administering their insulin.

Selection of Insulin Pumps

Continuous subcutaneous insulin infusion therapy (CSII) or insulin pump therapy is a safe and effective choice for patients with type 1 diabetes. These pumps are worn by the patient and deliver bolus insulin 24 hours per day.[11] Bolus insulin can also be delivered from the push of a button by the patient during meals or to correct high blood glucose levels.[11] There are three components to insulin pump therapy: the pump, the reservoir or cartridge and an infusion set.[11] The short tube (cannula) delivering insulin should be replaced every 24-72 hours.[11] Candidates for insulin pumps should be motivated, understand sick day management, willing to monitor blood glucose levels regularly and able to follow-up with their healthcare team.[1] An insulin pump should be considered in patients who do not reach glycemic targets despite optimized insulin therapy, have significant blood glucose variability, frequently experience hypoglycemia or require very low insulin doses.[1] Various insulin pumps are presented in table 6.

Selection of Blood Glucose Meters

With so many options available, choosing a blood glucose meter can be overwhelming for patients. The pharmacy technician should consider multiple factors that may influence the patient's choice of blood glucose meter—

TABLE 6 - Currently Approved Insulin Pumps in Canada[12]

	Approved for	Integrated CGM available	Linked BG meter	Insulin Reservoir
Medtronic Minimed 630G	All ages Type 1 or 2	Yes	Yes. Contour Next Link BG meter also works as remote for carb pre-sets	300U (3.0 ml)
Medtronic Minmed 670G	Age 7+ Type 1 only	Yes	Yes. Contour Next Link 2.4 BG meter also works as remote for carb pre-sets	300U (3.0 ml)
Omnipod	All ages	No, must use independent CGM system alongside	Yes. FreeStyle BG Meter also works as remote for insulin pump features.	200U (2.0 ml)
Tandem t:slim X2	Age 6+	Yes	No, must manually enter BG levels in meter of choice.	300U (3.0 ml)

CGM: continuous Glucose Monitoring, BG: Blood Glucose

including manual dexterity, visual impairment, technical aptitude and health literacy—before making a recommendation.

The two newest meters to hit the market are the FreeStyle Libre Flash Glucose Monitoring System and the Dexcom G5 Continuous Glucose Monitoring System. The FreeStyle monitoring system consists of a wearable interstitial glucose sensor, which is replaced every 14 days, along with a reader.[13] To measure interstitial glucose levels (in fluid just below the skin) and/or ketones, patients must simply wave the Libre Reader within 4 cm of the sensor.[13] Technically advanced patients can also download the FreeStyle Libre Link app on their smartphone and use this instead of the provided Libre Reader. Results will display current interstitial glucose levels, as well as data from the last eight hours and an arrow that indicates whether glucose levels are currently trending upwards or downwards.[13] It is important to note that the FreeStyle Libre is not a continuous glucose monitor as patients must extract the data by scanning the sensor.

The Dexcom G5 Continuous Glucose Monitoring (CGM) System works in a similar way where the patient implants a sensor in the interstitial fluid below the skin. Unlike the FreeStyle Libre, a patient using the Dexcom G5 CGM does not need to "pull" data using a reader, as data is continuously being synced to the patient's provided reader and/or smartphone via Bluetooth as long as it is within 20 feet of the sensor.[14] This allows patients to view their glucose levels at any time and act accordingly. Patients can also share their data with family and/or friends remotely if they wish to do so. Another important difference to note is that the Dexcom G5 CGM sensor must be replaced every seven days.[14] Finally, the Dexcom G5 CGM system also requires regular calibration with two finger pricks daily.[14]

These meters eliminate the need for multiple daily finger pricking to perform blood testing and provide patients with more independence. However, it is important to educate patients on the importance of finger prick testing of blood glucose levels in times of rapid glucose level changes, hypoglycemia, or when symptoms do not correlate with the interstitial glucose level detected. Provincial governments do not currently cover these devices; however, patients should be encouraged to consult with their third-party insurance as more and more companies are choosing to cover some of the costs.

Multiple conventional blood glucose meters are still available to patients. For patients who have trouble with manual dexterity, a larger meter is usually preferred for ease of handling. Try suggesting larger meters to this patient population to avoid difficulties with small meters and strips. For patients with visual impairment, Oracle is the only blood glucose meter available with audio capabilities.[15] The Oracle can communicate blood glucose levels to patients in English and French, and has a large backlit display. The Contour Next and FreeStyle meters are good options for patients with dexterity issues as they offer second-chance sampling.[15] This allows patients to apply more blood to the strip if they don't get enough the first time.

Younger patients, as well as patients with advanced health literacy skills, may benefit from technologically advanced meters. The Dario meter is advantageous for those who always carry their smartphones as it plugs into it and directly integrates information to the smartphone. This frees patients from having to carry a meter. Other more technologically advanced meters are the One Touch Verio Flex and the Contour Next One meters, which connect to applications on smartphones by Bluetooth, providing average and trend data. Other meters also have the capability of reporting trends, such as all meters from the One Touch Verio series, as well as the FreeStyle Precision Neo. See Table 7, 8 for more information on these and other blood glucose meters.[15]

Insulin Device and Glucose Meter Training

Pharmacy technicians can help educate patients on how to properly use and maintain insulin devices and blood glucose meters. Training patients on how to properly use insulin pens is essential to ensure they are correctly administering insulin. This includes routine priming, correct needle tip attachment, and correct insertion of cartridges into reusable pens. Blood glucose meter training is also essential. This includes proper strip insertion, using the lancing device, proper application of blood samples to the test strip and biohazard material disposal. In addition, technicians can teach patients how to navigate the monitor for results and trends, and can periodically re-assess the patient's injection and testing techniques. Patients who have clinical questions regarding blood glucose monitoring should be referred to the pharmacist.

Proper Blood Glucose Sampling[1]

Recommend that patients prime the lancing device according to the manufacturer's label. Then, they should bring the device to their finger of choice. Encourage them to prick the side of their finger rather than the pad to reduce pain. Recommend gently massaging the finger to extract blood and applying a small amount of blood to the glucose strip. Finally, they should apply light pressure on the bleeding finger and ensure proper disposal of all needle tips in a sharps container.

Priming the Insulin Device[1]

Patients should attach the pen needle to device and dial it up to 2 to 3 units. They should then face the pen tip upwards and push the dose button. They can go ahead with their true dose once they see insulin come out of the device. This is done to ensure the device is working properly and that the proper insulin dose is administered.

Giving the Injection[1]

Recommend that patients dial their insulin device up to the appropriate dose and insert pen tip into desired skin area at a 90º angle. They should push the dosing button until the device shows "0" and wait 10 seconds before removing the pen tip. This ensures a complete dose has been administered. Common injection sites include the abdomen, buttock, thigh or outer arm. Remind patients they should stay at least 2" (5 cm) away from the belly button and to rotate injection sites.

Technicians should also encourage the use of a blood glucose logbook or review of electronic records. This helps the patient and the pharmacy team analyze blood glucose levels for trends and helps reinforce the need for consistent monitoring by the patient. It is also important to remind patients of the importance of routine blood glucose monitoring if their logbook or meter shows evidence of irregular testing.

Drug Storage

Many pharmacy technicians are in charge of drug storage in the dispensary. It is important to ensure that insulin and other refrigerated medications received are stored in the refrigerator between 2 and 8ºC as soon as possible.[16] This avoids breakdown of the active ingredient and reduced efficacy when used.

Patients should be instructed to keep all insulin products in the refrigerator, except for the pen or cartridge they are currently using. All insulin products are stable for 28 days at room temperature, with the exceptions of insulin detemir and insulin degludec, which are stable at room temperature for 42 and 56 days, respectively.[8,17]

Medication Adherence and Tolerability

Screening for adverse effects of medications and episodes of hypoglycemia are important roles that technicians can help fulfill in a pharmacy. Asking questions as outlined in Table 5 can help with early identification of at-risk patients and allow the pharmacist to intervene. Furthermore, monitoring patient refill dates is crucial to help determine if patients are adherent with their medication. Screen for late refills and refer patients to the pharmacist as necessary. Suggesting combination medications where applicable can also help with adherence by simplifying regimens.

And finally, as most patients with diabetes are on several medications, using medication synchronization can also aid in convenience and adherence. Synchronization refers to aligning all of their refill dates so that they run out of all of their medications at the same time and can refill everything simultaneously. Pharmacy technicians can play a significant role in helping improve the quality of life for those living with diabetes.

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TABLE 7 - Flash and Continuous Blood Glucose Monitors[16]

Blood glucose meter	Mechanism	Graphs & monitoring	Sensor placement	Duration of sensors	Regular calibration of sensors required	Other features
FreeStyle Libre	Flash reading, must "pull" data with reader/ phone manually	Trends on a graph shown based on pulled data only	Arm (triceps area)	14 days	No	Approved for patients 18 years and older. No hypo or hyperglycemia alarms. No pump capability. FreeStyle Libre App available
DexCom	Continuous, automatically syncs to reader/ phone within 20 feet	Continuous glucose levels throughout the day shown.	Abdomen	7 days	Yes (2x per day)	Approved for patients 2 years and older. Automatically syncs to reader/personal phone with Dexcom App. May be part of insulin pump system. Includes hypo and hyperglycemia alarms.

TABLE 8 - Conventional Blood Glucose Monitors[15]

Blood glucose meter	On-screen pattern notification	Testing illumination and/or backlight	Sample size (µL)	Connectivity	Blood glucose test strips & expiry after unsealing	Other features
One Touch Vero IQ	Yes	Yes	0.4	USB	One Touch Verio Strips; 180 days	Need to recharge battery frequently. Large easy-to-read numbers.
One Touch Verio Flex	Yes	No	0.4	Bluetooth	One Touch Verio Strips; 180 days	Can sync with mobile device. Compact slim portable. Compatible with OneTouch app.
One Touch Verio	Yes	Yes	0.4	USB	One Touch Verio Strips; 180 days	Colour-coded range indicator.
One Touch UltraMini	No	No	1.0	USB	One Touch Verio Strips; 180 days	Puts information in chart & graphs through OneTouch diabetes management software. Small and portable.
One Touch Ultra 2	No	Yes	1.0	USB	One Touch Verio Strips; 180 days	Puts information in chart & graphs through OneTouch diabetes management software.
Accu-Chek Aviva Connect	No	Yes	0.6	Bluetooth/USB	Accu-Chek Aviva; According to expiry date	Connects to Accu-Chek Connect App, automatically transfers results to app. App can calculate insulin dose.
Accu-Chek Aviva Nano	No	Yes	0.6	Bluetooth/USB	Accu-Chek Aviva; According to expiry date	Can add meal markers and alarms. Small meter.
Accu-Chek Aviva	No	No	0.6	Bluetooth/USB	Accu-Chek Aviva; According to expiry date	Customizable hypoglycemia alarm.
Accu-Chek Mobile (Discontinued)	No	No	0.3	Bluetooth/USB	Contour Next; According to expiry date	Pre-loaded test strip cassette. Acoustic mode for visually impaired. Display available in multiple languages. Docking area on meter for lancing device.
Contour Next One	Yes	Yes	0.6	Bluetooth	Contour Next; According to expiry date	Second-chance sampling. Can add meal markers and alarms.
Contour Next	No	Yes	0.6	USB	Contour Next; According to expiry date	Second-chance sampling. Different language options. Larger buttons. Can add meal markers and alarms.
Contour Next Link	No	Yes	0.6	USB/Wirelessly compatible with insulin pumps	Contour Next; According to expiry date	Second-chance sampling. Only compatible with Medtronic insulin pumps.
Contour Next EZ	Yes	No	0.6	No	Contour Next; According to expiry date	Second-chance sampling. Large, easy-to-read display.
FreeStyle Precision Neo	Yes	No	0.6	USB	FreeStyle Precision β-Ketone; Individually wrapped. According to expiry date	Can re-apply blood within 5 seconds. Ketone testing. Suggestions for insulin dosing.
FreeStyle InsuLinx (Discontinued)	Yes	Yes	0.3	USB	FreeStyle Lite; According to expiry date	Can re-apply blood within 60 seconds. Plug and Play reports via FreeStyle Auto-Assist software. Touchscreen. Insulin calculator for rapid-acting insulin.
FreeStyle Freedom Lite	No	No	0.3	USB	FreeStyle Lite; According to expiry date	Can re-apply blood within 60 seconds. Easy-to-hold, ergonomic design, large screen, large display. Programmable alarms.
FreeStyle Lite	No	Yes	0.3	USB	FreeStyle Lite; According to expiry date	Can re-apply blood within 60 seconds. Similar features to Freedom Lite but more compact size.
Oracle	Yes	Yes	0.7	Data cable	EZ Health Oracle; 90 days	Audio function in English or French. Ketone testing.

Oracle Onyx	Yes	Yes	0.7	Data cable	EZ Health Oracle; 90 days	Need to request Data cable separately. Single-button operation.
Dario	Yes	Yes	0.3	Directly to select smartphones/ web portal	Dario; 30 days	Designed to plug into smartphone (not supported by all phones). Insulin calculator for rapid insulin.
GE200 Blood glucose monitoring system	No	Yes	0.75	Directly to select smartphones/ web portal	GE200; 120 days	Palm-sized, easy to hold, big buttons and extra-large device
iBGStar	No	No	0.5	Directly to iPhone or iPod Touch	BGStar; 90 days	Connects to iPhone or iPod Touch. Analysis of data and features through iBGStart Diabetes Manager App.

QUESTIONS

Please select the best answer for each question and answer online at eCortex.ca for instant results.

1. A patient who is known to have diabetes approaches the counter and reports they are not feeling well. They are currently on metformin and gliclazide. They did not have dinner today and had a few beers this afternoon. They report feeling dizzy. You see they are sweating and their hands are shaking. Which of the following is the least likely to contribute to the development of hypoglycemia?

a) Skipping meals
b) Metformin
c) Alcohol
d) Gliclazide

2. A patient comes to the pharmacy asking for tips to reduce his post-prandial glucose levels, specifically after breakfast. You ask what he usually eats for breakfast and he lists the following: One apple, two slices of white bread with peanut butter, a yogurt and a cup of coffee. What change could you recommend for this patient?

a) Avoid milk products as they have a high GI rating
b) Avoid apples in the morning as they have a high GI rating
c) Skip breakfast to keep blood glucose levels down
d) Replace the white bread with rye bread that has a lower GI rating

3. A patient using basal insulin at bedtime and mealtime insulin comes to the pharmacy with their blood glucose logbook. You notice that their fasting blood glucose levels before breakfast have been below 4.0 twice this past week and that their post-prandial sugars have been consistently elevated after dinner. What intervention should be made first?

a) Refer to the pharmacist to reduce basal insulin at bedtime.
b) Refer to the pharmacist to reduce mealtime insulin at dinner.
c) Refer to the pharmacist to increase mealtime insulin at dinner.
d) Refer to the pharmacist to increase mealtime insulin at lunchtime.

4. Patients with type 2 diabetes are at risk of developing all of the following EXCEPT:

a) Retinopathy
b) Type 1 diabetes
c) Neuropathy
d) Nephropathy

5. Which of the following are considered standard blood glucose level and A1C targets for patients with type 2 diabetes?

a) Fasting blood glucose: 4–7 mmol/L, Postprandial blood glucose: 5–10 mmol/L, A1C <7.0
b) Fasting blood glucose: 5–10 mmol/L, Postprandial blood glucose: 4–7 mmol/L, A1C <7.0
c) Fasting blood glucose: 4–7 mmol/L, Postprandial blood glucose: 5–10 mmol/L, A1C <8.5
d) Fasting blood glucose: 4–7 mmol/L, Postprandial blood glucose: 5–8 mmol/L, A1C <7.0

6. True or False: The FreeStyle Libre sensor can be worn for 30 days before having to change it?

a) False, the sensor should be changed after 7 days.
b) False, the sensor should be changed after 14 days
c) True, the sensor can be worn for up to 30 days.
d) False, the sensor should be changed after 21 days.

7. Which of the following can be recommended to the patient to help with blood glucose sampling? Select all that apply.

a) Prick side of finger to minimize pain.
b) Only test blood glucose levels if you feel dizzy.
c) After pricking finger, gently massage the area to extract enough blood for testing.
d) Provide sharps container for proper disposal of glucose strips and needle tips.

8. Glucose monitors should be recommended to patients based on all of the following except:

a) Cost to the patient
b) Convenience and ease of use
c) Patient preference
d) Profit for the pharmacy

9. A 40-year-old patient with type 2 diabetes comes in confused and asks why she is on a blood pressure medication called ramipril when she doesn't even have high blood pressure. How should you proceed?

a) She should not question what the doctor has prescribed, there must be a reason.
b) The doctor made a mistake and she should stop taking it.
c) Refer the patient to the pharmacist as ACEIs such as ramipril have been shown to protect the kidneys from long-term damage in type 2 diabetes.
d) Refer the patient to the pharmacist as ACEIs such as ramipril also help with glucose control.

10. The difference between glucose tablets and a glucagon injection is:

a) Glucose tablets are used for hyperglycemia and a glucagon injection is used for hypoglycemia.
b) They are interchangeable. You can use either.

c) Glucose tablets can be used by the patient if they are awake and hypoglycemic, while a glucagon injection is administered by a bystander if the patient is unconscious because of hypoglycemia.
d) A glucagon injection can be used by the patient if they are hypoglycemic, while glucose tablets are administered by a bystander if the patient is unconscious because of hypoglycemia

11. A patient with type 2 diabetes is to start mealtime insulin next week. The doctor is interested in trialing insulin at suppertime and has asked that the patient increase their frequency of SMBG prior. The doctor did not say anything more and the patient is wondering what time(s) of the day they should be testing. What would be the best response?

a) Two hours after supper and at bedtime
b) Before supper only
c) Two hours after supper only
d) Before and two hours after supper

12. A patient comes to your pharmacy complaining of multiple urinary tract infections (UTIs) in the last six months. Which of her following medications can increase a patient's risk of UTI?

a) Metformin
b) Dapagliflozin
c) Liraglutide
d) Sitagliptin

13. A newly diagnosed type 2 diabetes patient has been started on metformin 500 mg BID. He was originally dispensed 60 tablets of 500 mg metformin. He returns to the pharmacy two months later to get a refill. How should you approach this situation?

a) Assume he hasn't been tolerating it well and dispense the same quantity again.
b) Ask him how he has been taking his medication, as he is one month late according to your pharmacy's records.
c) Dispense 30 tablets so he comes back in one month.
d) Dispense 180 tablets for a three-month supply and get him on his way.

14. Pharmacists may recommend that patients titrate their basal insulin dose by 1 unit every day until their fasting blood glucose levels are in target. When would their insulin dose titration be considered complete?

a) When they have three consecutive days where all postprandial blood glucose readings are within target
b) When they have three consecutive days where fasting blood glucose readings are within target
c) When they have their first fasting blood glucose reading within target
d) When they have their first postprandial blood glucose reading within target.

15. Registered pharmacy technicians can help with patient's diabetes care by:

a) Assessing a patient's adherence to their diabetes medications by looking at their last fill date.
b) Screening patients for side effects from their antihyperglycemic medications
c) Educating patients on the proper use of blood glucose meters and/or insulin devices
d) All of the above

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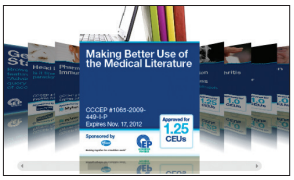

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