Clinical practice guidelines for treatment of diabetes mellitus

Expert Committee of the Canadian Diabetes Advisory Board*

Diabetes mellitus affects the health of 4% to 6% of Canadians and has a significant socioeconomic impact.[1] Care of Canadians with diabetes is highly variable; some receive care from trained multidisciplinary diabetes health care (DHC) teams, others do not.

Diabetologists in the USA[2] and Europe[3] have established separate guidelines for the management of diabetes in adults, not all of which are applicable in Canada. Neither group included guidelines for care of children and adolescents or special groups such as the elderly and native people. Although primary care physicians (usually family physicians, general practitioners or sometimes internists) provide most health care to patients with diabetes, their roles were not addressed. Finally, neither group addressed the rights and responsibilities of patients.

As a result, the Canadian Diabetes Advisory Board, cosponsored by the Department of National Health and Welfare, the Canadian Diabetes Association, the Juvenile Diabetes Foundation Canada and Association du Diabète du Québec, appointed an expert committee to develop clinical practice guidelines for treatment of diabetes mellitus. The 25 volunteer members, comprising specialist and family physicians, nurse educators, dietitians and a lawyer, were invited to participate by the Canadian Diabetes Advisory Board because of their expertise in diabetes issues. Two members have diabetes.

The goals of the committee were to identify problem areas; develop guidelines; define the roles of the primary care physician; and clarify the rights and responsibilities of the patient. Position papers were prepared by selected members who critically reviewed the current literature. These papers were evaluated and discussed by the expert committee when it developed the first draft of its guidelines in November 1990.

The guidelines were reviewed by 38 other health professionals involved in the care of patients with diabetes across Canada. Their comments were considered by the committee in preparing a second draft of their report, which was presented at a public consensus conference sponsored by the Canadian Diabetes Advisory Board in June 1991. A third version, incorporating the deliberations of this public meeting, was reviewed by the expert committee, which then prepared a final version.

The guidelines are directed to primary care physicians and other members of DHC teams.

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Classification of diabetes

Diabetes mellitus is a systemic disease characterized by hyperglycemia, dyslipidemia and hyperaminoacidemia. Caused by an absolute or relative insulin deficiency resulting in derangements in carbohydrate, lipid and protein metabolism, it is associated with specific macrovascular, microvascular, neuropathic and other complications. The various types of diabetes mellitus are insulin-dependent (IDDM), non-insulin-dependent (NIDDM), gestational (GDM) and others.[4] NIDDM accounts for 80% to 90% of cases, and IDDM accounts for most others.

Goals in care

In treating the patient with diabetes, the goals[2,3,5,6] are:

- To relieve the symptoms,
- To prevent and treat acute and long-term complications,
- To promote self-care where appropriate,
- To treat accompanying disorders,
- To improve the quality of the patient's life and
- To reduce morbidity and mortality associated with diabetes.

To achieve these goals, the physician and other health professionals (nurse educator and dietitian) work as a team that may also include a social worker, pharmacist, clinical psychologist and chiropodist. The DHC team works under the auspices and guidance of the physician, who should have diabetes expertise. After initial assessment, the DHC team develops a management plan with the patient. Follow-up visits are needed to provide ongoing care. Much time and effort are required from the patient and the DHC team.

Role of the primary care physician

Most diagnoses of diabetes are made by primary care physicians whose subsequent involvement depends on their education, interest and the availability of other resources. A primary care physician is often responsible for teaching survival skills to the diabetic patient, with or without the use of hospital facilities and the assistance of nurses and other health care personnel.

Enabling patients to assume responsibility for their own care is an ongoing process that is likely to be shared with others. The primary care physician should:

- Help the patient attain goals that have been jointly set (this can best be done by working with a DHC team);
- Educate the patient toward self-care ensuring that the patient understands every stage;
- Motivate the patient and enlist the support of his or her family and friends;
- Communicate with the other members of the DHC team and specialists;
- Enhance the patient's adherence to therapy through encouragement, caring and establishing mutual trust;
- Identify and modify risk factors for diabetes complications; and
- Refer the patient to a specialist when indicated (Table 1).

Diabetes in adults

Making the diagnosis

In nonpregnant adults, the diagnosis of diabetes[4] is made in patients who have symptoms and signs of diabetes (increased thirst, polydipsia, polyuria, polyphagia, weight loss, fatigue, blurred vision etc.) and a random venous plasma glucose concentration above 11.1 mmol/L; a fasting venous plasma glucose concentration over 7.8 mmol/L on at least two occasions; or a fasting venous plasma glucose concentration below 7.8 mmol/L, but above 11.1 mmol/L in a 2-hour sample and one other sample obtained 0 to 2 hours after 75 g oral glucose in two tolerance tests. *A glucose tolerance test is unnecessary if the patient meets either of the other two criteria.* In people with no obvious symptoms of hyperglycemia, biochemical hyperglycemia must be confirmed. All tests must be done by an accredited laboratory. It may be difficult to distinguish between IDDM and NIDDM, but treatment must not be delayed once the diagnosis is made. The physician should inform the patient of the diagnosis.

The initial visit

At the first visit of the patient with newly or previously diagnosed diabetes, the primary care physician should conduct a comprehensive medical

Table 1: Indications for referring patients with diabetes mellitus to specialists

Compromised metabolic control
Coronary heart disease
Refractory hypertension
Retinopathy
Nephropathy
Neuropathy
Foot problems
Pregnancy

interview focusing on diabetes symptoms to obtain information on:

- Onset and progression of symptoms of hyperglycemia;
- Symptoms of the acute, long-term complications of diabetes (e.g., eye, renal, cardiovascular, neurological and skin problems);
- Risk factors for diabetes (e.g., family history, obesity and past gestational diabetes);
- Relevant medical history (e.g., pancreatic surgery, endocrine disorders, infections and cardiovascular diseases);
- Family history of diabetes, cardiovascular disease, dyslipidemias, hypertension and other endocrine disorders;
- Review of systems to determine other medical disorders;
- Eating habits of the patient (e.g., food choices, meal plans, ethnic and cultural influences);
- Weight history, especially recent changes;
- Level of physical activity (i.e., type, duration, intensity, frequency and time of day of exercise);
- Socioeconomic status (e.g., family dynamics, education, employment, lifestyle, coping skills);
- Other risk factors for coronary heart disease (e.g., hypertension, dyslipidemia and cigarette smoking); and
- Drug history (e.g., current medications, ethanol and possible drug interactions).

If the patient has had previously diagnosed diabetes, the following information is necessary:

- Details of previous nutrition counselling, meal plans, adherence to prescribed meal plans and weight changes;
- Types of hypoglycemic medications used: type, dose and compliance for oral medications; type, source, dose, injection sites and assessment of patient's ability to adjust dose based on blood glucose profile for insulin;
- Methods used for monitoring glycemia (testing blood or urine): technique, frequency, timing of tests in relation to meals, records, adjustment of hypoglycemic medications based on glucose profile and quality control (correlation with laboratory results);
- Diabetes education received in the past (location and level of program) and current understanding of diabetes and its management;
- Information on hypoglycemia: occurrence, frequency, severity, perception, precipitating causes, treatment and prevention; and
- Support received from family and others.

This information forms the basis for a long-term care plan and provides data for the initial assessment.

The physician should make a comprehensive physical examination with special attention to systems affected by diabetes. Weight and height should be measured to allow calculation of body mass index, and the patient's general appearance should be noted. Information on the following may have to be obtained in stages, but it is essential for good diabetes management.

- Eyes: pupil reactions, extraocular movements, red reflex (lens opacities) and fundi;
- Oral cavity;
- Thyroid;
- Musculoskeletal: limited joint mobility;
- Cardiovascular system: pulses, blood pressure, heart, peripheral circulation including bruits (abdominal, carotid and femoral);
- Abdomen: organomegaly;
- Skin: infections, xanthoma;
- Feet: nails, web spaces and ulcers;
- Neurological system: sensory state of hands and feet, wasting, deep tendon reflexes;
- Insulin injection sites if the patient is taking insulin.

The physician should order appropriate laboratory tests to assess metabolic control, the presence of risk factors, and the presence and status of diabetes complications: determination of plasma glucose level, ideally after fasting overnight (otherwise, the time blood was taken should be recorded); glycated hemoglobin level; fasting plasma lipid levels (total serum cholesterol, high-density lipoprotein [HDL] cholesterol and triglycerides); serum creatinine level; urinalysis for protein, glucose and ketone concentration and microscopy; electrocardiogram (if indicated); level of thyroid stimulating hormone in serum (of patients with IDDM); and others if indicated.

After medical assessment, the physician should refer the patient to a diabetes education centre where a DHC team is based. Based on the information obtained in the assessment, the DHC team, with the patient's participation, understanding and agreement, can formulate a management plan to achieve the targets for glycemic control, self-care and quality of life. Education of the patient is the key to success, although compromise may be needed to accommodate his or her life-style. Management includes a meal plan, physical activity program, hypoglycemic medication(s) if required, monitoring of blood glucose levels, education, and prevention and treatment of complications. If the patient is referred to a specialist (Table 1), the specialist should give appropriate written instructions to the patient with a copy sent to the referring physician. The patient should wear proper identification (e.g., Medic-Alert), indicating that he or she has diabetes.

Follow-up visits

Diabetes is a life-long disorder requiring regular

medical assessment and laboratory testing. Some patients newly diagnosed with diabetes may require daily visits, others weekly or monthly visits until target blood glucose levels are reached. Thereafter, all patients should have follow-up visits every 6 months or more often if indicated.

During all visits, the physician should assess metabolic control clinically and biochemically; evaluate the patient's ability to cope with diabetes; review the management plan; and deal with pertinent matters, such as psychosocial problems.

At least every 6 months, the physician should review and update the patient's history and physical status; inspect the feet; check blood pressure; check the patient's technique for monitoring blood glucose; weigh the patient and compare current with previous weight; order tests for levels of blood glucose (fasting or postprandial), glycated hemoglobin, urinary protein, fasting serum lipids (if elevated) and other factors as necessary; and refer to a specialist if indicated (Table 1).

Each year the physician should obtain a comprehensive history, make a physical examination and order the biochemical tests listed under initial visit. The patient's therapy and progress should be evaluated and, if considered unsatisfactory, a specialist should be consulted.

Management

Patients should be involved in setting targets for metabolic control (Table 2). The DHC team should teach the patient about proper meal plans, physical activity, use of hypoglycemic medications when indicated and monitoring blood glucose level. The goal of optimal metabolic control is to relieve the patient of the symptoms of diabetes and prevent or delay the onset and progression of long-term complications.[2,7-10] If the targets for acceptable control cannot be achieved, the primary care physician should refer the patient to a specialist.

Meal plans Effective management requires an appropriate meal plan for the patient. The objective is to provide nutritionally adequate meals that are compatible with the patient's established way of life and allow him or her to attain and maintain a healthy body weight with good metabolic control. The Canadian Diabetes Association's "Guidelines for the nutritional management of diabetes in the 1990's"[11] should be followed, but meal plans should be adapted to the individual. Dietary fat should provide 30% of total energy, but less than 10% should be in the form of saturated fatty acids. The amount of protein required is 0.8 g/kg of desirable body weight. Carbohydrates provide the balance of energy in the diet; they should be mainly complex and high in fibre. Non-nutritive sweeteners (e.g., aspartame and cyclamates) should be used in moderation. Sodium should be restricted in patients with hypertension or nephropathy. Alcohol is permitted in moderation; its energy and hypoglycemic and hypertriglyceridemic effects should be considered. Patients should eat at least three meals a day, with snacks according to preference and hypoglycemic agents used.

Patients using insulin (IDDM patients and those with NIDDM who require insulin) have special needs. A bedtime snack is usually required. Consistency of carbohydrate intake from day to day and proper timing of meals and snacks are encouraged to improve glycemic control.

For patients not using insulin, total energy intake should be designed to attain and maintain a healthy body weight. If weight reduction is needed, it should be gradual (0.25 to 1.0 kg/wk). Food intake should be distributed as evenly as possible through-

Table 2: Targets for control of diabetes

	Metabolic level		
Value*	Optimal	Acceptable	Compromised
Plasma glucose level (mmol/L)			
Preprandial	4–7	≤ 10	> 10
Postprandial	5–10	≤ 12	> 12
Glycated Hb level (% of upper limit)	< 110	≤ 140	> 140
Total cholesterol level (mmol/L)	< 5.2†	≤ 6.2†	> 6.2
LDL cholesterol level (mmol/L)	< 3.4†	≤ 4.1†	> 4.1
HDL cholesterol level (mmol/L)	> 1.1†	≥ 0.9	< 0.9
Triglyceride level (mmol/L)	< 1.7†	≤ 2.5	> 2.5
BMI (under age 65 years)	< 25	≤ 27	> 27
Blood pressure (mm Hg)‡	< 140/90	≤ 150/90	> 150/90

*Hb = Hemoglobin, LDL = low-density lipoprotein, HDL = high-density lipoprotein, BMI = body mass index.
†Should be adjusted for other risk factors. Less strict targets may be appropriate for older patients with limited life expectancy.
‡For patients with diabetic nephropathy, it has been suggested that optimal blood pressure should be 130/80 to 135/85 mm Hg; however, conclusive evidence is lacking.

out the day. Restriction of alcohol intake is recommended for those who have hypertriglyceridemia, obesity and hypertension.

Weight reduction is the primary therapy for obese patients with NIDDM. Often the loss of a relatively small amount of weight (2.5 to 5.0 kg) can result in marked improvement in glycemia. Very low energy diets should not be used routinely in the treatment of obese patients with NIDDM because the weight loss is often short lived and there may be side effects. Their use should be restricted to carefully screened patients who are monitored by a specially trained physician.[12]

Patients should be referred to registered dietitians who will assess their current dietary intake and individual needs. Eating habits are shaped by the patient's attitudes and feelings about food, which are influenced by culture, values, economy, family, education, advertising and mass media. The dietitian, in consultation with the physician and the patient, develops a meal plan, then provides continuing support as necessary through follow-up appointments. Dietary counselling should be a continuing process, with a step-wise increase in the complexity of the information given to the patient. Other members of the DHC team should discuss and reinforce dietary strategies with the patient.

Exercise Exercise and physical training are known to affect blood glucose level.[13] Individual response can vary greatly depending on fitness, type and duration of exercise, timing of exercise in relation to meals and medication, and metabolic status at the time of exercise. In general, aerobic exercise, which may also improve cardiorespiratory fitness, is preferred. Exercise recommendations for IDDM and NIDDM patients are distinctly different. For people with IDDM, the treatment regimen must be adjusted to allow safe participation in activities consistent with their life-styles. The nonglycemic effects of exercise in improving lipid profile, psychologic state, blood pressure and so on should be stressed. Exercise should not be considered an integral component of the treatment of IDDM because controlled studies have failed to show a benefit.[14] Exercise should be part of the treatment plan of patients with NIDDM because physical activity can promote weight loss and reduce insulin resistance, which in turn improve control of the diabetes.[15]

Exercise is not without risk.[16] The most common adverse effect is hypoglycemia (immediate or delayed) in those taking insulin or sulfonylurea. Hyperglycemia and ketosis can occur in those who are insulinopenic; cardiovascular ischemia and cardiac arrythmia in those with macroangiopathy; vitreous hemorrhage in patients with proliferative retinopathy; and foot injury in those with neuropathy. Adult patients should enter a physical training program only after a physical examination and assessment of their metabolic control. A stress electrocardiogram may be indicated because silent ischemia and premature coronary atherosclerosis can occur.[17]

Therapeutic strategies *Unless the symptoms are severe, nonpharmacologic measures should be the initial therapy for adult patients with NIDDM.*[6] A significant percentage of these patients respond to a diet and exercise regimen. When such measures do not result in acceptable metabolic control, the physician must decide whether oral hypoglycemic agents or insulin should be administered (Fig. 1).

Oral hypoglycemic medications fall into two groups: sulfonylureas and biguanides. There are many sulphonylureas from which to choose: first generation (tolbutamide, acetohexamide and chlorpropamide) and second generation (glyburide and glycazide). Only one biguanide (metformin) is marketed in Canada.

Patients taking oral hypoglycemic medications should monitor their blood glucose level.[6,18-23] Unless contraindicated (e.g., in the elderly), the treatment should aim for optimal metabolic control. The patients should be assessed regularly to determine whether the dose should be increased, decreased or discontinued. Some patients do not respond to oral hypoglycemic medications (primary failure), whereas others respond for only a limited time (secondary failure). Biguanides and sulfonylureas can be used in combination in patients whose metabolic control is not acceptable with one medication (Fig. 1). The combined use of insulin and oral hypoglycemic medications is not generally recommended.[23]

Sulfonylureas may cause hypoglycemia, which can be fatal; it is potentiated by renal or hepatic dysfunction. Hyponatremia can occur in patients taking chlorpropamide. Lactic acidosis due to metformin may occur in patients with significant renal or hepatic dysfunction.

Patients with NIDDM do not need insulin therapy when diet and exercise, with or without oral hypoglycemic medications, lead to acceptable metabolic control (Table 2). The only exception is the woman who needs sulfonylurea, biguanide or both to control her diabetes and is planning a pregnancy. When the fasting plasma glucose level is consistently over 10 mmol/L despite strict diet and exercise therapy and oral hypoglycemic medication, insulin should be initiated.[6,24] Although a single daily injection may achieve acceptable metabolic control in some patients with NIDDM, most require twice-daily injections, and some may require multiple doses. Temporary insulin therapy may be required by some NIDDM patients during periods of illness or stress.

All patients with IDDM require insulin in addition to a diet and exercise regimen to achieve target

metabolic levels and prevent diabetic ketoacidosis.[5,24] The physician should strive for optimal metabolic control, recognizing that this is not always achieved. To be practical and safe, the targeted blood glucose levels should be selected to meet individual patient needs based on several factors, including body weight, diabetes complications, life expectancy and personal preference and priorities. Insulin injections are required at least twice daily; sometimes multiple injections may be needed.

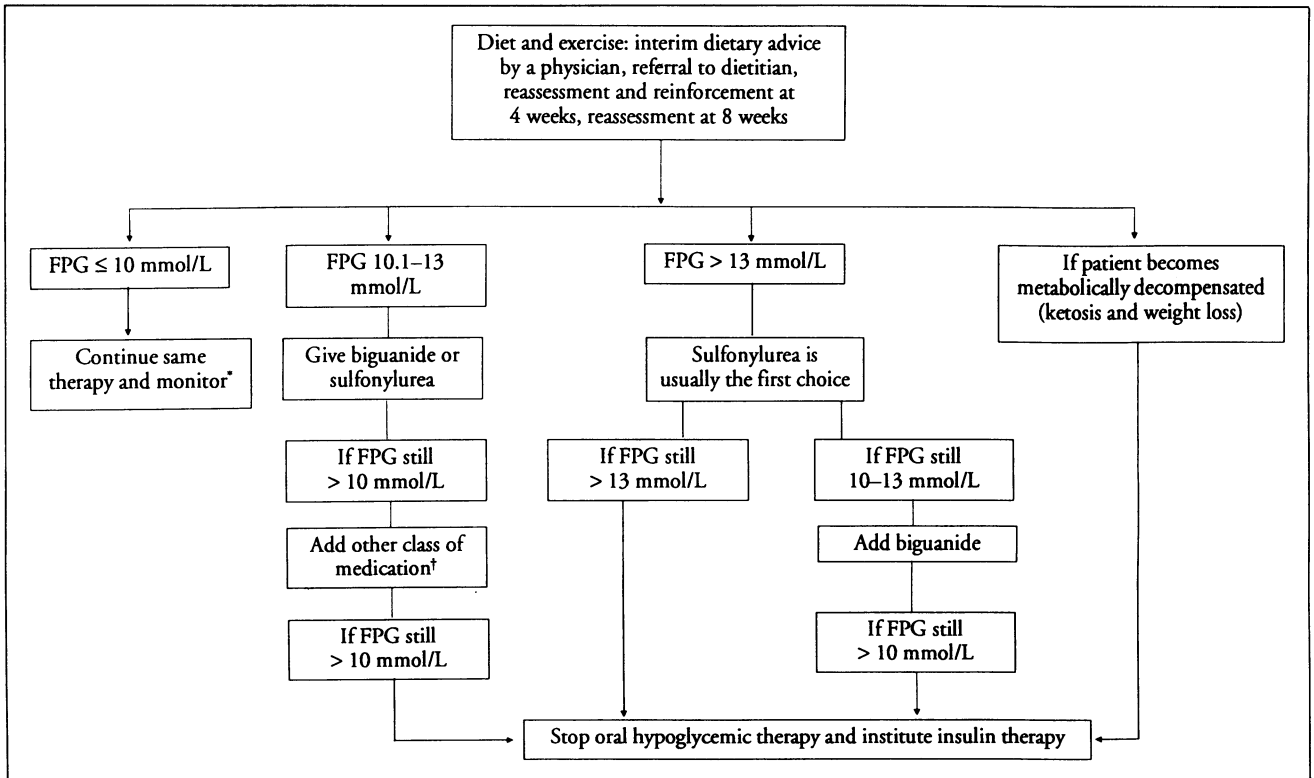
Human insulin should be used in all pregnant women with diabetes as well as in all newly diagnosed patients with IDDM. Other patients who are well controlled on porcine or bovine/porcine insulin need not change to human insulin.

Patients should receive proper instruction regarding the use of insulin and its potential complications, especially regarding recognition, treatment and prevention of hypoglycemia. Patients taking insulin should monitor their blood glucose level and be instructed in making appropriate changes to their insulin dosage, meals and exercise according to blood glucose profile.[25-27]

Self-monitoring of blood glucose level A major goal of treatment is achieving and maintaining an optimal level of blood glucose. Self-monitoring is a key component of the management plan because it enhances the quality and safety of the treatment.[25,26] For patients taking insulin, monitoring blood glucose level is essential; it may also be helpful for those taking oral hypoglycemic medications, particularly those with a high renal threshold for glucose.

Frequency of measuring blood glucose should be decided by the patient in consultation with the physician and other members of the DHC team. Patients with stable metabolic control may test once daily at different times or before each main meal and at bedtime twice weekly. For patients whose metabolic control is unstable (e.g., during acute illness, change in routine or life-style) and for those with unexpected symptoms of hypoglycemia or hyperglycemia, more frequent testing is indicated. Patients requiring multiple injections (three or more) should also monitor their blood glucose level more frequently.

Patients should record their blood glucose level together with information on meals, physical activity, insulin dose changes and other pertinent information. Patients should be provided with appropriate instructions on how to modify treatment according to blood glucose levels.[27] At each visit the physician and other members of the DHC team should discuss the blood glucose profiles with the patient. These steps are essential if the patient is to attain the goal



* In some patients, it may be desirable to lower the fasting plasma glucose (FPG) level to 4 to 7 mmol/L (Table 2).

† The two classes of oral hypoglycemic agents, sulfonylurea and biguanide, may be used together to achieve an additive effect. There is no benefit from combining two drugs of the same class.

Fig. 1: Therapeutic strategy for patients with non-insulin-dependent diabetes mellitus.

of self-care on a daily basis. Accuracy and precision of the measurements should be verified periodically (every 4 to 6 months) by comparing a blood glucose value obtained by the patient with one simultaneously measured in an accredited laboratory.

Testing for glycosuria[28] using a second-void urine specimen (i.e., a urine sample taken a short time after the patient has voided once) may be acceptable in some people, such as elderly patients with stable diabetes and in whom strict glycemic control is not important, patients in whom blood glucose monitoring is impractical and patients who refuse to monitor their blood glucose. Testing for glycosuria is useful only if the patient has a known normal renal threshold. The goal is aglycosuria.

Testing for ketonuria[28] is recommended if the blood glucose level is consistently over 20 mmol/L and during intercurrent illness.

Education Education is fundamental in self-management for patients with diabetes. All patients should be referred to a qualified DHC team. In Canada, DHC teams are usually based at diabetes education centres. The importance of participating in a diabetes education program should be emphasized by the DHC team because such programs have been shown to be effective.[29,30] Preassessment of the patient ensures individualized and appropriate care skills (survival, intermediate or advanced) and amount of education.[31,32] Coordination and communication among all care providers are essential. Education at the time of diagnosis should be followed by regular counselling sessions as needed.[29]

The following broad categories should be included in the teaching program: an explanation of what diabetes is and the various types; goals in control of the condition; monitoring, interpretation and use of blood glucose level; hypoglycemia; meal planning; exercise; foot care; how to stay healthy; interaction with health care providers; psychosocial considerations; complications of diabetes; what to do on sick days; when to consult a physician; illness; travelling; and available community services. Additional specific topics can be discussed when applicable: obesity; insulin; oral hypoglycemic agents; other medications; ketoacidosis; pregnancy and so forth.

Complications

Major acute complications are ketoacidosis in patients with IDDM, hyperglycemic hyperosmolar nonketotic state in patients with NIDDM and hypoglycemia in both groups. In patients with IDDM, diabetic ketoacidosis is dangerous and requires prompt treatment in hospital; depending on available resources and severity of the ketoacidosis, the patient may be treated as an outpatient (in the emergency department) or admitted to a hospital ward or intensive care unit.[5] Patients in this condition have hyperglycemia, ketonemia and acidosis in addition to dehydration and electrolyte imbalance. After recovering from an acute episode, these patients should be taught how to prevent future episodes. Recurrent episodes demand a detailed psychosocial evaluation and referral to a diabetes specialist. The hyperosmolar, hyperglycemic, nonketotic state is an equivalent emergency condition in patients with NIDDM and requires similar, prompt treatment.[6]

Mild hypoglycemia can occur at different times in patients with diabetes, and patients should be taught to recognize and treat it.[5,6] All patients should have identification indicating they have diabetes and should carry a source of fast-acting oral glucose. Patients should try to identify precipitating causes of their hypoglycemic episodes to prevent future episodes. Patients who have frequent, severe or unexplained hypoglycemia should be re-evaluated and their management plan revised.

Long-term complications may occur in both IDDM and NIDDM patients; the major ones are microangiopathy (retinopathy and nephropathy), macroangiopathy (coronary heart disease, peripheral vascular disease and cerebral vascular disease), neuropathy and foot problems (infection, ulcer and gangrene).

Cardiovascular disease Cardiovascular disease is the major cause of the increased morbidity and mortality associated with diabetes. The risk for coronary heart disease and cerebral vascular disease is enhanced two- to threefold in patients with diabetes,[33-35] and coronary heart disease is the leading cause of death in these patients.[36] Peripheral vascular disease is a major factor in the increased risk of gangrene in the lower extremities.[34,37]

At the initial visit, the medical history and physical examination should establish the existence of coronary heart disease and its complications,[33-35] and identify risk factors (e.g., history of premature coronary heart disease in the immediate family, smoking, dyslipidemia, hypertension, obesity, sedentary life-style, and peripheral and cerebral vascular disease).[9,38,39] Initial laboratory tests should include measuring levels of fasting total plasma cholesterol, triglycerides and HDL cholesterol.[2,9] An electrocardiogram should be taken for patients with risk factors or suspected cardiovascular disease; one must be taken for patients with cardiac disease.[9] An exercise stress test should be considered for patients planning strenuous physical training.[17] The patient should be informed of macroangiopathy and risk factors.

At follow-up visits, the patient's cardiovascular status should be re-evaluated. Serum lipid levels in normolipidemic patients should be measured annu-

ally. If dyslipidemia exists, intervention is needed and more frequent determination of serum lipid profile (e.g., every 4 months) is indicated.[38,39] The patient should be informed of the macroangiopathy and risk factors.

Treatment of cardiovascular disease and changing modifiable risk factors should be the main thrusts of therapy.[9] Dyslipidemia should be treated initially with nonpharmacologic therapy: weight reduction, decreased fat (especially saturated fat) and cholesterol intake, increased exercise and changes in life-style.[11,38,39] Drugs to decrease lipid levels should be added if indicated according to guidelines.[9,40] Response to therapy should be monitored and the treatment regimen changed appropriately. Smoking should be stopped.[41,42] Hypertension should be controlled.[43,44] Insulin resistance in patients with NIDDM should be treated by modifying diet and increasing physical activity.[11,45] The patient should strive for optimal blood glucose levels.[8,46,47] If the patient does not respond to this treatment, a specialist should be consulted.

Secondary intervention measures are the same as for nondiabetic patients, as no specific studies have been done on diabetic patients.[48] Unless contraindicated, aspirin should be given after acute myocardial infarction. Beta-blockers should be considered for patients with diabetes after myocardial infarction because they prevent reinfarction in nondiabetic patients despite possible negative effects on serum lipids and counter-regulation.[49,50]

Hypertension, which is common in people with diabetes, is a risk factor for coronary heart disease, stroke, nephropathy and possibly retinopathy.[34,35,44,51-53] Control of hypertension can slow the progress of diabetic nephropathy. Early detection and aggressive treatment are important.[54,55]

At the initial visit the blood pressure should be measured, using the appropriate cuff sizes, with the patient supine or sitting and standing.[56] Systolic pressure should be under 140 mm Hg and diastolic pressure under 90 mm Hg (caution in the elderly).[10,43,44,56] Aggressive therapy to reach these levels is recommended in patients with microalbuminuria.[44,57-59] An initial high reading should be confirmed on follow-up visits. Standing blood pressure should be assessed in patients taking antihypertensive medication. A significant decrease (over 20 mm Hg) may indicate autonomic neuropathy or excessive drug treatment. An electrocardiogram should be taken for patients with NIDDM and hypertension. Blood pressure should be measured at each follow-up visit.

If hypertension is confirmed, the patient should be informed and antihypertensive therapy initiated.[10,43,60] If the hypertension is mild, nonpharmacologic therapy should be used.[61] If this treatment is not efficacious, selection of an antihypertensive drug should be based on the needs of the individual patient. The medications of first choice include angiotensin-converting enzyme inhibitors (potassium should be monitored), calcium-channel blockers and α-adrenergic blocking agents (particularly for patients with dyslipidemia).[62] If diuretics are necessary, nonthiazide diuretics such as indapamide should be used[63] to avoid the potential adverse effects on serum lipids and insulin resistance. Beta-blockers should be used with caution in insulin-treated patients, as they may mask the symptoms of hypoglycemia.[10,50,60] The response to therapy should be monitored and the treatment regimen adjusted to attain the goal and minimize side effects.[10,43,57,60] A specialist should be consulted if blood pressure is refractory to treatment or the patient has marked associated postural hypotension.

Retinopathy In North America, diabetic retinopathy is the leading cause of blindness in adults.[64] Visual loss is primarily the result of two types of diabetic retinopathy: proliferative diabetic retinopathy and macular edema. Although both can develop without warning[65] and the first symptom may be catastrophic vision loss, they can very frequently be remedied before blindness occurs if the eyes are examined during the asymptomatic stage. Timely treatment, usually by laser photocoagulation, can stop or ameliorate the progression to vision loss.[66,67] On the basis of the known risk factors for diabetic retinopathy[68] and visual loss,[69] and in the absence of organized screening programs, the following patients should be referred to an ophthalmologist for a detailed examination with the pupils dilated:[70]

- Patients with IDDM who are at the onset of puberty or older and who have had diabetes for at least 5 years;
- Patients aged 30 years or more when they are first diagnosed as having diabetes or people with diabetes who have never had an ophthalmologic examination with dilated pupils;
- Diabetic patients with minimal background retinopathy, any other ocular pathology, reduced corrected visual acuity or elevated intraocular pressure;[71]
- Women with IDDM who are planning a pregnancy in the next year;[72]
- Women with diabetes who are in the first trimester of pregnancy.[73]

Patients with retinopathy should be assessed at least annually by an ophthalmologist, and these assessments should be done with the pupils dilated. Pregnant women with diabetes should be followed up at the discretion of the ophthalmologist.

Patients should be informed of their retinopathy. The patient and the DHC team must be knowl-

edgeable about the management of the condition. The attending physician should reinforce the need for regular review by an ophthalmologist because default from regular review or treatment may lead to vision loss. Optimal glycemic control in patients with diabetes[74,75] and blood pressure control in patients with IDDM[76] may delay the onset and progression of retinopathy.

Patients with either high-risk proliferative retinopathy[77] or clinically significant macular edema[78] should undergo scatter or focal laser treatment, respectively, and those with severe nonproliferative or early proliferative retinopathy[79] should be considered for laser treatment at the discretion of the ophthalmologist. Patients with nonresolving vitreous hemorrhage,[80] advanced active proliferative retinopathy[81] and retinal detachment threatening the macula should undergo pars plana vitrectomy at the discretion of the ophthalmologist. Visually disabled patients should undergo low-vision evaluation and rehabilitation.[82]

Nephropathy Diabetic nephropathy is a major cause of death among people with diabetes, especially those with IDDM.[83,84] It is also a leading indication for dialysis or renal transplantation in patients with end-stage renal disease.[85,86] Once established, it cannot be reversed; however, it may be stabilized through optimal diabetes control if detected and treated early,[87,88] and its progression can be slowed with control of hypertension.[43,44,57]

At the initial examination the physician should order complete urinalysis and testing for serum creatinine.[2,3,89,90] If possible, when there is no proteinuria, urine should be collected over 24 hours for determination of microalbuminuria. If there is proteinuria at the initial urinalysis, 24-hour urine samples should be collected for quantitation of proteinuria and creatinine clearance. Blood pressure should be measured. Patients with abnormal renal function (proteinuria or elevated serum creatinine level) should have more frequent regular follow-up visits. The patient should be informed of nephropathy.

During follow-up care, the patient should be assessed clinically and biochemically.[2,3,89] Urine and serum creatinine level should be tested at least annually. After a patient has had diabetes for more than 5 years, total urinary protein excretion (in the patient with proteinuria) or microalbuminuria (in the patient with no detectable proteinuria) should be measured annually. Should proteinuria occur before 5 years, a similar follow-up is recommended. Blood pressure should be measured.

When persistent proteinuria or declining renal function is confirmed, the physician should refer the patient to an appropriate specialist for medical treatment[91] and to a dietitian for instruction in decreasing dietary protein and sodium. If hypertension is present, it should be treated appropriately and early.[43,60]

Neuropathy Neuropathy is common in all patients with diabetes and can be detected soon after the onset of the disease.[47,92] Neuropathies can affect the sensory, motor and autonomic nervous systems and can be disabling, depending on the system involved and the severity. At the initial visit, the physician should question the patient regarding symptoms related to sensory (numbness, anesthesia, incoordination etc.), motor (nocturnal muscle cramps, weakness etc.) and autonomic (gastrointestinal and bladder symptoms, sexual dysfunction, lightheadedness) nervous systems, and these should be documented.[93] This information should be sought and physical examination done at least annually to assess the progress of neuropathy. The patient should be informed of the condition and told that recovery may occur but that it may be a lengthy process.

The physician should rule out other neurological disorders before attributing the findings to diabetes. The patient should try to achieve optimal glycemic control.[94] If narcotic pain relievers are used, the dosage should be carefully monitored. Other drugs (tricyclic antidepressants, carbamazepine etc.) may be more effective.[95] If neuropathy progresses and becomes disabling, the patient should be referred to a specialist with experience in this area.

Foot disorders Foot problems are a major cause of disability, prolonged hospitalization, health care costs and mortality in patients with diabetes.[96,97] In patients with neuropathy or peripheral vascular disease, a minor trauma to the foot can often lead to skin ulceration, infection and gangrene, resulting in amputation. Educating patients in foot care and proper care by DHC teams can significantly reduce the rate of amputation.

At the initial visit, any conditions that put the patient at greater risk of foot ulcer or infection (e.g., neuropathy, vascular disease, structural deformities, callus formation, nail abnormalities, abnormal gait and a history of previous foot ulcers or infections) should be identified.[2,98] The patient's legs and feet must be examined by the physician. A comprehensive skin, soft tissue, musculoskeletal, neurological and vascular examination should be done. At follow-up visits the feet should be examined by a qualified health care professional. A comprehensive evaluation should be done annually and the patient informed of any foot problems.

Foot ulcer or infection should be detected early and treated promptly by members of the DHC team.[99] When indicated, referral to a specialist should be made. Patients unable to care properly for their own feet should be referred to a chiropodist or other trained health care professional for regular care. Patients should be instructed in

preventive care and have routine foot inspections.

Diabetes in children and adolescents

Making the diagnosis

The diagnosis of diabetes in children and adolescents is based on symptoms of hyperglycemia (polyuria, polydipsia, weight loss etc.) and a random (nonfasting) venous plasma glucose concentration over 11.1 mmol/L, with or without ketonuria.[4]

Goals in care

The goals and general principles of management of diabetic children and adolescents are the same as those for adults.[100,101] However, special consideration must be given to the effects of diabetes on growth and development of the child and the impact of its management on the family unit. The response to acute illness must be rapid because of the greater risk of acute complications such as hypoglycemia and ketoacidosis.

Initial and follow-up visits

Following stabilization, the patient should be referred to a diabetes centre with a multidisciplinary DHC team with expertise in dealing with children and their families. Teaching should be individualized and appropriate to age. Initial education should be reinforced at follow-up visits every 3 to 6 months. Growth and metabolic control should be carefully monitored. Glycated hemoglobin level should be measured and urine analysed at each clinic visit. Levels of total plasma cholesterol, triglycerides and HDL cholesterol should be measured following stabilization. Thyroid function tests should be performed annually. After puberty, and more than 5 years after diagnosis, an ophthalmologic assessment and 24-hour urine collection to test for microalbuminuria are recommended annually.

Management

Meal plans and exercise Meal plans should be individualized and appropriate to age, with more flexibility for younger children. The Canadian Diabetes Association guidelines[11] should be followed; composition of the diet is the same as for adults, but there may be a greater proportion of fat to allow for snack foods. Food intake should be in three meals and two or three snacks. Assessment by a dietitian is recommended at least annually but more often during the first year of diabetes.

Children with diabetes should be allowed to participate in normal exercise activity, with appropriate adjustments of diet and insulin.

Insulin Insulin should be given twice daily, using intermediate- and short-acting insulin in ratios determined on an individual basis. More frequent injections to achieve better control have not been proven safe or beneficial. Target levels for premeal capillary blood glucose are 6 to 12 mmol/L for infants to 5 year olds and 4 to 10 mmol/L for children 5 to 12 years old. An acceptable glycated hemoglobin level is less than 150% of the upper limit of the normal range. Blood glucose levels in the normal range are difficult to achieve with current insulin schedules without producing hypoglycemia.

Education The DHC team should provide continuing care and education to the child or adolescent and family to maintain health and a normal life-style. Education and counselling are particularly important for adolescents with an elevated glycated hemoglobin level (over 150% of the upper limit of the normal range). Age appropriate self-care by the child and adolescent should be encouraged and a smooth transition should be made from the pediatric to an adult DHC team.

The parents of children who have diabetes must be educated about the principles of insulin therapy and dietary adjustment so that minor illnesses can be safely managed at home. They should know when a physician's advice should be sought immediately (e.g., if the patient vomits more than once, is unable to maintain capillary blood glucose levels over 4.4 mmol/L or has a capillary blood glucose level over 14 mmol/L with ketonuria).

Acute complications

Caregivers and older children should be taught how to prevent and manage hypoglycemia. Wearing proper identification (e.g., Medic-Alert) is essential.

Diabetic ketoacidosis may occur more abruptly in children than adults and is usually precipitated by infection and/or insulin deficiency.[102] The condition is potentially life threatening, with an increased risk of cerebral edema, and must be promptly treated by the judicious administration of insulin and intravenous fluids and electrolytes in accordance with modern standards. All episodes of diabetic ketoacidosis after diagnosis must be viewed with suspicion. The most common cause is omission of insulin by a child who has been given too much responsibility for self-management. Family dynamics must be reviewed.

Children and adolescents with diabetes who are undergoing surgery should be evaluated before the operation and followed up later by a physician knowledgeable in diabetes care. Hypoglycemia and severe hyperglycemia should be avoided during surgical procedures.

Diabetes in the elderly

Making the diagnosis

Many elderly patients do not present with the classic symptoms of hyperglycemia (polydipsia, polyuria and polyphagia); rather, they present with nonspecific symptoms (insidious weight loss and fatigue) or are asymptomatic.[103] They also present more frequently with symptoms related to such complications of diabetes as microangiopathy (e.g., visual impairment), macroangiopathy (e.g., angina), neuropathy (e.g., foot ulcers) and peripheral vasculopathy (e.g., claudication). Nevertheless, the criteria used for diagnosis of diabetes mellitus are similar to those used for other nonpregnant adults. Most elderly people with diabetes have NIDDM,[104-106] although there may be an early need for insulin therapy.

Management

The principles for managing elderly patients with diabetes are similar to those for other adults.

Meal plans and exercise Simplified meal plans for elderly patients should be developed with a dietitian, based on the Canadian Diabetes Association guidelines,[11] considering that these patients may have multiple health problems (coronary heart disease, hypertension, osteoporosis) and changing food preferences due to altered dentition, salivation and taste. Weight reduction is desirable for obese elderly patients with NIDDM,[107] but the process should be gradual and the weight goal less stringent than for younger adults.[108,109] An ideal body weight of up to 10% above normal is satisfactory. Once a healthy body weight is attained, a maintenance meal plan should be provided. The agreed-upon plan should be written out for the patient and those who prepare the meals. Follow-up visits may be of greater importance to reinforce education and monitor adherence and response to therapy than they are in younger adult patients, with visits three or four times a year.

Exercise should be encouraged but should be regular, aerobic and not overly strenuous and must not aggravate coexisting disease.[110-112] The duration, frequency and progression of exercise should be adapted to the individual. Patients should avoid straining and holding their breath. Proper foot care should be taught; avoidance of injury during exercise is especially important in the elderly.

Oral hypoglycemic medications Oral hypoglycemic medications should be considered when an elderly patient has symptomatic hyperglycemia and persistent high blood glucose levels despite close adherence to diet and exercise therapy. Targets for control are those given in Table 2. Long-acting sulfonylureas should be avoided[113-115] because hypoglycemia is a significant risk for elderly patients who take sulfonylureas, especially when they are ill and eat less than usual. Metformin may be used with caution, but only if there is no renal or hepatic dysfunction. These medications should be started at a low dose and gradually increased to the maximum when necessary. Thus, glyburide, 2.5 mg twice daily, glycazide, 40 mg twice daily, or metformin, 500 mg once a day increasing to 500 mg twice daily, would be reasonable to start.

Insulin An elderly patient with diabetes who does not attain acceptable control in response to diet, exercise and oral hypoglycemic medications requires insulin to prevent exacerbation of hyperglycemia. Older people with diabetes may be more sensitive to insulin. The following regimens can be considered:

- Long- or intermediate-acting insulin once daily (morning or evening) or twice daily before breakfast and supper;[116]
- A mixture of short- and intermediate-acting insulin once or twice daily;
- Premixed insulins, which may be easier and more convenient, injected once or twice daily.[117-119]

For those who are visually or physically impaired, insulin injection aids (e.g., "pens") may be helpful. Attempts to achieve completely normal blood glucose levels may result in severe hypoglycemia in the elderly. The use of combined insulin and oral medications is generally not recommended.[120-122]

Education Diabetes education should be provided to the elderly as for other adults, although the approach and level of education must be modified and adapted to the individual. Learning requires greater reinforcement. Life-style issues are different from those of younger adults. Foot care and the use of chiropody care are of greater importance. For those on oral hypoglycemic medications or insulin, hypoglycemia may be a greater problem. The patient should learn to recognize, treat and prevent hypoglycemia. Failing vision and other physical disabilities can affect self-care, and community resources must be used to overcome these problems. Drug interactions become an important issue, as many elderly patients are taking several drugs. Life expectancy must be borne in mind, and goals for blood glucose level should be less rigid. Efforts should be made to ensure that the goals of therapy are achieved without causing significant risk to the patient.

Diabetes in native Canadians

Since 1940, when diabetes was virtually unknown in Canadian native people, the prevalence of NIDDM and its complications has increased significantly.[123-126] Despite this, access to professional diabetes education, treatment or prevention services for native people is limited or nonexistent in many

areas.[127] Most native communities in Canada are small, remote and lack infrastructure. Existing health care facilities (principally nursing stations) often suffer from high personnel turnover and cross-cultural differences.

Native people with diabetes are likely to be cared for by non-native physicians, who usually see their patients outside the native milieu. This applies particularly to urban or nonstatus Indians. Critical to the overall approach of non-native physicians to their native patients with diabetes should be the understanding that diabetes is a symptom of the profound changes in the lives of native people. Action on these issues may well be beyond the scope of the average medical practitioner, but awareness of, and sensitivity to, these issues will aid in his or her approach.

Diabetes within native communities is a symptom of other community problems, and appropriate care requires involvement of the community. There must be greater emphasis on prevention,[128] especially reversal of behaviour leading to overnutrition and insufficient exercise. Native people must be involved in the development and implementation of diabetes education programs. Nutritional and life-style counselling must be compatible with traditional practices and an integral part of care and prevention.

A trained native diabetes worker who is familiar with local languages and customs can provide the foundation for community care.[128] These workers can be existing community health representatives or other motivated community members. Integral to the presence of local diabetes workers is the need for all native communities to have access to a DHC team. The native person with diabetes should be able to rely on a team including a local community diabetes worker, health care services (where available) and regional diabetes education teams. The key is to incorporate traditional values and customs into the overall treatment approach.[128]

Diabetes and pregnancy

Pregnancy in diabetic women

Counselling of a woman with diabetes should begin 3 to 6 months before conception. Patients who are well controlled on oral hypoglycemic medications should begin insulin and achieve optimal control before conception. Patients well controlled on diet may become pregnant without intervention but should understand the potential need for insulin during pregnancy. Insulin-using patients should continue and achieve optimal control.

Before becoming pregnant, all patients should achieve preprandial glucose levels of 3 to 7 mmol/L and freedom from major hypoglycemia and have a full medical review with renal and retinal assessment. Where appropriate, patients should begin taking human insulin.[129]

Once pregnancy has begun, a further retinal assessment should be carried out and the patient followed up by an ophthalmologist as necessary. If there are documented retinal abnormalities, an ophthalmology review is required once each trimester. Urine albumin should be monitored throughout the pregnancy. The presence of albuminuria at the onset of pregnancy may increase the likelihood of hypertension and progressive renal decline.

The woman with diabetes should meet with a DHC team, who will assist her during the pregnancy.[130] The team should include a specialist experienced in the management of diabetes during pregnancy who will assist in maintaining optimal glucose control, a nurse and dietitian who will maintain ongoing supervision and an obstetrician. Where access to this level of care is limited, the primary care physician can maintain ongoing care with assessment by the specialist team at the beginning of pregnancy and at the time of delivery.

It is valuable to know the exact time of the commencement of pregnancy to ensure optimal control of glycemia early after conception, when the risk of malformations is highest.[131,132] This can be achieved by monitoring a temperature chart to determine the time of ovulation and by measuring β-human chorionic gonadotropin in the blood or urine as soon as the woman has missed a period.

During pregnancy, the patient should have a medical and obstetric review every 2 to 4 weeks, and preprandial blood sugar levels should be maintained between 3 and 7 mmol/L without significant hypoglycemia. Two hours after meals the glucose level may be monitored and should generally be below 7 mmol/L. These values, however, are not predictable because of the variable rate of absorption of food, particularly later in pregnancy. Early-morning urine should be tested for ketones, which would indicate "starvation" and require a change in diet and possibly insulin therapy.

Women whose diabetes is controlled by diet may require insulin after the 20th week of gestation; those taking insulin may require a two- or threefold increase in dosage at this time. Insulin may be needed three or four times a day, and the use of an insulin pen may be helpful if premeal fast-acting insulin is used alone. A sudden decrease in insulin requirements may herald a decrease in placental function and possible fetal death.

Delivery can be planned at term without surgical intervention, although an earlier induction or cesarian section may be required if obstetric concerns arise. During delivery, the blood glucose level should be maintained below 6 mmol/L, possibly

using an intravenous insulin infusion. Following delivery, women with diabetes are prone to hypoglycemia, and insulin may not be required for 24 to 48 hours.

In the postpartum phase, insulin readjustment will be needed to accommodate the patient's new metabolic state. Before leaving hospital, she should be counselled regarding contraception with emphasis on the importance of ideal blood glucose control before future pregnancies are contemplated.

Gestational diabetes

Because this subject is controversial and rapidly evolving, diagnostic and management criteria may be expected to change in the future.[133-138]

Women with high-risk characteristics for GDM (e.g., previous GDM, large-for-date babies, obesity and family history of diabetes or GDM) should receive prepregnancy counselling. They should be encouraged to achieve ideal weight before conception and to recognize the need for follow-up throughout the pregnancy.[139]

Screening for GDM should begin at the 24th week of pregnancy. Blood glucose levels should be measured 1 hour after a 50-g oral glucose load. Values above 7.8 mmol/L suggest GDM; a 100-g oral glucose tolerance test should follow. GDM is diagnosed if two or more venous plasma glucose values following the tolerance test meet or exceed 5.8 mmol/L (fasting), 10.6 mmol/L at 1 hour, 9.2 mmol/L at 2 hours and 8.1 mmol/L at 3 hours.[138] Other methods of diagnosing GDM are under review. Because many pregnant women may not tolerate large doses of oral glucose, and large-dose oral glucose tolerance tests are considered by some to be nonphysiologic, 2-hour postprandial glucose values may be valuable for screening. Values above 6.5 mmol/L should raise the suspicion of GDM, requiring follow-up and treatment, if necessary.

If blood glucose levels are elevated, the pregnant woman should be referred to a dietitian for dietary instruction. Self-monitoring or laboratory testing should aim to achieve a 2-hour postprandial blood glocose level below 6.5 mmol/L. The presence of significant ketonuria (ketone concentration at or above 3 mmol/L) or hyperglycemia may require further dietary assessment and insulin therapy.

Women with GDM can be cared for by their primary care physicians with intermittent review by a DHC team. Delivery can be at term, unless obstetric concerns arise, when a review by an obstetrician should be sought. A need for insulin will require more intensive help from a specialist experienced in diabetes treatment and from the DHC team.

After delivery, the woman should be counselled to achieve ideal weight, and nursing mothers may require ongoing dietary assistance. The woman should be warned of the risk of later developing diabetes mellitus, and a 2-hour venous plasma glucose test should be performed 3 to 6 months after delivery and at regular intervals in later life.

Patient rights and responsibilities

Because of the nature of diabetes, the methods used to control it and its many serious complications, diabetic patients have a special need to be fully informed and involved in their treatment. Conversely, because of the chronic nature of the condition and the severity of its complications, diabetic patients could put an undue strain on the health care system if they were to abuse their rights. Proper treatment will only occur if there is an effective working partnership between patient and physician.

The patient should be considered an essential member of the DHC team. Patients with diabetes should receive the health care described in the clinical practice guidelines outlined here.[140] Patients should receive sufficient, appropriate information about their condition and its complications to enable them to grant informed consent to the treatment prescribed.[141,142] Finally, patients should have the responsibility to cooperate and communicate openly and honestly with the professionals on the DHC team.

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