

7.0 Management of glycaemia: treatment options

7.1 Recommendations

7.1.1 Diabetes self-management education

- All people with diabetes should be offered a structured education programme around the time of diagnosis,
- People with diabetes should have a structured education programme around the time of diagnosis to initiate effective self-care, and reinforcement periodically thereafter
- Competent and trained professionals should deliver diabetes education
- Self-management behaviour change should be measured and monitored as part of care
- Self-management education should address psychological issues, since emotional well-being is strongly associated with positive diabetic outcomes.

7.1.2 Nutritional management

- Optimal dietary therapy and nutritional requirements should be provided to children and young people with diabetes (see section 7.3.1.2) by professionals with specific expertise in this area
- Annual assessment (educational and developmental) of young people with diabetes should be performed to identify specific dietary problems and eating disorders
- Young people should be given the dietary education that enables them to take part in normal physical exercise
- Adults with diabetes should be given advice on healthy eating, and where overweight advice on appropriate calorie control
- Adults with diabetes should be encouraged to take significant physical exercise on at least 3 days every week

7.1.3 Recommendations

- Recommend at least 150 min/wk of moderate-intensity aerobic physical activity (50-70% of maximum heart rate) and/or at least 90 min/week of vigorous aerobic exercise (>70% of maximum heart rate) distributed over at least 3 days/week.

7.1.4 Glucose-lowering therapy

- Begin with metformin, unless contraindicated, from the time of diagnosis
- Add a sulfonylurea, preferably not glibenclamide, to metformin where metformin + lifestyle no longer achieves glucose control targets. If a

sulfonylurea gives problems in particular hypoglycaemia a thiazolidinedione or a DPP-4 inhibitor (gliptin) may be considered.

- Add basal insulin therapy to metformin + sulfonylurea where oral therapy no longer achieves glucose control targets. Alternatives if insulin is not an option would be a thiazolidinedione or a DPP-4 inhibitor (gliptin). A GLP-1 mimetic may be considered in the obese. Acarbose is a further alternative oral agent.
- Where basal insulin therapy no longer achieves glucose control targets, add meal-time insulin therapy either as a pre-mix or converting to a multiple insulin injection regimen – discontinue sulfonylurea.

7.1.5 Clinical monitoring of blood glucose control

- Judge glycaemic control by the combination of the results of the person's current HbA_{1c} result and SMBG testing (if performed).

7.1.6 Self monitoring of blood glucose (SMBG)

- All people with type 1 diabetes should be taught how to self-monitor and record their blood glucose levels with home meters, and to adjust their insulin doses accordingly
- People with type 2 diabetes on insulin should be taught how to self-monitor and record their blood glucose levels with home meters and to adjust their insulin doses accordingly
- For people not on insulin, SMBG may be useful in achieving glycaemic goals, through support for self-management
- Insulin-treated patients should optimally test their plasma glucose daily before meals, and in some cases 1-2 hours after meals, and at bed-time specifically in more intensively treated patients
- People should receive initial instruction, but also routine follow-up evaluation of SMBG techniques and their ability to use data to adjust therapy
- People with type 1 diabetes should be instructed on methods of testing for urine ketones using reagent strips. They should be advised to test: whenever they develop symptoms of a cold, 'flu', or other intercurrent illness; if they develop nausea, vomiting, abdominal pain, or polyuria; or if they find an unexpectedly high plasma glucose level on self-monitoring.

7.2 Background

The backbone of diabetes management is proper diet and regular exercise, both of which have to be individualized. Often they are the only management needed for controlling blood glucose in gestational diabetes, IGT and sometimes in type 2 diabetes in its early phase.

People with type 2 diabetes may also require oral glucose-lowering medications and/or insulin or other injectables, while people with type 1 patients need insulin therapy to survive.

The treatment plan for diabetes includes:

- Diabetes education: making structured patient education an integral part of the management
- Meal planning and nutritional recommendations: provide access to dietician
- Regular exercise
- Glucose-lowering oral agents and/or Insulin
- Management of associated conditions and diabetes complications

In addition to lifestyle modification, Appendices 4 and 5 list the different groups of oral glucose-lowering agents, types of insulin and their commonly used doses. The physician's judgment will direct the method of treatment. These are commonly used in a step-wise manner as illustrated in the algorithm proposed in the literature (see Figure 1).

The glycaemic control strategies and options of pharmacological and non-pharmacological treatments will be discussed here in the following order:

- Diabetes education (7.3)
- Nutritional management of diabetes (7.4)
- Oral glucose-lowering treatment and non-insulin injectables (7.5)
- Insulin therapy (7.6)
- Diabetes self-management (7.7)

7.3 Diabetes education

7.3.1 Definition

Diabetes education is an interactive process that facilitates and supports the individual and/or their families to acquire and apply the knowledge, confidence, practical problem-solving and coping skills needed to manage their life with diabetes, and achieve optimal metabolic control.

7.3.2 Rationale

There is strong evidence that diabetes education is responsible for reduction in amputation rates, hospital admissions, length of stay and re-admission rates. It improves HbA_{1c}, systolic BP, lipid profile, body weight control, and patient satisfaction and thus reduces the cost of diabetes care.

7.3.3 Recommendations

Recommendations are given in section 7.1

7.3.4 Programmes

In view of the constraints imposed by resource limitations and the geographical nature of our country, with a widely scattered population, all health professional disciplines and levels involved in the care of people with diabetes have a responsibility to ensure that whatever information or education they provide to people with diabetes is timely, relevant, consistent, accurate and empowering. Diabetes educators should provide comprehensive and structured diabetes education to people with diabetes and their families where possible.

All people with diabetes should have the opportunity for individualised education tailored to their personal needs, learning styles and type of treatment. Group sessions are appropriate for patients who share similar circumstances such as age, treatment type, and pregnancy. Education has to be delivered by techniques of active learning, and the individual must be an active participant in their ongoing management.

The structured programme should include the following:

- Overview of diabetes
- Nutrition, exercise and medication
- Relationship between nutrition, exercise, medication and blood glucose levels
- Monitoring of blood glucose, HbA_{1c} and use of results
- Acute and chronic complications of diabetes and their prevention
- Dental, skin and foot care
- Preconception care, pregnancy and gestational diabetes
- Use of health-care systems and community resources
- Newly diagnosed type 1 people with diabetes must also have specific instructions on:
 - Insulin injections and storage
 - Home blood glucose and urine ketone monitoring
 - Recognising and treating hypoglycaemia
 - Sick-day management
 - Seeking medical assistance in emergencies

7.3.5 Diabetes education for the community

The community at large should also be educated about diabetes, its prevention and the needs of people with diabetes. This can be achieved through the media, by conducting public campaigns, and through schools.

7.4 Nutritional management of diabetes mellitus

7.4.1 Diet management of diabetic children and adolescent

7.4.1.1 Aims of nutritional management

- To provide sufficient energy and nutrients for optimal growth and development
- Establish healthy eating habits that optimise glycaemic control
- Prevent acute complications such as hypoglycaemia and hyperglycaemic crises
- Achieve and maintain ideal body weight (physical exercise)
- Reduce or prevent microvascular and macrovascular complications.

7.4.1.2 *Dietary therapy*

There is limited evidence concerning the optimal dietary therapy and nutritional requirements of children and young people with diabetes. There is consensus that the nutritional requirements for diabetic children are similar to other children to promote good health. However, many reputable bodies recommend that the total food energy and carbohydrate intake should be distributed as follows:

- Carbohydrates >50% (encouraging complex unrefined high fibre carbohydrate and moderate sucrose intake)
- Fats 30-35% (<10% saturated fat, <10% polyunsaturated fat & >10% monounsaturated fat, with low trans-fatty acids).
- Proteins 10–15% (decreasing with age)
- Five portion of fruit and vegetable per day.

Energy intake varies greatly with the availability of food and according to the age, appetite, growth rate, puberty, and energy expenditure. When food is in abundance excess energy intake causes obesity which in combination with diabetes, increases the risk of cardiovascular diseases. At the diagnosis of diabetes, appetite and energy needs intake may be high in order to restore the preceding catabolic weight loss. However when body weight is restored, or in the overweight this is no longer necessary. In puberty, energy intake and nutritional demands increase substantially along with increase in insulin dosage.

7.4.1.3 *Nutritional support and follow up*

- Initial nutritional planning in children should be reviewed by a specialist paediatric dietician within a month and so after diagnosis.
- Annual assessment of height, weight, diabetes management, lifestyle changes, developmental stages and identification of specific dietary problems such as weight loss, obesity and eating disorders.

7.4.1.4 *Diet and exercise*

- Exercise offers many health-promoting benefits for people with or without diabetes and intervention strategies that promote life- long physical activity should be encouraged
- Hyperglycaemia may occur during or immediately after exercise because of increased hepatic glucose output secondary to both β and α adrenergic stimulation. This hyperglycaemia followed by hypoglycaemia

within 1 to 6 hours of completion of exercise due to hepatic glycogen depletion. So diabetic children who are involved in sport activities require frequent blood glucose monitoring to determine how to best adjust insulin and food. It is recommended that the blood glucose be done before and at termination of exercise and at hourly intervals during episodes of prolonged activity

- 15 g of carbohydrates maybe administrated as a readily absorbed sugar if blood glucose <100 mg/dl during the period of exercise. The use of readily absorbable carbohydrates source such as electrolyte containing sport drinks may be helpful in preventing hypoglycaemia both during and after exercise
- In children with mild to moderate hypoglycaemia should receive immediate treatment by consumption of rapidly absorbed simple carbohydrate (10 to 20 g), it may be appropriate to give small amounts of rapidly absorbed carbohydrates frequently as hypoglycaemia may cause vomiting. As symptoms improve additional complex long acting carbohydrate should be given orally and the blood glucose level should be recorded within 15 minutes.
- NICE (UK) guidelines recommend that parents, school teachers and other caregivers should ensure that children and young people with type 1 diabetes have access to an immediate source of carbohydrate (glucose or sucrose) and blood glucose monitoring equipment for immediate confirmation and safe management of hypoglycaemia.
- Children should be encouraged to wear medical alert identification indicating diagnosis of type 1 diabetes.

7.4.2 Nutritional management of type 2 diabetes

7.4.2.1 Healthy eating

Healthy eating has beneficial effects on weight, metabolic control, and general well-being. Many individuals with type 2 diabetes are overweight and have insulin insensitivity. Weight control by reducing energy intake and increasing energy expenditure, will improve glycaemic control and prevent coronary heart disease. Plasma glucose monitoring can be used to determine whether adjustment of food and meals will be sufficient to achieve blood glucose goals or if medications need to be added.

7.4.2.2 Exercise

Increase physical activity can improve hyperglycaemia, decrease insulin resistance, decrease body weight, and reduce cardiovascular risk. At least 150 min/wk of moderate intensity aerobic physical activity distributed over 3 days is recommended. In addition to encouraging patients with type 2 diabetes to perform resistance exercise three times a week.

7.5 Glucose-lowering therapies

7.5.1 Rationale

In type 1 diabetes, maintaining glycaemic levels as close to the non-diabetic range as possible has been demonstrated to have a powerful beneficial effect on diabetes-specific microvascular as well as cardiovascular complications. In type 2 diabetes, more intensive treatment strategies have also been demonstrated to reduce microvascular and macrovascular complications.

7.5.2 Selecting glucose-lowering interventions

The currently available glucose-lowering agents are used based on the glycaemic control achieved rather than any other specific benefits. Therefore, it is reasonable to judge and compare blood glucose lowering medications, and combinations of such agents, primarily because of their capacity to decrease and maintain HbA_{1c} levels and according to their safety, specific side effects, tolerability, ease-of-use and expense.

7.5.3 Initiation of glucose-lowering therapy

Hospitalization is not required for initiation or adjustment of therapy including insulin therapy. People with HbA_{1c} less than 8.0 % are usually treated initially with single oral agents. People with initial HbA_{1c} greater than 8.0-10.0 % may benefit from initial therapy with two oral agents or sometimes insulin.

7.5.4 Up-titration of glucose-lowering therapies (Figure 7.1)

With increasing islet β -cell failure, addition of further oral glucose-lowering therapies are required, including eventually insulin, and multiple injection therapy. Choices are divided into usual therapies, and alternatives used in specific circumstances.

7.5.4.1 Step 1 – lifestyle intervention and metformin

Metformin therapy should be started concurrently with lifestyle intervention at diagnosis. Metformin is recommended as the initial pharmacological therapy, in the absence of specific contraindications (in particular renal impairment), for its effect on glycaemia, absence of weight gain or hypoglycaemia, and relatively low cost. Metformin should be titrated to its maximally effective dose (2000 mg/day or more over 1–3 months, as tolerated).

7.5.4.2 Step 2 – sulfonylureas and alternatives

A sulfonylurea is usually added to metformin, when metformin and lifestyle no longer maintain glucose control to target levels. Hypoglycaemia is sometimes a problem with sulfonylureas, and in particular with glibenclamide. Where hypoglycaemia with other sulfonylureas is a problem, a thiazolidinedione or DPP-4 inhibitor are alternatives, as is basal insulin therapy. Sulfonylureas are sometimes used first line where metformin is contraindicated, or for their rapid glucose lowering effect.

7.5.4.3 Step 3 – basal insulin therapy and alternatives

Basal insulin therapy is highly effective provided proper dose titration and training are provided. It should be added to metformin + sulfonylurea. Risk of hypoglycaemia is a significant issue in many people using insulin – education and self-monitoring should be provided. Alternatives at this stage are a thiazolidinedione or DPP-4 inhibitor (gliptin), or in the obese a GLP-1 mimetic or acarbose.

7.5.4.4 Step 4 – multiple insulin therapy

In people already on basal insulin therapy, multiple insulin injections including meal-time insulin or by use of pre-mixes may become necessary as islet β -cell failure progresses. Further educational and self-monitoring support should be provided.

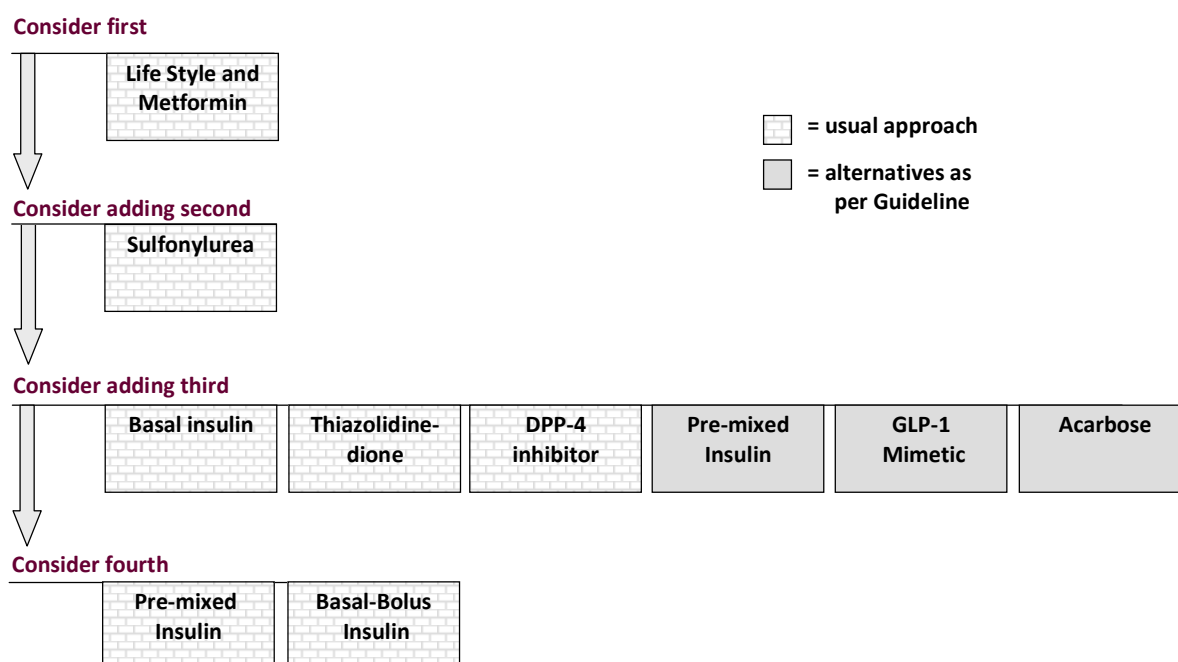


Figure 7.1 The stepped approach to glucose-lowering therapies

7.6 Practical insulin therapy

Appendices 2 and 3 gives a comprehensive list of currently available insulin preparations, their types, duration of action and some general guidance on their clinical use.

With so many various insulin and mixtures available, a wide range of possible injection regimens exist that can be broadly categorized into:

- Basal: Once or twice daily basal insulin (NPH insulin, insulin glargine, insulin detemir)
- Pre-mix: Usually twice daily meal-time and basal insulin provided in a combined injection formulation

- Multiple injection therapy: Separate provision of basal insulin therapy with meal-time insulin injections (unmodified insulin or a rapid-acting insulin analogue).

An appropriate insulin regimen can usually be adopted to conform to an individual's preferred meal routine, food choices, and physical activity.

A wide variety of insulin-injection devices is available, including a simple syringe and needle, pen injector devices, and insulin pumps (CSII). These are essential for proper delivery of insulin in many individuals and should be readily available for insulin-treated patients.

7.7 Diabetes self-management

7.7.1 Assessment of glycaemic control

Glycaemic control is best judged by the combination of the results of the person's current HbA_{1c} result and SMBG testing (as performed). The HbA_{1c} should be used not only to assess the blood glucose control over the preceding 2-3 months, but also as a check on the accuracy of the self-reported results and the adequacy of the SMBG testing schedule.

7.7.2 Self monitoring of blood glucose (SMBG)

- All people with type 1 diabetes should be taught how to self-monitor and record their blood glucose levels with home meters, and to adjust their insulin doses accordingly
- People with type 2 diabetes on insulin should be taught how to self-monitor and record their blood glucose levels with home meters and to adjust their insulin doses accordingly
- For people not on insulin, SMBG may be useful in achieving glycaemic goals, through support for self-management
- Insulin-treated patients should optimally test their plasma glucose daily before meals, and in some cases 1-2 hours after meals, and at bed-time specifically in more intensively treated patients. In practice, however, two measurements each day is acceptable, including fasting levels and at various other times, including pre-prandial and at bedtime
- People should receive initial instruction, but also routine follow-up evaluation of SMBG techniques and their ability to use data to adjust therapy
- People with type 1 diabetes should be instructed on methods of testing for urine ketones using reagent strips. They should be advised to test for urine ketones: whenever they develop symptoms of a cold, 'flu', or other intercurrent illness; if they develop nausea, vomiting, abdominal pain, or polyuria; or if they find an unexpectedly high plasma glucose level on self-monitoring.

7.7.3 Diabetes self-management education (DSME)

- People with diabetes should have a structured education programme at the time of diagnosis to initiate effective self care and are supported as needed to maintain it
- Health care providers who are qualified based on their professional training and continuing medical education should provide DSME
- DSME helps patients optimize metabolic control, prevent and manage complications, and maximize quality of life, in a cost effective manner
- DSME is associated with improved diabetes knowledge, self-care behaviour, and clinical outcomes such as lower HbA_{1c}, lower weight, and improved quality of life
- Better outcomes were reported for DSME that were longer and included follow up support
- Self-management behaviour change is the key outcome of DSME and should be measured and monitored as part of care
- DSME should also addresses psychological issues, since emotional well-being is strongly associated with positive diabetic outcomes.

7.7.4 Physical activity

7.7.4.1 Physiological background

Physical activity is defined as bodily movement produced by the contraction of skeletal muscle that requires energy expenditure in excess of resting energy expenditure.

Exercise is subset of physical activity: planned, structured, and repetitive bodily movement performed to improve or maintain one or more component of physical fitness.

Aerobic exercise consists of rhythmic, repeated, and continuous movement of the same large muscle groups for at least 10 min at a time examples include walking, bicycling, jogging swimming, and many sports. Resistance exercise consists of activities that use muscles strength to move a weight or work against a resistive load. Examples include weight lifting and exercises using weight machines.

7.7.4.2 Recommendations

- At least 150 min/wk of moderate-intensity aerobic physical activity (50-70% of maximum heart rate) and/or at least 90 min/week of vigorous aerobic exercise (>70% of maximum heart rate) is recommended
- The physical activity should be distributed over at least 3 days/week and with no more two consecutive days without physical activity

7.7.4.3 Evaluation before commencing an exercise programme

The area of screening asymptomatic people with diabetes for heart disease remains unclear, but routine screening is not recommended. Providers should use clinical judgment. High-risk individuals should be encouraged to start with short periods of low-intensity exercise and increase the intensity and duration slowly. Providers should assess patients for conditions that contraindicate certain types of

exercise or predispose to injury such as uncontrolled hypertension, severe peripheral neuropathy, severe autonomic neuropathy, a history of foot lesions, or active proliferative retinopathy.

7.7.4.1 Exercise in the presence of non-optimal glycaemic control

- *Hyperglycaemia*

When people with type 1 diabetes are deprived of insulin for 12-48 h or are ketotic, exercise can worsen hyperglycaemia and ketosis; therefore, vigorous activity should be avoided in the presence of ketosis. However it is not necessary to postpone exercise based simply on hyperglycaemia, provided the patient feels well and urine and/or blood ketones are negative

- *Hypoglycaemia*

In individuals taking insulin, physical activity can cause hypoglycaemia if medication dosage or carbohydrate consumption is not altered. For individuals on insulin, added carbohydrate should be ingested if pre-exercise glucose levels are <100 mg/dl. Hypoglycaemia following exercise is most likely after prolonged exercise involving the legs, such as walking, running or cycling. It may occur many hours after exercise has finished and even affect insulin requirements the following day. A larger than usual snack is advisable at bedtime following intensive exercise.