NATIONAL CLINICAL GUIDELINES

THE DIAGNOSIS & MANAGEMENT OF DIABETES IN CHILDREN AND ADOLESCENTS

Ministry of Public Health

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المبادئ الإرشادية السريرية لدولة قطر
NATIONAL CLINICAL GUIDELINES FOR QATAR

وزارة الصحـــة العامـــة
Ministry of Public Health
State of Qatar • دولـــة قطـــر

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2.0	Final	10th March 2021	Guidelines Team	Updated Version for Publication.

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Abbreviations

The abbreviations used in this guideline are as follows:

ACE	Angiotensin-Converting Enzyme
ACR	Albumin-Creatinine Ratio
ASCVD	Atherosclerotic Cardiovascular Disease
BG	Blood Glucose
BMI	Body Mass Index
BP	Blood Pressure
CBC	Complete Blood Count
CGM	Continuous Glucose Monitoring
CSII	Continuous Subcutaneous Insulin Infusion
DBP	Diastolic Blood Pressure
DKA	Diabetic Ketoacidosis
DSME	Diabetes Self-Management Education
DSMS	Diabetes Self-Management Support
ECG	Electrocardiogram
FBS	Fasting Blood Sugar
HbA1C	Glycated Haemoglobin Level
HDL	High Density Lipoprotein
HHS	Hyperglycaemic Hyperosmolar State
IFG	Impaired Fasting Glucose

IGT	Impaired Glucose Tolerance
IV	Intravenous Route
LDL-C	Low Density Lipoprotein Cholesterol
MODY	Maturity-Onset Diabetes of the Young
MOPH	Ministry of Public Health of Qatar
NAFLD	Non-Alcoholic Fatty Liver Disease
OGTT	Oral Glucose Tolerance Test
PCOS	Polycystic Ovary Syndrome
PCV	Pneumococcal Conjugate Vaccine
PPSV23	23-Valent Pneumococcal Polysaccharide Vaccine
RBS	Random Blood Sugar
SBP	Systolic Blood Pressure
SMBG	Self-Monitoring of Blood Glucose
T1DM	Type 1 Diabetes Mellitus
T2DM	Type 1 Diabetes Mellitus
TDD	Total Daily Dose
TIR	Time in Ranges

View Pathway

Table of Contents

1 Information about this Guideline

1.1 Objective and Purpose of the Guideline

The purpose of this guideline is to define the appropriate diagnosis and management of both type 1 and type 2 diabetes mellitus in children and adolescents. The objective is to improve appropriate investigation, prescribing and referral of patients presenting to any provider organisation in Qatar. It is intended that the guideline will be used primarily by physicians, nurses and health educators in primary/generalist care in both private and public sector organisations.

1.2 Scope of the Guideline

Aspects of care covered in this guideline include the following:

- Assessment and management of type 1 and type 2 diabetes mellitus in children and adolescents including:
    - Diabetes screening.
    - Lifestyle management of confirmed type 1 and type 2 diabetes.
    - Pharmacological therapy for type 1 and type 2 diabetes.
    - Glycaemic targets and glucose monitoring.
    - Hypoglycaemia prevention and management.
    - Complications and comorbidity screening and management.

Aspects of care not covered in this guideline include the following:

- Neonatal diabetes mellitus.
- Maturity-onset diabetes of the young.
- Detailed management of diabetic complications.

1.3 Editorial Approach

This guideline document has been developed and issued by the Ministry of Public Health of Qatar (MOPH), through a process which aligns with international best practice in guideline development and localisation. The guideline will be reviewed on a regular basis and updated to incorporate comments and feedback from stakeholders across Qatar.

The editorial methodology, used to develop this guideline, has involved the following critical steps:

- Extensive literature search for well-reputed published evidence relating to the topic.
- Critical appraisal of the literature.
- Development of a draft summary guideline.
- Review of the summary guideline with a Guideline Development Group, comprised of practising healthcare professionals, subject matter experts and patient representatives, from across Qatar.
- Independent review of the guideline by the National Clinical Guidelines & Pathways Committee, appointed by the MOPH, from amongst stakeholder organisations across Qatar.

Whilst the MOPH has sponsored the development of the guideline, the MOPH has not influenced the specific recommendations made within it.

1.4 Sources of Evidence

The professional literature has been systematically queried using specially developed, customised, and tested search strings. Search strategies are developed to allow efficient yet comprehensive analysis of relevant publications for a given topic and to maximise retrieval of articles with certain desired characteristics pertinent to a guideline.

For each guideline, all retrieved publications have been individually reviewed by a member of the Editorial Team and assessed in terms of quality, utility, and relevance. Preference is given to publications that:

1. Are designed with rigorous scientific methodology.
2. Are published in higher-quality journals.
3. Address an aspect of specific importance to the guideline in question.

Further information about the literature search and appraisal process is included in the appendix.

1.5 Evidence Grading and Recommendations

Recommendations made within this guideline are supported by evidence from the medical literature and where possible the most authoritative sources have been used in the development of this guideline. In order to provide insight into the evidence basis for each recommendation, the following evidence hierarchy has been used to grade the level of authoritativeness of the evidence used, where recommendations have been made within this guideline.

Where the recommendations of international guidelines have been adopted, the evidence grading is assigned to the underlying evidence used by the international guideline. Where more than one source has been cited, the evidence grading relates to the highest level of evidence cited:

- **Level 1 (L1):**
  - Meta-analyses.
  - Randomised controlled trials with meta-analysis.
  - Randomised controlled trials.
  - Systematic reviews.

- **Level 2 (L2):**
  - Observational studies, examples include:
    - Cohort studies with statistical adjustment for potential confounders.
    - Cohort studies without adjustment.
    - Case series with historical or literature controls.
    - Uncontrolled case series.
  - Statements in published articles or textbooks.

- **Level 3 (L3):**
  - Expert opinion.
  - Unpublished data, examples include:
    - Large database analyses.
    - Written protocols or outcomes reports from large practices.

In order to give additional insight into the reasoning underlying certain recommendations and the strength of recommendation, the following recommendation grading has been used, where recommendations are made:

- **Recommendation Grade A (RGA):** Evidence demonstrates at least moderate certainty of a net benefit from the recommendation.
- **Recommendation Grade B (RGB):** Evidence is insufficient, conflicting, or poor and demonstrates an incomplete assessment of net benefit vs harm; additional research is recommended.
- **Recommendation Grade C (RGC):** Evidence demonstrates potential harm that outweighs benefit; additional research is recommended.
- **Recommendation of the GDG (R-GDG):** Recommended best practice on the basis of the clinical experience of the Guideline Development Group members.

1.6 Guideline Development Group Members

The following table lists members of the Guideline Development Group (GDG) nominated by their respective organisations and the National Clinical Guidelines & Pathways Committee. The GDG members have reviewed and provided their feedback and approval of the guideline document. Each member has completed a declaration of conflicts of interest, which has been reviewed and retained by the MOPH.

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Name	**Title**	**Organisation**
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1.7 National Clinical Guidelines & Pathways Committee Members

The following table lists members of the National Clinical Guidelines & Pathways Committee (NCGPC), appointed by the MOPH. The NCGPC members have reviewed and provided their feedback and approval of the guideline document. Each member has completed a declaration of conflicts of interest, which has been reviewed and retained by the MOPH.

National Clinical Guidelines & Pathways Committee (NCGPC) Members		
Name	**Title**	**Organisation**
Ms Huda Amer Al-Katheeri	Chair of the NCGPC, Director of Strategic Planning & Performance Department	Ministry of Public Health
Shk Dr Mohammed Hamad J. Al Thani	Co-Chair of the NCGPC, Director of Public Health	Ministry of Public Health
Dr Hani Ben Hassen Al Kilani	Senior Consultant, Executive Director for Corporate Clinical Policy and Guidelines	Hamad Medical Corporation
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Dr Dahlia Mustafa Hassan	Senior Consultant Family Medicine	Primary Health Care Corp
Dr Ghassan Youseph Hommos	Senior Consultant Endocrinology	Al Emadi Hospital
Dr Egon Toft	VP and Dean	College of Medicine, Qatar University

1.8 Responsibilities of Healthcare Professionals

This guideline has been issued by the MOPH to define how care should be provided in Qatar. It is based upon a comprehensive assessment of the evidence as well as its applicability to the national context of Qatar. Healthcare professionals are expected to take this guidance into account when exercising their clinical judgement in the care of patients presenting to them.

The guidance does not override individual professional responsibility to take decisions which are appropriate to the circumstances of the patient concerned. Such decisions should be made in consultation with the patient, their guardians, or caregivers and should consider the individual risks and benefits of any intervention that is contemplated in the patient's care.

2 Management of Diabetes in Children and Adolescents Pathway

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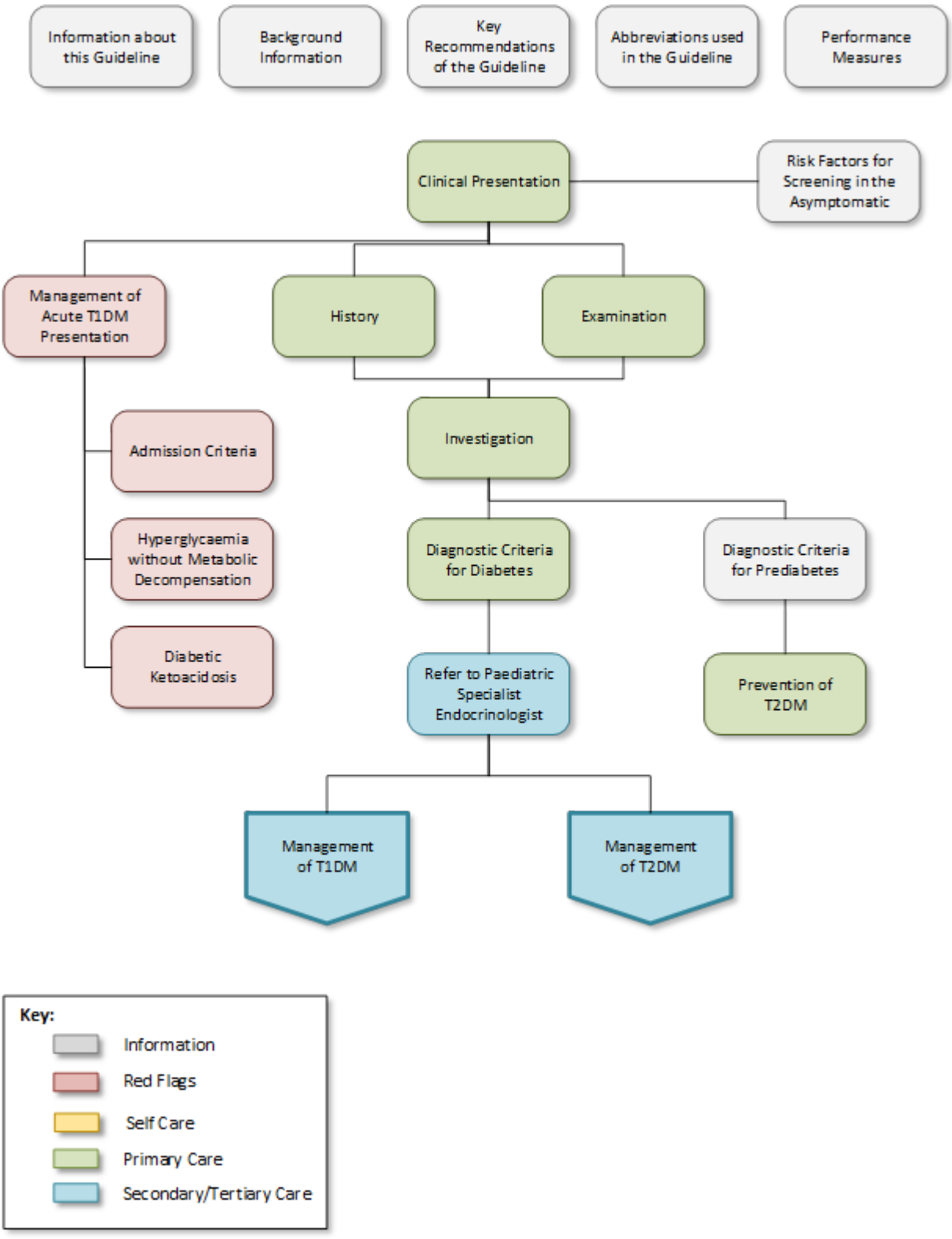

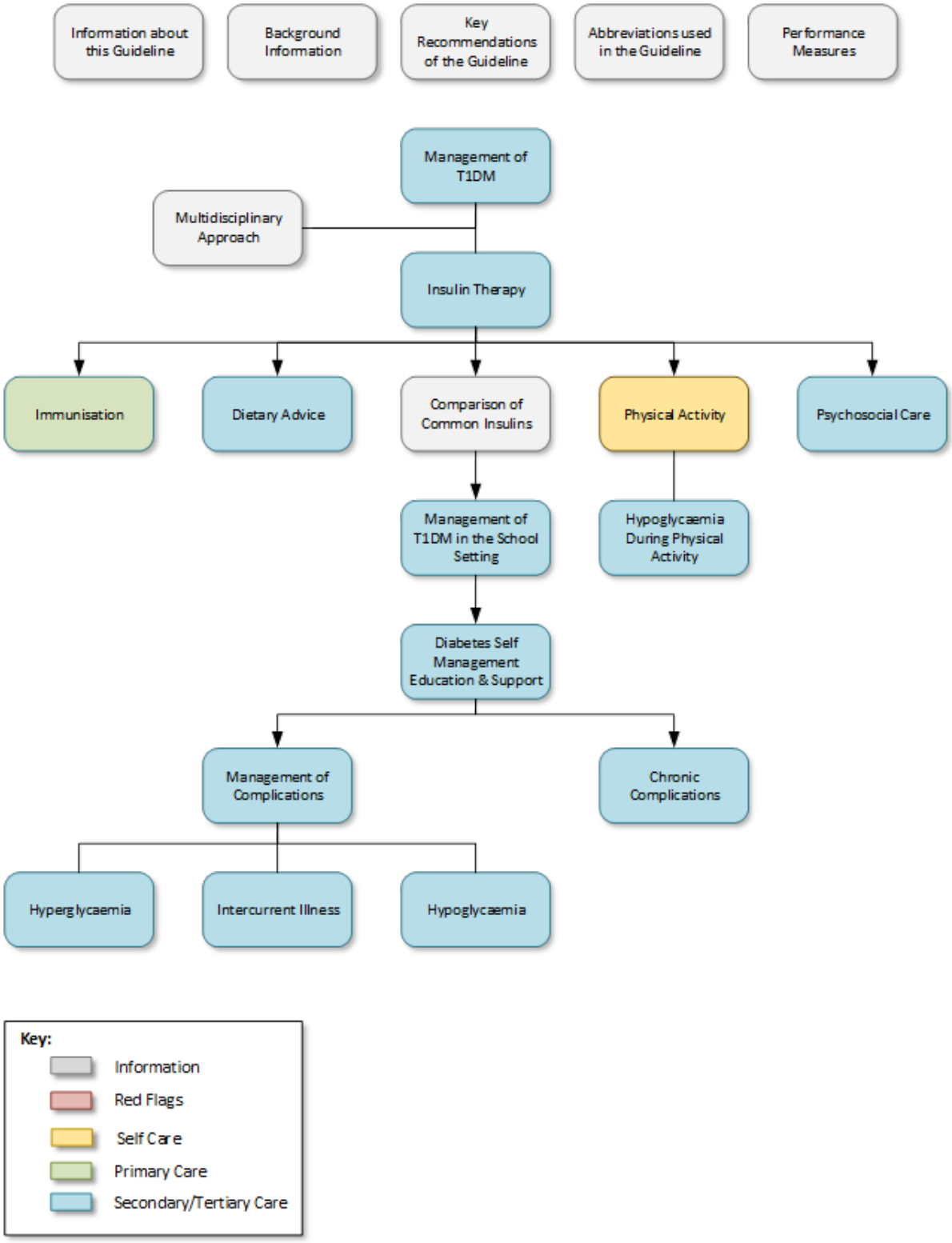
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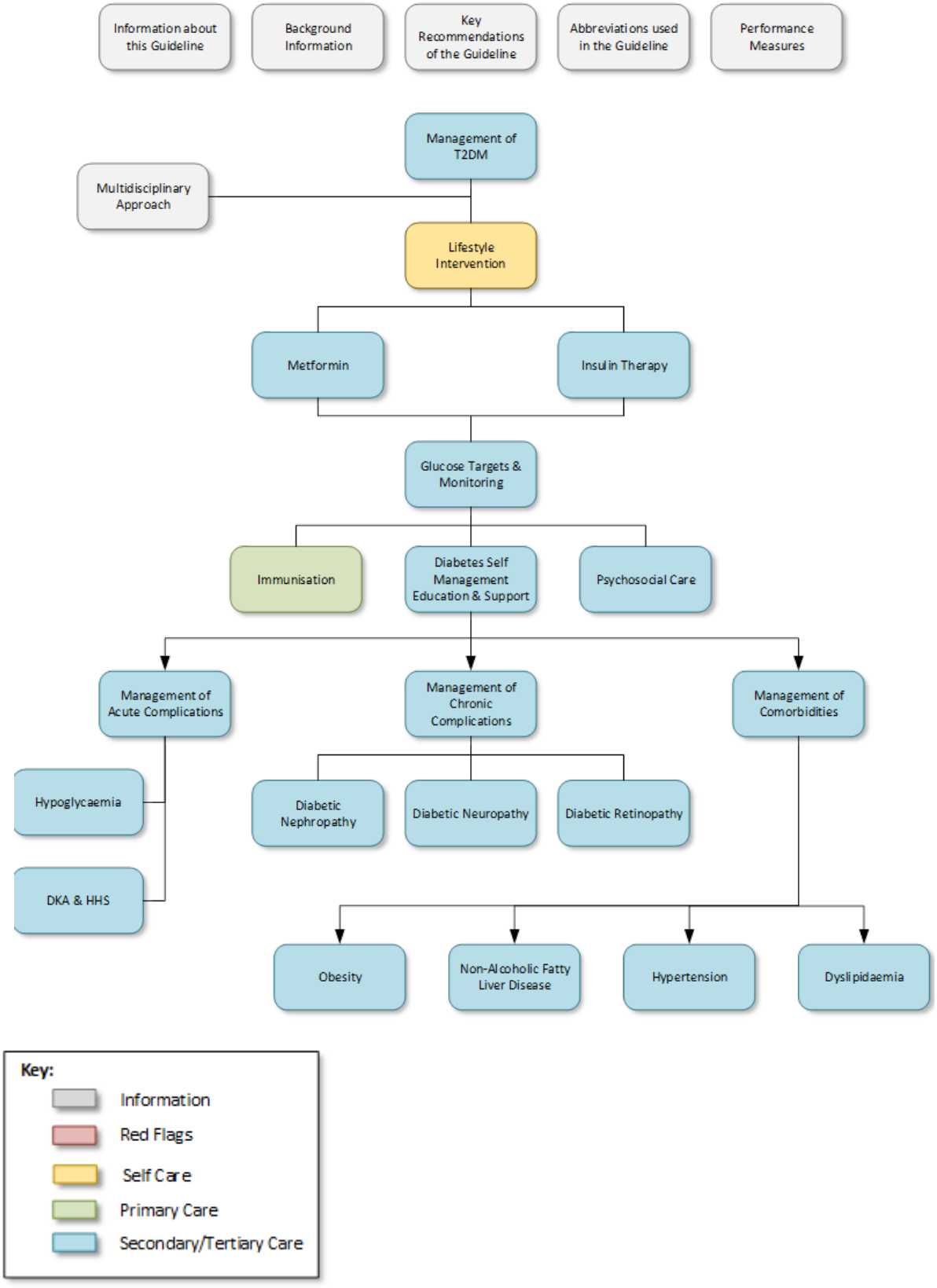
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Key:
Information
Red Flags
Self Care
Primary Care
Secondary/Tertiary Care

3 Key Recommendations of the Guideline

The key recommendations of this guideline are:

Diagnosis (see *Section 6.1*):

- Distinguishing between T1DM and T2DM in the paediatric and adolescent population is not consistently easy to define [1].
- T2DM remains a diagnosis of exclusion in adolescents [2].
- Exclude T1DM by assessing immune markers and monogenic diabetes through a careful family history and genetic testing [2].
- American Diabetes Association criteria for the diagnosis of T2DM requires one of the following [3]:
    - FBS: ≥7.0 mmol/L (126 mg/dL).
    - OGTT: ≥11.1 mmol/L (200 mg/dL) at 2-hours post-glucose.
    - RBS: ≥11.1 mmol/L (200 mg/dL) and the patient has classic symptoms of hyperglycaemia.
    - HbA_{1C}: ≥6.5%.
- In the absence of unequivocal hyperglycaemia, the diagnosis of diabetes should be confirmed by repeat testing [3] [**L2**].

Initial Management of an Acute Presentation of Type 1 Diabetes (see *Section 7*):

- Patients with symptoms can deteriorate rapidly, irrespective of the underlying type of diabetes and require urgent assessment and appropriate treatment [**R-GDG**].
- See *Section 7.1* for admission criteria.
- Refer acutely unwell patients to the Paediatric Emergency Centre for evaluation and management [3,4].

Management of Type 1 Diabetes (see *Section 8*):

- Care should be provided by an integrated and collaborative multidisciplinary team [3].
- The majority of type 1 diabetes patients should be managed using multiple-dose insulin injections from the time of diagnosis; or continuous subcutaneous insulin infusion (CSII), if multi-dose injections are not appropriate for the child [3,5].
- Most patients should be managed with insulin analogues that reduce hypoglycaemia risk, especially if the patient is at elevated risk of hypoglycaemia [3] [**L1**].
- Intensive management strategies should be used that employ pump therapy or continuous glucose monitoring and encourage active participation of the patient and family [3] [**L1**].
- Recommendations on optimal prandial insulin dose administration should be individualised to each patient [3].
- Recommended total daily doses (TDD) of insulin [**R-GDG**]:
    - Infants: TDD: 0.5- 0.7 unit/kg
    - Pre-pubertal children: TDD: 0.75- 1.0 unit/kg
    - Pubertal children: TDD:1.0–1.2 unit/kg
- NB: 50% of the TDD should be from basal insulin and 50% should be from prandial insulin [**R-GDG**].

Glycaemic Controls and Targets (see *Section 8.4*):

- The target BG levels across all paediatric age groups are as follows [3]:
    - Before meals: 5.0 – 7.2 mmol/L (90 – 130 mg/dL).
    - Bedtime/overnight: 5.0 – 8.3 mmol/L (90 – 150 mg/dL).
    - HbA_{1C}: < 7 % (a target of < 6.5 % is reasonable if it can be achieved without problematic hypoglycaemia, and a target of <8.0% can be set for patients with comorbid conditions or those with a

history of severe hypoglycaemia). (Ref Glycemic Targets: Standards of Medical Care in Diabetes—2021, American Diabetes Association

- If using ambulatory glucose profile/glucose management indicator to assess glycaemia, a parallel goal is a time in range of >70% with time below range <4% (Ref Glycemic Targets: Standards of Medical Care in Diabetes—2021, American Diabetes Association)

Lifestyle Advice (see *Section 8.5*):

- All patients should receive dietary advice delivered by a registered paediatric diabetes dietician [3] [**L1**].
- Consider individualised dietary advice for all children and adolescents with T1DM [3] [**L1**].
- Each member of the care team should be knowledgeable about the principles of appropriate well balanced nutrition and be supportive of its implementation [3] [**L2**].
- All children and adolescents with T1DM should be encouraged to exercise normally [6] [**L2**].

Management of Type 1 Diabetes in a School Setting (see *Section 8.11*):

- The school nurse and other school staff should be trained to meet the needs of students with T1DM [7] [**L2**].
- School staff should have access to relevant equipment and be trained in their use [7] [**L2**].
- Students with diabetes should participate fully in school sports and physical education.
- Parental attendance should not be required for a child's participation during the school day, on school trips or at extracurricular activities.

Management of Complications of Type 1 Diabetes (see *Sections 9 &10*):

- Hypoglycaemia:
  - Patients at risk for hypoglycaemia should be asked about symptomatic and asymptomatic hypoglycaemia at each encounter [3] [**L2**].
  - Those in close contact with hypoglycaemia-prone patients should be educated in the treatment of hypoglycaemia and the use of glucagon kits [3] [**L2**].
- Intercurrent illness:
  - See *Section 9.3* for advice on the management of patients with an intercurrent illness.
- Nephropathy:
  - In children who have had T1DM for 5 years [4]:
  - Screen annually for nephropathy, using a random spot urine sample for ACR.
  - Refer to paediatric nephrology if elevated ACR is confirmed on repeat sampling [**R-GDG**].
- Retinopathy:
  - In children aged ≥11 years or who are post-puberty (whichever occurs first), who have had T1DM for 3-5 years, should have an eye examination performed by an ophthalmologist [**R-GDG**]:
    - At the time of the initial diagnosis [3].
    - Every 2 years thereafter [3].
- Dyslipidaemia:
  - Obtain a fasting lipid profile in children aged ≥10 years, soon after the initial diagnosis and annually thereafter [3].

Management of Type 2 Diabetes (see *Section 12*):

- Care should be provided by an integrated and collaborative multidisciplinary team [3].
- A lifestyle modification programme including nutrition and physical activity should be started in all patients irrespective of pharmacotherapy [1] [**L1**].

- Nutritional interventions should only be provided by a healthcare professional (e.g. dietician) who has the relevant expert knowledge and experience in growth and development in children [8].

Pharmacotherapy for Type 2 Diabetes (see *Sections 12.3, 12.4 & 12.5*):

- Initial treatment is determined by the symptoms and severity of hyperglycaemia and the presence or absence of ketosis or ketoacidosis [1,3].
- Start metformin with lifestyle intervention as first-line therapy at the time of diagnosis of T2DM, unless the patient requires insulin therapy [1].
- Insulin should be used for patients presenting with [1,3,9]:
    - Ketosis.
    - Diabetic ketoacidosis (DKA) or hyperglycaemic hyperosmolar state (HHS).
    - In whom the distinction between T1DM and T2DM is unclear.
    - Who have RBS or FBS ≥13.9 mmol/L (250 mg/dL).
    - Whose HbA_{1C} is ≥8.5%.
- Insulin therapy in patients started on metformin:
    - Should be considered when glycaemic targets are not achieved with lifestyle measures and metformin therapy [2] [**L1**].
    - Should be supervised by a physician with experienced in insulin treatment in diabetic patients.
- Consider liraglutide in children >10 years old if glycaemic targets are not met with metformin with or without basal insulin [10–12] [**L1**]. Contraindications must be considered.

Treatment Targets for Type 2 Diabetes (see *Section 12.5*):

- Blood glucose range [3]:
    - 5.0-7.2 mmol/L (90-130 mg/dL) before meals.
    - 5.0-8.3mmol/L (90-150 mg/dL) 2 hours after meals.
    - Blood glucose (BG) targets should be modified in children with frequent hypoglycaemia or hypoglycaemia unawareness.
- HbA_{1C} of ≤7.0% across all patient age groups [1].

Screening for Type 2 Diabetes in Asymptomatic Patients (see *Section 13*):

- Screening for diabetes and prediabetes should be undertaken in those individuals who are overweight or obese, and who have additional risk factors for diabetes (see *Section 8.1*) [3]:

Management of Common Comorbidities Associated with Type 2 Diabetes:

- See *Section 14* for information on the management of common comorbidities associated with T2DM.

Management of Complications of Type 2 Diabetes (see *Section 15*):

- Patients with symptoms can deteriorate rapidly, irrespective of the underlying type of diabetes and require urgent assessment and appropriate treatment [**R-GDG**].
- Hypoglycaemia:
    - Patients at risk for hypoglycaemia should be asked about symptomatic and asymptomatic hypoglycaemia at each encounter [3].
    - Patients should be aware of situations in which they have an increased risk of hypoglycaemia [**R-GDG**].
- DKA and HHS:

    - Refer all patients to the Paediatric Emergency Centre for evaluation and management of DKA and HHS [**R-GDG**].
- Diabetic nephropathy:
    - Annual screening for albuminuria random spot urine sample for albumin–creatinine ratio (ACR) should be considered once diabetes has been present for ≥5 years [3].
    - Treatment is indicated when elevated urinary ACR (>30 mg/g) is documented in at least 2 of 3 urine samples which have been obtained over a 6-month interval, following efforts to improve glycaemic control and normalise BP [3].
- Retinopathy screening [3]:
    - Should be performed at age ≥11 years or after puberty has started (whichever is earlier), once the patient has had diabetes for 3–5 years [**R-GDG**].
    - After the initial examination, routine follow-up every 2 years is generally recommended.
- Neuropathy screening [3]:
    - Should be performed at age ≥10 years or post-puberty (whichever occurs first) [3]:
        - Screen for neuropathy at the time of diagnosis of T2DM.
        - Perform a comprehensive foot examination annually thereafter.

Psychosocial Care for all Children with Diabetes (see *Sections 8.9 & 12.7*):

- Children and young people with diabetes have a greater risk of emotional and behavioural difficulties [3,5].
- A lack of adequate psychosocial support has a negative effect on various outcomes, including BG control, and can also reduce self-esteem [3,5].
- Offer children and adolescents with diabetes and their family members or carers [3,5]:
    - Timely and ongoing access to mental health professionals.
    - Emotional support after diagnosis, which should be tailored to their emotional, social, cultural and age dependent needs.
    - Screening for anxiety and depression to patients who have persistently suboptimal BG control.
    - Prompt referral for those with suspected anxiety and/or depression to child mental health professionals.

4 Background Information

4.1 Classification

The general categories of diabetes mellitus are classified as follows [3,13]:

- Type 1 diabetes mellitus (T1DM) arises as the result of beta-cell insufficiency or destruction, usually leading to absolute insulin deficiency.
- Type 2 diabetes (T2DM) arises as the result of progressive loss of insulin secretion on the background of insulin resistance.
- Specific types of diabetes due to other causes, including:
    - Monogenic diabetes syndromes e.g.:
        - Neonatal diabetes.
        - Maturity-onset diabetes of the young (MODY).
    - Secondary diabetes, including:
        - Diseases of the exocrine pancreas.
        - Drug- or chemical-induced diabetes.
        - Endocrinopathies.

Childhood T1DM is defined by the presence of one or more of the following autoimmune markers [3]:

- Islet cell autoantibodies.
- Insulin autoantibodies.
- Glutamic acid decarboxylase (GAD65) antibodies.
- Antibodies to tyrosine phosphatases IA-2 and IA-2β.
- Antibodies to zinc transporter 8 (ZnT8).

Childhood T2DM is typically seen in children who [1]:

- Are overweight or obese.
- Have a strong family history of T2DM.
- At diagnosis, have substantial residual insulin secretory capacity (reflected by normal or elevated insulin and C-peptide concentrations).
- Demonstrate insulin resistance (including clinical evidence of polycystic ovarian syndrome (PCOS) or acanthosis nigricans).
- Lack evidence for diabetic autoimmunity (i.e. are negative for autoantibodies typically associated with T1DM).

Pre-diabetes [14]:

- Is a term used to refer to individuals with an impaired fasting glucose (IFG) and/or impaired glucose tolerance (IGT).
- Indicates a high risk for the future development of T2DM and cardiovascular disease.

5 Clinical Presentation

5.1 History and Examination

Key points to note in the medical history include [1,3] [**L2**]:

- Symptoms and duration of hyperglycaemia:
  - Including polyuria, polydipsia, polyphagia, fatigue, blurred vision and weight loss.
- Symptoms of diabetic ketoacidosis, including:
  - Abdominal pain, vomiting, drowsiness, tachypnoea and acetone-smelling breath.
- Pre-natal, birth and post-natal history, including:
  - Maternal gestational diabetes, gestational age at birth, birth weight, NICU admission.
- Family history of autoimmune-mediated disorders, including:
  - T1DM, thyroid disease, coeliac disease, adrenal disease.
- Lifestyle risk factors for DM, including:
  - Eating patterns and habit.
  - Weight history.
  - Physical activity.
- Symptoms of comorbidities associated with obesity including psychosocial problems.
- Social history, including:
  - Family circumstances.
  - School performance.
  - Nurse availability at school.
  - Smoking, alcohol and/or substance use.
- Medication history:
  - Especially medication that may exacerbate hyperglycaemia e.g.:
    - Glucocorticoids.
    - Beta-blockers.

Conduct a general physical examination noting in particular the following [3] [**L2**]:

- Height (including standard deviation), weight and body mass index (BMI).
- Pubertal development.
- Blood pressure (BP), including orthostatic BP, if indicated.
- Head and neck examination including:
  - Facial dysmorphism.
  - Thyroid or tonsillar enlargement.
- Skin stigmata (e.g. striae, acanthosis nigricans, hyperpigmentation, alopecia or vitiligo).
- Hepatomegaly.
- Comprehensive foot examination, including [**R-GDG**]:
  - Inspection for skin damage.
  - Palpation of dorsalis pedis and posterior tibialis pulses.
  - Absence or presence of patellar and Achilles tendon reflexes.
  - Determination of proprioception, vibration, and monofilament sensation.

5.2 Differentiating Between Type 1 and Type 2 Diabetes

The American Paediatric Association acknowledges that [1,14]:

- Distinguishing between T1DM and T2DM in the paediatric and adolescent population is not consistently easy to define.
- Clinical judgment plays an important role.

Differentiating between T1DM and T2DM [2]:

- Phenotypic overlap between T1DM and T2DM in children is common.
- T2DM remains a diagnosis of exclusion in adolescents.
- Although T2DM has been reported in preschool children, care must be taken in making this diagnosis in pre-adolescent children.
    - Exclude T1DM by assessing immune markers and monogenic diabetes through a careful family history and genetic testing.

In children and adolescents, the initial classification of diabetes is usually based on clinical features at first presentation and subsequent course [3,8].

Typical Presentations	
Type 1 Diabetes Mellitus	**Type 2 Diabetes Mellitus**

• Usually not overweight:
  ○ However, percentage of those who are overweight is increasing.
• Have recent weight loss, polyuria, and polydipsia.
• Short duration of symptoms.
• Frequently have ketosis:
  ○ 30–40% have ketoacidosis at presentation.
• 5% have a first- or second-degree relative with the same disease.
• Commonly occurs in childhood and adolescence but can occur at any age.
• After metabolic stabilization, may initially have diminished insulin needs, but thereafter require insulin for survival.
• Are at ongoing risk of ketoacidosis.
	• Usually overweight or obese.
	• Absent or mild polyuria and polydipsia, with little or no weight loss.
	• Acanthosis nigricans and PCOS may be present.
	• Usually present with glycosuria without ketonuria:
	  ○ However up to 33% have ketonuria at diagnosis.
	  ○ 5-25% of patients who are subsequently classified as T2DM, have ketoacidosis as the initial finding.
	  ○ Ketoacidosis is usually without any associated stress, other illness, or infection.
	• 74-100% have a first- or second-degree relative with T2DM.
	• Usually diagnosed over the age of 10 and in middle or late puberty.
	  ○ As obesity increases, may be diagnosed in younger or prepubertal children.

Table 5.2: Typical Presentations of T1DM and T2DM in Children [3,8,14].

6 Initial Investigations

6.1 Diagnostic Tests for Diabetes

The following investigations are used to test for diabetes [3]:

- Fasting blood sugar (FBS).
  - Patients should be fasting for at least 8 hours.
- Oral glucose tolerance test (OGTT):
  - Studies have confirmed that the 2-hour post-glucose value diagnoses more people with diabetes compared with FBS cut points and HbA_{1C}.
  - An anhydrous glucose load of 1.75 g/kg (up to a maximum of 75g) should be used in children [15].
- Random blood sugar (RBS).
- HbA_{1C} [3]:
  - In the diagnosis of diabetes in children and adolescents, it is not clear if the same HbA_{1C} cut points as adults, should be used.
  - Point-of-care HbA_{1C} assays are not recommended for diagnostic purposes.
  - In haemoglobinopathies and anaemias, a HbA_{1C} assay without interference from abnormal haemoglobins should be used.

6.1.1 Diagnostic Criteria for Diabetes

American Diabetes Association criteria for the diagnosis of diabetes requires one of the following [3]:

- FBS: ≥7.0 mmol/L (126 mg/dL).
- OGTT: ≥11.1 mmol/L (200 mg/dL) at 2 hours post-glucose.
- RBS: ≥11.1 mmol/L (200 mg/dL) - if the patient also has classic symptoms of hyperglycaemia.
- HbA_{1C}: ≥6.5%.

6.1.2 Diagnostic Criteria for Prediabetes

American Diabetes Association criteria for diagnosis of prediabetes requires one of the following [3]:

- Impaired fasting glucose (IFG):
  - FBS: 5.6-6.9 mmol/L (100-125mg/dL).
- Impaired glucose tolerance (IGT):
  - OGTT: 7.8-11.0 mmol/L (140-199 mg/dL) at 2 hours post-glucose.
- HbA_{1C}: 5.7–6.4%.

6.1.3 Confirmatory Testing

Confirming the diagnosis:

- A second diagnostic test is usually required to confirm the diagnosis [3] [**L2**]:
  - Unless the diagnosis is clear, e.g.:
    - Patient is in hyperglycaemic crisis.
    - Patient has classic symptoms of hyperglycaemia and a RBS ≥11.1 mmol/L (200 mg/dL).
- The same diagnostic test should be repeated using a new blood sample [3] [**L2**].

6.2 Additional Investigations

In patients with symptoms of hyperglycaemia and an elevated plasma glucose of ≥13.9 mmol/L (250 mg/dL) [1]:

- Test for ketosis with serum (e.g. beta-hydroxybutyrate) or urinary ketones.
- If positive, test for ketoacidosis by performing a venous blood gas.

Further laboratory evaluation [3]:

- Complete blood count (CBC).
- Urea, electrolytes and creatinine.
- Spot urinary albumin-creatinine ratio.
- Liver function tests.
- Fasting lipid profile (in children ≥5 years of age), including:
    - Total, LDL and HDL cholesterol and triglycerides.
- Fasting insulin level.
- C-peptide level.
- Thyroid function tests.
- Anti-thyroid antibodies (anti-thyroid peroxidase antibodies).
- Anti-insulin antibodies and anti-islets cell antibodies.
- GAD65 antibodies.
- Coeliac screen:
    - IgG and IgA anti-tissue transglutaminase antibody.
    - Deamidated gliadin antibodies.

Other investigations may be required for evaluation of obese children and adolescents e.g. [**R-GDG**]:

- Sleep studies for sleep apnoea.
- Hepatic ultrasound for fatty liver disease.

View Pathway

7 Initial Management of an Acute Presentation of Type 1 Diabetes

Patients with symptoms can deteriorate rapidly, irrespective of the underlying type of diabetes and require urgent assessment and appropriate treatment [**R-GDG**].

7.1 Admission Criteria

Admission to hospital is recommended for any of the following [**R-GDG**]:

- Children who have any of the following:
  - Diabetic ketoacidosis.
  - Dehydration.
  - Inability to tolerate oral fluids.
  - Electrolyte disturbance.
- Children aged <5 years.
- Parents who are unable to cope with management of the child as an outpatient.
- Presentation over the weekend (i.e. on a Thursday, Friday or Saturday).

7.2 Management of Diabetic Ketoacidosis:

Refer all patients to the Paediatric Emergency Centre for evaluation and management with [3,4]:

- Intravenous (IV) fluids.
- IV insulin.
- Electrolyte monitoring.
- BG monitoring.
- Cerebral oedema prevention measures.

7.2.1 Initial Management of DKA in Hospital

Ensure the following are recorded at admission [5]:

- Level of consciousness.
- Heart rate, blood pressure, temperature, respiratory rate (look for Kussmaul breathing).
- History of nausea or vomiting.
- Clinical evidence of dehydration.
- Weight.

Measure and record the capillary or venous [5]:

- pH and pCO2.
- Plasma sodium, potassium, urea, and creatinine.
- Plasma bicarbonate.

Consider [5]:

- Testing for ketones using a near patient blood ketone testing method for rapid diagnosis and monitoring of DKA in children and young people, if available.
- Insertion of a nasogastric tube if the child has a reduced level of consciousness and is vomiting.

Note [5]:

- If the child is <2 years or has severe DKA (blood pH <7.1), the patient should be admitted to a high dependency unit.
- Seek urgent anaesthetic review and discuss with a paediatric critical care specialist if the child cannot protect their airway because they have a reduced level of consciousness.
- Consider the use of inotropes in conjunction with a paediatric critical care specialist, if the child develops hypotensive shock.
- Consider sepsis in any child with any of the following features and refer to the National Clinical Guideline on the Diagnosis and Management of Sepsis [16]:
    - Fever or hypothermia.
    - Hypotension.
    - Refractory acidosis.
    - Lactic acidosis.

7.2.2 Fluid and Insulin Therapy

DKA should be treated with intravenous fluids and intravenous insulin if the child is not alert, is nauseated or vomiting, or is clinically dehydrated [5] [**L1**].

Do not offer oral fluids to the child if they are receiving intravenous fluids for DKA ***unless*** ketosis is resolving, the child is alert, and is not nauseated or vomiting [5].

For children and young people with DKA who are clinically dehydrated, but not in shock [5] [**L1**]:

- Give an initial intravenous bolus of 10 ml/kg of 0.9% sodium chloride over 30 minutes.
- Discuss with a senior paediatrician before giving more than one intravenous bolus of 10 ml/kg of 0.9% sodium chloride.
- Only consider giving a second 10ml/kg 0.9% sodium chloride intravenous bolus if needed to improve tissue perfusion, and only after reassessing the child's clinical status.
- When calculating the total fluid requirement, subtract these initial bolus volumes from the total fluid deficit.

For children and young people who have signs of shock [5] [**L1**]:

- Give an initial intravenous bolus of 20 ml/kg of 0.9% sodium chloride as soon as possible.
- When calculating the total fluid requirement, do not subtract this fluid bolus from the total fluid deficit.

NB [5]:

- Shock is rare in children and young people with DKA.
- Prolonged capillary refill, tachycardia and tachypnoea are common in children with moderate to severe DKA, but this does not mean the child is in shock (these are signs of vasoconstriction caused by metabolic acidosis and hypocapnia).
- Calculate the total fluid requirement for the first 48 hours in children and young people with DKA by adding the estimated fluid deficit to the fluid maintenance requirement:
- For the fluid deficit:
    - In mild to moderate DKA (blood pH ≥7.1), assume 5% dehydration (so a 10 kg child needs 500 ml).
    - in severe DKA (blood pH <7.1), assume 10% dehydration.
    - Aim to replace the deficit evenly over the first 48 hours, but in critically ill children and young people, discuss the fluid regimen early with the senior paediatrician or paediatric intensivist (or both), because the risk of cerebral oedema is higher.
- For the fluid maintenance requirement, use the Holliday-Segar formula:
    - Give 100 ml/kg for the first 10 kg of weight.

    - Give 50 ml/kg for the second 10 kg of weight.
    - Give 20 ml/kg for every kg after this amount.
    - Use a maximum weight of 75 kg in the calculation.
- When calculating the total fluid requirement, subtract any initial bolus volumes from the total fluid deficit unless the child is in shock.
- Use 0.9% sodium chloride without added glucose for both rehydration and maintenance fluid in children and with DKA, until the plasma glucose concentration is <14 mmol/litre.
- Be aware that some children and young people with DKA may develop hyperchloraemic acidosis, but this resolves on its own over time and specific management is not needed.
- Include 40 mmol/litre (or 20 mmol/500 ml) potassium chloride in all fluids (except the initial intravenous boluses) given to children with DKA, unless they have anuria or their potassium level is above the normal range. Do not delay potassium replacement, because hypokalaemia can occur once the insulin infusion starts.
- For children with potassium levels above the normal range, only add 40 mmol/litre (or 20 mmol/500 ml) potassium chloride to their intravenous fluids if:
    - Their potassium is less than 5.5 mmol/litre or;
    - They have a history of passing urine.
- For children with DKA who have hypokalaemia at presentation, include potassium chloride in intravenous fluids, before starting the insulin infusion.

Monitor sodium levels throughout DKA treatment and calculate the corrected sodium initially to identify if the child has hyponatraemia [5] [**L1**].

When monitoring serum sodium levels in children with DKA, be aware that [5]:

- Serum sodium should rise as DKA is treated as blood glucose falls.
- Falling serum sodium is a sign of possible cerebral oedema.
- A rapid and ongoing rise in serum sodium concentration may also be a sign of cerebral oedema, caused by the loss of free water in the urine.

Do not give intravenous sodium bicarbonate to children with DKA unless [5] [**L1**]:

- They have compromised cardiac contractility, caused by life-threatening hyperkalaemia or severe acidosis and
- The opinion of a paediatric intensivist has been obtained.

NB: Do not give children with DKA additional intravenous fluid to replace urinary losses [5] [**L1**].

Start an intravenous insulin infusion 1-2 hours after beginning intravenous fluid therapy in children with DKA [5] [**L1**]. If a child with DKA is using an insulin pump, disconnect the pump when starting intravenous insulin therapy. When treating DKA with intravenous insulin in children and young people, use a soluble insulin infusion at a dosage 0.05-0.1 units/kg/hour. Do not give bolus doses of intravenous insulin.

In discussion with a diabetes specialist, consider continuing subcutaneous basal insulin in a child who was using a basal insulin before DKA started [5].

When the plasma glucose concentration falls <14 mmol/litre in children with DKA, change fluids to 0.9% sodium chloride with 5% glucose and 40 mmol/litre (or 20 mmol/500 ml) potassium chloride [5] [**L1**].

If a child's plasma glucose falls <6 mmol/litre during DKA treatment [5] [**L1**]:

- Increase the glucose concentration of the intravenous fluid infusion and
- If they have persisting ketosis, continue to give insulin at a dosage of least 0.05 units/kg/hour.

If the blood beta hydroxybutyrate level is not falling within 6-8 hours in a child with DKA, think about increasing the insulin dosage to 0.1 units/kg/hour or more [5] [**L1**].

Think about stopping intravenous fluid therapy for DKA in a child if [5]:

- Ketosis is resolving and their blood pH has reached 7.3; and
- The child is alert; and
- The child is able to tolerate oral fluids without nausea or vomiting.

NB [5]:

- Discuss with a senior paediatrician before stopping intravenous fluid therapy and changing to oral fluids for DKA in a child if they still have mild acidosis or ketosis.
- Do not change from intravenous insulin to subcutaneous insulin in a child with DKA until ketosis is resolving, they are alert, and they can take oral fluids without nausea or vomiting.
- Start subcutaneous insulin in a child with DKA at least 30 minutes before stopping intravenous insulin.
- For a child with DKA who is using an insulin pump, restart the pump at least 60 minutes before stopping intravenous insulin. Change the insulin cartridge and infusion set and insert the cannula into a new subcutaneous site.

7.2.3 Patient Monitoring During Therapy

Monitor and record the following at least hourly in children with DKA [5]:

- Capillary blood glucose.
- Heart rate, blood pressure, temperature, respiratory rate (look for Kussmaul breathing).
- Fluid balance, with fluid input and output charts.
- Level of consciousness using the modified Glasgow Coma Scale.

Due to the increased risk of cerebral oedema, monitor and record the level of consciousness (using the modified Glasgow coma scale) and heart rate (to detect bradycardia) every 30 minutes in [5]:

- Children under 2 years with DKA.
- Children with severe DKA (blood pH <7.1).

Monitor children and young people having intravenous therapy for DKA using continuous electrocardiogram (ECG), to detect signs of hypokalaemia (including ST-segment depression and prominent U-waves) [5] [**L1**].

At 2 hours after starting treatment, and then at least every 4 hours, carry out and record the results of the following blood tests in children with DKA [5]:

- Glucose (laboratory measurement).
- Blood pH and pCO2.
- Plasma sodium, potassium and urea.
- Beta-hydroxybutyrate.

A doctor involved in the care of the child with DKA should review them face-to-face at diagnosis and then at least every 4 hours, and more frequently if [5]:

- The child is <2 years old.
- The child has severe DKA (blood pH <7.1).
- Any other reasons for special concern.

At each face-to-face review of the child with DKA, assess the following [5]:

- Clinical status, including vital signs and neurological status.
- Results of blood investigations.

- ECG trace.
- Cumulative fluid balance record.

7.2.4 Complications of Diabetic Ketoacidosis

Cerebral Oedema [5]
Immediately assess children and young people with DKA for suspected cerebral oedema if they have any of these early manifestations:

- Headache.
- Agitation or irritability.
- Unexpected fall in heart rate.
- Increased blood pressure.

If cerebral oedema is suspected in a child with DKA, start treatment immediately [5] [**L1, RGA**].

Start treatment for cerebral oedema immediately in children with DKA and any of these signs [5] [**L1, RGA**]:

- Deterioration in level of consciousness.
- Abnormalities of breathing pattern, for example respiratory pauses.
- Oculomotor palsies.
- Pupillary inequality or dilatation.

When treating cerebral oedema in children and young people with DKA, use the most readily available of:

- Mannitol (20%, 0.5-1 g/kg over 10-15 minutes); or
- Hypertonic sodium chloride (2.7% or 3%, 2.5-5 ml/kg over 1015 minutes).
- After starting treatment for cerebral oedema with mannitol or hypertonic sodium chloride in a child with DKA, immediately seek specialist advice on further management, including on the most suitable care setting for treatment.

Hypokalaemia [5]
If a child with DKA develops hypokalaemia (potassium <3 mmol/L):

- Consider temporarily suspending the insulin infusion.
- Discuss hypokalaemia management urgently with a paediatric critical care specialist, as a central venous catheter will be needed to administer intravenous potassium solutions >40 mmol/litre.

Venous thromboembolic disease [5]
Be aware of the increased risk of venous thromboembolism in children with DKA, especially if a central venous catheter has been inserted.

7.3 Management of Hyperglycaemia without Metabolic Decompensation

All patients who present with hyperglycaemia, but without metabolic decompensation should be referred first to the Paediatric Emergency Centre and then to the Paediatric Diabetes Day Care Unit, if all of the following criteria are met **[R-GDG]**:

- Children with normal hydration status, normal electrolytes and tolerating oral intake.
- Children aged 5 years and older.
- Children who are transferred from the Paediatric Emergency Centre at day time before 12 noon.

NB: If the above criteria are not met, consider hospital admission.

8 Management of Type 1 Diabetes

8.1 Multi-Disciplinary Approach

Care should be provided by an integrated and collaborative multidisciplinary team, which may include the following [3]:

- Paediatric endocrinologists with an interest in diabetes.
- Paediatric diabetes educator.
- Paediatric dieticians.
- Mental health professionals.

8.2 Roles and Responsibilities of the Multidisciplinary Team

The role of the diabetologist includes [**R-GDG**]:

- Monitor physical development and well-being with particular emphasis on
    - Growth.
    - Pubertal development.
    - Associated conditions including:
        - Goitre or thyroid disease.
        - Coeliac disease.
        - Other autoimmune conditions
        - Skin or foot problems.
- Choice of insulin types, doses, and injection/insulin delivery devices.
- Insulin adjustments based on BG values, food, and exercise.
- Glycaemic control, including:
    - HbA_{1C}
    - Analysis of home BG records.
- Hypoglycaemia history, including determination of hypoglycaemia awareness.
- Assessment of the psychosocial burden and referral to mental health professionals if needed.
- Management of intercurrent health problems, including:
    - Infections.
    - Disabilities.
    - Enuresis.
    - Nocturia
    - Diabetes-related emergency and Emergency Department visits.
    - Other paediatric and developmental problems.
- Assessment of the patient's understanding of the risks of complications.
- Formulation of care plans to minimise risk of complications and provide age-appropriate information.
- Ensure complication risk screening.
- Introducing insulin pump therapy.
- Introducing new technologies where available (e.g. continuous glucose monitoring).
- Assessment for co-morbidities.

The role of the paediatric diabetes educator includes education on the following [**R-GDG**]:

- The importance and timing of BG monitoring.
- The importance of insulin, different types and storage conditions.
- Promote Diabetes Self-Management Education (DSME) and Support (DSMS).
- Key skills, including: safe glucometer use, insulin administration technique and injection sites.
- Acute complications of T1DM:

    - Prevention, recognition and management of hypoglycaemia, including glucagon injections.
    - Prevention, recognition and management of intercurrent illness, hyperglycaemia, ketosis and ketoacidosis.
- Chronic complications of T1DM.
- T1DM management during physical activity.
- Sick-day management.
- Management of diabetes in school particularly school absences/problems and sport
    - Holiday planning and travel, including educational holidays and camps.
    - Establish and maintain follow-up in Paediatric Diabetes Educator's clinic
- Education regarding insulin pumps or new technologies, if prescribed by the diabetologist.
- Re-education when needed (at least 4 times/year).

The role of the paediatric dietician includes [**R-GDG**]:

- Qualitative and quantitative advice on intake of:
    - Carbohydrates
    - Fat.
    - Protein.
    - Dietary fibre.
- Advanced carbohydrate counting.
- Advice on the adjustment of the carbohydrate intake during exercise, social events and activities.
- Coping with special events and eating out.
- Growth and weight gain.
- Diabetic foods.
- Sweeteners and drinks.
- Management of hypoglycaemia.
- Re-education when needed (at least 3 times/year)

The role of the metal health professionals includes [**R-GDG**]:

- Age-appropriate assessment of the typical range of emotional reactions to the diagnosis of T1DM.
- Adherence to treatment.
- Anxiety and depression assessment and increased risk factors.
- Establish and maintain a system of recall and review.
- Provision of support for family & careers.

8.3 Multi-Disciplinary Team Roles in Patient Education

Education should be provided by the multidisciplinary team as outlined below [**R-GDG**].

The role of the diabetologist includes [**R-GDG**]:

- Psychosocial support for the child and family, ensuring parents do not blame themselves.
- Assessment of the growth of the child, and pubertal stage.
- Simple explanation of the unknown aetiology of T1DM.
- Describing the diabetes disease process and treatment options
- Follow up of the glucose monitoring and modify the insulin dose and/or regimen accordingly.
- Honeymoon remission period.
- Importance of glucose monitoring and HbA_{1C}.

The role of the paediatric diabetes educator includes [**R-GDG**]:

- Education about glucose, normal BG levels and glucose targets.
- Types of diabetes and the pathophysiology of T1DM.
- Teaching practical skills, including:

    - Insulin injection technique.
    - BG testing and timings.
    - Interpretation of results.
- Simple explanation of prevention and management of hypoglycaemia or hyperglycaemia.
- Management of diabetes during illnesses.
- How to prevent DKA.
- Importance of adherence to insulin therapy.
- Diabetes management at school.
- Encourage membership of a diabetes association.
- Provision of emergency telephone contacts.
- Provision of written education materials for parents and children.

The role of the paediatric dietician includes [**R-GDG**]:

- Anthropometric assessment.
- Diet history including:
- Usual diet.
- Energy intake.
- Total and saturated fat intake.
- Basic carbohydrate counting.
- Intake and distribution of carbohydrates.
- Appetite and food preferences.
- Family structure, social situation and factors may impact on diet
- Nutritional Requirements calculations for age.
- Meal Planning: provide suitable meal plan that matches the patient's nutrient requirements.
- Provision of patient information leaflets regarding diet in diabetes.

8.4 Insulin Therapy

Insulin regimens:

- The majority of type 1 diabetes patients should be managed using multiple-dose insulin injections or continuous subcutaneous insulin infusion (CSII, i.e. insulin pump) [3] [**L1**].
- Multiple-dose insulin injections should include [6] [**L1**]:
    - ≥3 injections of prandial insulin per day; and
    - 1-2 injections of basal insulin.
- Children and young patients should be offered multiple daily dose basal-bolus regimens from the time of diagnosis [5].
- Offer CSII if multiple daily injection regimens are not appropriate for the child [5].
- Intensive insulin therapy using ≥3 injections per day, or CSII provides improved glycaemic control and patient health outcomes [3] [**L1**].
- However, intensive insulin therapy is also linked to higher rates of severe hypoglycaemia [3] [**L1**].

Insulin administration:

- Most patients should be managed with insulin analogues that reduce hypoglycaemia risk, especially if the patient is at elevated risk of hypoglycaemia [3] [**L1**].
- Intensive management strategies should be used that employ pump therapy or continuous glucose monitoring and encourage active participation of the patient and family [3] [**L1**].
- Postprandial increases in glucose may be controlled by altering the timing of prandial (bolus) insulin administration [3] [**L2**].
- Recommendations on optimal prandial insulin dose administration should be individualised to each patient [3].
- The optimal time to inject prandial insulin is based on the following [3] [**L2**]:

  - The type of insulin used.
  - The measured blood glucose level.
  - Timing of meals.
  - Carbohydrate consumption.
- Provide children and young patients with needles that are an adequate length for their body fat [17].
- Consider the use of a sensor-augmented low glucose threshold suspend pump in the following patients [3] [**L2**]:
  - Frequent nocturnal hypoglycaemia.
  - Recurrent severe hypoglycaemia
  - Hypoglycaemia unawareness.

Recommended total daily doses (TDD) of insulin [**R-GDG**]:

- Infants: TDD: 0.5- 0.7 unit/kg
- Pre-pubertal children: TDD: 0.75- 1.0 unit/kg
- Pubertal children: TDD:1.0–1.2 unit/kg

NB: 50% of the TDD should be from basal insulin and 50% should be from prandial insulin [**R-GDG**].

8.4.1 Comparison of Common Insulins

Table 8.4.1 below outlines the main differences between common insulin formulations.

Insulin Type	Trade Name	Onset of Action	Duration of action
Rapid-acting analogues			
Lispro	*Humalog*	5-15 minutes	2-4 hours
Aspart	*Novorapid*		
Glulisine	*Apidra*		
Short-acting insulin			
Human Regular	*Actrapid*	30 minutes	5-8 hours
Intermediate-acting insulin			
Human NPH	*Isophane*	1-3 hours	12-18 hours
Basal insulin analogues			
Detemir Used in all age groups	*Levimer*	1-3 hours	6-24 hours
Glargine U300	*Toujeo*	1-2 hours	Up to 36 hours
Degludec Used in ≥1 year of age	*Tresiba*	1-2 hours	Up to 42 hours
Glargine Used in children ≥5 years	*Lantus*	1-2 hours	20-24 hours

Table 8.4.1: Comparison of Common Insulins [**R-GDG**].

8.5 Open and Closed Loop Insulin Delivery Systems

In the last decade, the improvements in pump therapy have shown remarkable results in achieving better glycaemic outcome in people with T1DM, using combined insulin pump and glucose sensor [18]. The management of this diabetes technology systems is covered by specialized and trained teams in tertiary health organizations [**R-GDG**].

There are two groups of insulin delivery systems [19]:

- Open Loop Systems:
  - Insulin pumps have predefined basal rates used to mimic near to physiological insulin delivery.
  - All systems have personal (patient) basal and bolus settings, which can be changed to achieve better glycaemic outcome.
- Closed Loop Systems ("artificial pancreas" or "automated insulin pump) [18]:
  - The system combines a continuous glucose monitor and an insulin pump to regulate patient's insulin with minimal interaction required from the patient.
  - The algorithm built in the pump regulates basal insulin delivery every five minutes based on the glucose readings.
  - Two types of commercialized closed loop systems are currently available:
    - Hybrid closed loop.
    - Advanced hybrid closed loop system.

The new systems have option to share the data (glucose levels, bolus insulin, meals and other) in real time with caregivers (parents, guardians, health providers) [18].

8.6 Glycaemic Control and Treatment Targets

The target BG levels across all paediatric age groups are as follows [3]:

- Before meals: 5.0 – 7.2 mmol/L (90 – 130 mg/dL).
- Bedtime/overnight: 5.0 – 8.3 mmol/L (90 – 150 mg/dL).
- HbA_{1C}: <7% (a target of <6.5 % is reasonable if it can be achieved without problematic hypoglycaemia, and a target of <8.0% can be set for patients with comorbid conditions or those with a history of severe hypoglycaemia).
- Time in Ranges [20]:
  - Both HbA_{1C} and self- monitoring blood glucose (SMBG) are the cornerstones of diabetes care. HbA_{1C} does not distinguish individuals with similar average glycemia but with pronounced differences in hypoglycaemic events and/or hyperglycaemic excursions. The glucose sensor or continuous glucose monitoring (CGM) provides a continuous measurement of the interstitial glucose over time and offers the opportunity to detect glucose variations, hypoglycaemic events, and different time in ranges (TIR) (refer to *Table 8. 6* for recommended TIR values).
  - The use of CGM together with HbA_{1C} promotes therapy adjustments in both T1DM and T2DM, especially for patients with frequent hypoglycaemia.
  - Individualized TIR goals are particularly important for paediatric populations.
  - All patients should be trained how to access, interpret and answer questions regarding their glycaemic control in the available devices and tools.

Note [3]:

- Goals should be individualised to the patient and modified if frequent hypoglycaemia or hypoglycaemia unawareness is present.
- Measure post-prandial BG if pre-prandial results do not correlate with the HbA_{1C} level and if assessment of pre-prandial insulin doses in basal–bolus regimens, is required.

	>250 mg/dL (13.9 mmol/L)	>180 mg/dL (10.0 mmol/L)	70-180 mg/dL (3.9-10.0 mmol/L)	<70 mg/dL (3.9 mmol/L)	<54 mg/dL (3.0 mmol/L)
T1DM & T2DM	<5%	<25%*	>70%	<4%**	<1%
High Risk T1DM & T2DM	<10%	<50%*	>50%	<1%	-
		>140 mg/dL (7.8 mmol/L)	63-140 mg/dL (3.5-7.8 mmol/L)	<63 mg/dL (3.5 mmol/L)	<54 mg/dL (3.0 mmol/L)
Pregnancy: T1DM	-	<25%	>70%	<4%**	<1%
Pregnancy: T2DM & Gestational	-	N/A	N/A	N/A	N/A

Table 8.6: CGM-Based Targets for Different Diabetes Populations [20]. * - Includes percentage of values >250 mg/dL (13.9 mmol/L). ** - Includes percentage of values <54 mg/dL (3.0 mmol/L). N/A – No sufficient data is available.

8.7 Diabetes Self-Management Education and Support

All children with T1DM should receive [1,3,9]:

- Comprehensive DSME, to include all knowledge and skills for self-care and SMBG.
- Comprehensive DSMS, to teach all the necessary skills needed for ongoing self-care.
- Use of tools including social network applications, distance learning, hard drive based media, and mobile content to support lifestyle modification to prevent diabetes [3] [**L2**].

The four critical times to deliver DSME and DSMS are [3]:

- At initial diagnosis.
- At every single outpatient visit (at least 4 times per year).
- Each time new complications arise that influence self-management.
- At transition points in care.

8.7.1 Self-Monitoring of Blood Glucose

The following advice should be given to both the patients and their families/caregivers [5]:

- Capillary blood testing should be performed at least 5 times per day.
- Self-monitoring of capillary blood glucose should be more frequent with increased physical exertion and at times of illness – ensure adequate test strips are available for this.

Children and adolescents should be offered a choice of monitoring equipment to optimise their glucose control [5].

Explain that blood glucose levels should be interpreted in the context of the 'whole child', which includes the social, emotional and physical environment [5].

8.7.2 Continuous Glucose Monitoring

The glucose sensor (or CGM) provides a continuous measurement of the interstitial glucose over time and offers the opportunity to detect glucose variations, hypoglycaemic events, and different time in ranges (TIR) [21].

It is recommended together with HbA_{1c} to promote therapy adjustments in both T1DM and type T2DM, especially for patients with frequent hypoglycaemia [21,22] [**L1, RGA**].

All patients and their parents or caregivers (when required) should be trained in how to access, interpret, and answer questions regarding their glycaemic control in the available devices and tools [21,22] [**L1**].

Ongoing real-time CGM with alarms [5]:

- This should be offered to the following patients:
  - Those with frequent episodes of severe hypoglycaemia.
  - Those with an impaired awareness of hypoglycaemia associated with adverse consequences (for example, seizures or anxiety).
  - Those with an inability to explain symptoms of hypoglycaemia (e.g. very young children or those with learning difficulties).
  - Children less than 6 years old [**R-GDG**].
- This should be considered for the following patients [5]:
  - Those who undertake high levels of physical exertion.
  - Those with significant co-morbidities or who are on medications that may make blood glucose levels difficult to control (e.g. those on corticosteroids).

Consider intermittent (real-time or retrospective) continuous glucose monitoring to help improve blood glucose control in children and young people who continue to have hyperglycaemia despite insulin adjustment and additional support [5].

8.8 Dietary Advice

All patients should receive dietary advice delivered by a registered paediatric diabetes dietician [3] [**L1**]. Consider individualised dietary advice for all children and adolescents with T1DM [3] [**L1**]. Each member of the care team should be knowledgeable about the principles of appropriate well balanced nutrition and be supportive of its implementation [3] [**L2**].

Educate patients on how to use carbohydrate counting or estimation to determine mealtime insulin dosing to improve glycaemic control [3] [**L1**]. Consider a consistent pattern of carbohydrate intake in patients who have a fixed insulin therapy programme [3].

Emphasise carbohydrate intake from the following sources, avoiding those containing sugars [3]:

- Whole grains.
- Vegetable.
- Fruits.
- Legumes.
- Dairy products.
- Foods higher in fibre and lower in glycaemic control.

8.9 Physical Activity

All children and adolescents with T1DM should be encouraged to exercise normally [6] [**L2**]. Children with T1DM should be encouraged to participate in at least 60 minutes of physical activity each day [3]. All children and adolescents with T1DM, should be encourage to reduce the amount of time they spend sitting [3] [**L1**].

Precautions [3]:

- Exercise can lead to metabolic disturbances occasionally leading to hyperglycaemia and ketosis or, more frequently, to hypoglycaemia.
- Tell children and adolescents with T1DM that they can lead a relatively normal life and take part in all forms of exercise, provided that this exercise is taken into account when reviewing their insulin requirements and diet.
- Blood glucose levels should be monitored pre- and post-exercise, as:
    - Blood glucose response varies to different types of exercise.
    - Hypoglycaemia may occur as a delayed response many hours after prolonged exercise.

8.9.1 Hypoglycaemia and Physical Activity

Hypoglycaemia can occur during and after aerobic physical exercise.

In patients managed with insulin [6]:

- Patients may need to ingest additional carbohydrate prior to exercise if pre-exercise glucose levels are <7 mmol/L (126mg/dL).
- Reducing the prandial insulin dose for the meal or snack prior to exercise or increasing food intake prior to exercise will raise the pre-exercise glucose level and reduce hypoglycaemia risk [6] [**L3**].
- Consider reducing the overnight basal insulin the night following exercise to reduce the risk of delayed exercise-induced hypoglycaemia [6] [**L2**].
- Keep a source of simple carbohydrate readily available before, during, and after exercise to treat and prevent hypoglycaemia [6] [**L3**].
- Note that intensive physical activity may increase blood glucose levels rather than lowering them[3] [**L2**].

8.10 Psychosocial Care

Consider the patient's psychosocial and social circumstances while managing T1DM [3]:

- Routinely screen for psychosocial problems, such as [3]:
    - Depression.
    - Diabetes-related distress:
        - Significant negative psychological reactions related to emotional burdens and worries associated with managing diabetes.
        - High levels of distress are associated with medication non-adherence, higher HbA_{1C} levels, lower self-efficacy, and poorer exercise and dietary behaviours.
    - Anxiety.
    - Eating disorders.
- Patients with diabetes and depression should receive stepwise collaborative care that aims to manage both the diabetes and the depression [3] [**L1**].

Consider referral to a mental health specialist familiar with diabetes if [3] [**L2**]:

- There is a possibility of self-harm.
- There is poor parental or care-giver support.
- The patient has a gross disregard for the medical regimen.
- The patient has depression.
- The patient has debilitating anxiety.
- There are indications of an eating disorder.
- Cognitive function significantly impairs function.

It is preferable to incorporate psychological assessment into the routine care of diabetes, rather than waiting for a specific problem to occur [3].

8.11 Immunisation

All children with T1DM should receive the standard vaccinations in childhood. In addition, the MOPH Public Health department recommends the following[23,24]:

- Pneumococcal vaccination:
  - 1 dose of PPSV23 at ≥2 years of age and at least 8 weeks after last dose of PCV.
    - Revaccination with PPSV23 is not required.
- Annual influenza vaccination prior to the start of the influenza season.

8.12 Management of Type 1 Diabetes in the School Setting

The school nurse and other school staff should be trained to meet the needs of students with T1DM including [7] [**L2**]:

- Recognition of the signs and symptoms of hypoglycaemia and hyperglycaemia.
- Prompt treatment of hypoglycaemia and hyperglycaemia.
- Administration of glucagon and insulin.
- Basic management of insulin pumps.

School staff should have access to the following equipment and be trained in their use [7] [**L2**]:

- Glucometer.
- Insulin therapy.
- Needles or pens.
- Glucagon injections.
- Glucose gel.
- Diabetes information manual.

School staff should be made aware of the following [7] [**L2**]:

- An individualised medical management plan.
- The child's management needs during the school day and during all school sponsored events.
- Help will always be required in the event of a diabetes emergency, regardless of the child's level of self-care.
- Nutritional information and carbohydrate content for school meals.
- Students with diabetes should participate fully in school sports and physical education.
- Parental attendance should not be required for a child's participation during the school day, on school trips or at extracurricular activities.
- To contact parents and the diabetes team if the there are concerns about the child's health.

8.13 Pancreas and Islet Cell Transplantation

Pancreas and islet cell transplantation is frequently explored by parents of patients with T1DM. Explain the following to patients and their families [3,6]:

- Transplantation may normalise glucose levels.
- But is only an option to be considered in adults.
- The use of islet transplantation remains under investigation at present.

9 Management of Acute Complications of Type 1 Diabetes

9.1 Hypoglycaemia

Hypoglycaemia is defined as [3]:

- Plasma glucose concentration of <3.9 mmol/L (70 mg/dL).

Mild to moderate hypoglycaemia is defined as [derived from [3]:

- Plasma glucose concentration of 2.2 – 3.9 mmol/L (40-70 mg/dL).
- Hypoglycaemia, which does not require assistance from another person.

Severe hypoglycaemia is defined as [3]:

- Plasma glucose concentration of <2.2 mmol/L (40 mg/dL).
- Hypoglycaemia requiring assistance from another person.
- It is characterised by cognitive impairment that may be recognised or unrecognised and can progress to loss of consciousness, seizure, coma or death (symptoms may be non-specific in children).

9.1.1 Education

Patients at risk for hypoglycaemia should be asked about symptomatic and asymptomatic hypoglycaemia at each encounter [3] [**L2**].

Patients should understand the situations that increase their risk of hypoglycaemia, such as [3] **[L2]**:

- Taking insulin without eating adequately.
- Fasting for tests or procedures.
- During or after intense exercise.
- During sleep.

Teaching patients how to balance their insulin use with their carbohydrate intake and exercise is required to reduce the risk of hypoglycaemia, however this method is not always sufficient for prevention [3] [**L2**].

Those in close contact with patients with hypoglycaemia prone patients should be educated in the use of glucagon kits [3] [**L2**].

9.1.2 Treatment

Mild to Moderate Hypoglycaemia:
Treatment of patients with mild-to-moderate hypoglycaemia comprises of [3]:

- 15–20g of Glucose (juice or glucose tablets/gels) is the preferred treatment for the conscious individual with hypoglycaemia, although any form of carbohydrate that contains glucose may be used.
- 15 mins after treatment, if SMBG shows continued hypoglycaemia, the treatment should be repeated.
- Once SMBG returns to normal, the individual should consume a meal or snack to prevent recurrence of hypoglycaemia.

Severe Hypoglycaemia:
Patients with a decreased level of consciousness [17] **[L1]**:

- Should be administered intramuscular glucagon by a family member or friend who has been educated on its use; and

- Then monitored for 10 minutes, if their level of consciousness is not significantly improving then they should be administered intravenous glucose; and
- Then given oral carbohydrate when it is safe for the patient, and put under continued observation by a third party who has been warned of the risk of relapse.
- Send the patient to the Paediatric Emergency Centre if not improving [**R-GDG**].

9.1.3 Hypoglycaemia Unawareness

Hypoglycaemia unawareness is indicated by or one or more episodes of severe hypoglycaemia and should trigger re-evaluation of the treatment regimen [3] [**L3**].

Insulin-treated patients with hypoglycaemia unawareness or an episode of severe hypoglycaemia should be advised:

- To raise their glycaemic targets to strictly avoid further hypoglycaemia for at least several weeks in order to partially reverse hypoglycaemia unawareness and reduce risk of future episodes [3] [**L1**].
- Ongoing assessment of cognitive function is suggested with increased vigilance for hypoglycaemia by the clinician, patient, and caregivers if low cognition or declining cognition is found [3] [**L2**].

9.2 Hyperglycaemia

Stressful events or intercurrent illness may aggravate glycaemic control and may lead to the development of diabetic ketoacidosis [3].

Provide each child and young patient and their family members and carers with verbal and written advice about management during intercurrent illness or episodes or hyperglycaemia, including [5] [**L2**]:

- Monitoring blood glucose.
- Monitoring and interpreting blood ketones.
- Adjusting their insulin regimen.
- Food and fluid intake.
- When and where to seek further advice for help.

9.3 Managing Diabetes during an Intercurrent Illness

Parents (and patients) should be advised of the following general measures to manage intercurrent illness and prevent DKA or hypoglycaemia (i.e. sick-day management) [4]:

Monitoring [4]:

- Increase the frequency of observation of the child.
- Measure BG every 2-3 hours and ketones every 4 hours.

Food and fluid intake [4]:

- Encourage fluids and rest.
- Encourage normal meals but encourage carbohydrate intake.

9.3.1 Patients on Multi-Dose Injection Regimens

Insulin management [**R-GDG**]:

- Basal insulin should always be continued, but doses should be modified if food consumption is less than usual [4].
- If BG is >250 mg/dL (13.9 mmol/L), or ketones are positive (i.e. detected in blood or urine):
    - Give additional rapid-acting insulin analogues every 2-4 hours (as per *Table 9.3.1* below), i.e. *Humalog*, *Novorapid* or *Apidra*.
    - Additional doses of insulin can be added to the usual dose or given with meals or snacks.
    - Encourage eating between doses of rapid-acting insulin analogues.
    - NB:
        - Omit additional doses if the BG is not elevated, even if ketones are present in blood or urine.
        - Ketones should decrease within 8 hours from the first dose of additional insulin.

Specialist advice and support [**R-GDG**]:

- Advise the patient and their family/carer to seek additional advice from the paediatric diabetes team.
- Emergency Department attendance is warranted if:
    - Ketones remain elevated despite two additional doses of rapid-acting insulin.
    - Symptoms of DKA develop.
    - The patient/family/carer is concerned about the child's illness of BG control.
    - BG is persistently >300 mg/dL (16.5 mmol/L), despite additional insulin.
    - BG is persistently <70 mg/dL (3.9 mmol/L).

Ketone levels		Insulin response according to blood glucose level	
Urine ketones:	Blood ketones:	BG: 250 – 350 mg/dL	BG: ≥351 mg/dL
Negative (-)	< 0.6mmol/l	No extra insulin required	Give 5% of TDD
Small (+)	0.6- 1.5mmol/l	Give 5% of TDD	Give 10% of TDD
Medium (++)	1.5- 3.0mmol/l	Give 10% of TDD	Give 15% of TDD
Large (+++/++++)	> 3.0mmol/l	Give 15% of TDD	Give 20% of TDD

Table 9.3.1: Insulin Management According to Urinary or Blood Ketones and BG Level [**R-GDG**]. TDD: Total daily dose of insulin.

9.3.2 Patients using insulin pumps

In addition to the general measures listed above. Patients should be advised to manage their insulin as outlined in *Table 9.3.2* below.

Blood glucose	Urinary ketones	Blood ketones	Actions

<6 mmol/L (110 mg/dL)	Negative or positive	0 - 3 mmol/L	• Reduce the dose of both basal insulin and any bolus doses by 10 - 20%.
			• Encourage consumption of sugar-containing fluids.
			• Seek specialist advice if
			  ○ Further insulin reductions are required.
			  ○ If the child is unable to drink, or
			  ○ If vomiting occurs.
			• Administer glucagon if BG remains low.

6 - 14 mmol/L (110 - 250 mg/dL)	Negative or positive (any amount)	0 - 3 mmol/L	• Give the usual insulin at the usual time. • Do NOT give extra insulin. • Retest BG in 2-4 hours.
>14 mmol/L (250 mg/dL)	negative or small (+)	0 - 0.6 mmol/L	• Temporarily increase the basal insulin rate by 20%. ○ Further increases may be required if BG remains elevated. • Give an additional bolus dose of insulin - up to 10% of the total daily dose. • Retest BG in 2-4 hours.
	moderate or large (+, ++)	0.7 - 3 mmol/L	• Temporarily increase the basal rate by 20%. ○ Further increases may be required if BG remains elevated. • Give an additional bolus dose of insulin - at least 10-20% of the total daily dose. • Retest BG in 2-4 hours.

Table 9.3.2: Insulin Management of Patients Using Insulin Pumps [**R-GDG**].

10 Management of Chronic Complications of Type 1 Diabetes

Nephropathy:
In children who have had T1DM for 5 years [4]:

- Screen annually for nephropathy, using a random spot urine sample for ACR.
- Refer to paediatric nephrology if elevated ACR is confirmed on repeat sampling [**R-GDG**].
- Should be considered at puberty or at age 10 years, whichever is earlier,

Retinopathy:

- Children aged ≥11 years or who are post-puberty (whichever occurs first), should have an eye examination performed by an ophthalmologist at the time of the initial diagnosis [3].
- For pre-pubertal children, an eye examination should be performed by an ophthalmologist, once the patient has had T1DM for 3-5 years [3].
- In all cases the eye examination should be repeated every 2 years thereafter [3].

Neuropathy:
For children aged ≥10 years or who are post-puberty (whichever occurs first), who have had T1DM for 3-5 years [**R-GDG**]:

- Perform a comprehensive foot examination annually [3].

Cardiovascular Risk Factors

- **Hypertension (see *Section 14.3*).**
- **Dyslipidaemia: (see *Section 14.4*).**

Obtain a fasting lipid profile in children aged ≥10 years, soon after the initial diagnosis and annually thereafter [3].

Management of dyslipidaemia [3]:

- Optimise glycaemic control and diet.
- Consider statin therapy in patients with:
  - LDL-C >4.1 mmol/L (160 mg/dL); or
  - LDL-C >3.4 mmol/L (130 mg/dL), if ≥1 ASCVD risk factor is present following lifestyle and diet improvement.
- Consider seeking the advice of a consultant in metabolic medicine prior to initiating therapy [**R-GDG**].
- LDL-C treatment target:
  - LDL-C <2.6 mmol/L (100 mg/dL).

11 Screening for Associated Autoimmune Conditions

Hypothyroidism [3]:

- Consider testing children with type 1 diabetes for antithyroid peroxidase and antithyroglobulin antibodies soon after diagnosis.
- Measure TSH after the initial diagnosis and once glucose control has been established
- If normal, suggest rechecking every 1-2years or soonerif the patient has positive thyroid antibodies or develops symptoms or signs suggestive of thyroid dysfunction,

Coeliac Disease [3]:

- Screen after the initial diagnosis by measuring:
    - IgG and IgA tissue transglutaminase antibody (with normal serum IgA levels) and/or
    - Deamidated gliadin antibodies
- Repeat screening should be performed annually thereafter or sooner if symptoms develop [**R-GDG**].
- Consider in patients with any of the following:
    - Family history of coeliac disease.
    - Failure to grow or gain weight.
    - Weight loss.
    - Diarrhoea or flatulence.
    - Abdominal pain.
    - Signs of malabsorption.
    - Repeated hypoglycaemia of unknown cause or decline in glycaemic control.

12 Management of Type 2 Diabetes

12.1 Multidisciplinary Approach

Care should be provided by an integrated and collaborative multidisciplinary team, which may include the following [3]:

- Paediatric endocrinologists with an interest in diabetes.
- Paediatric diabetes educator.
- Paediatric dieticians.
- Exercise specialists.
- Mental health professionals.

12.2 Lifestyle Intervention

Lifestyle intervention [1,8]:

- A lifestyle modification programme including nutrition and physical activity should be started in all patients irrespective of pharmacotherapy [1] [**L1**].
- Weight management and regular physical activity should be promoted in all children with T2DM.
- In paediatric patients, lifestyle change is most likely to be successful when a multidisciplinary approach is used and the entire family is involved [1] [**L1**]:
    - The family's ideal role in lifestyle interventions varies, depending on the child's age:
        - In younger children, behavioural interventions have shown a favourable effect.
        - In adolescents, interventions based on target-age behaviours (e.g. phone or internet-based interventions as well as face-to-face or peer-enhanced activities) appear to foster better results, at least for weight management.

Physical activity should include [1]:

- Moderate-to-vigorous exercise for at least 60 mins daily.
- Defined as exercise that results in the person breathing hard and perspiring and raises his or her heart rate:
    - Moderate physical activity - a person can talk but not sing
    - Vigorous activity - a person cannot talk without pausing to catch a breath.
- 60 mins of exercise can be done in shorter time intervals e.g. 10–15 minutes.
- Recommended for reduction of BMI and improved glycaemic control.
- With patients and their families, jointly determine an individualised plan that includes specific goals to reduce sedentary behaviours and increase physical activity:
    - A written prescription to engage in physical activity may improve adherence and should include a "dose" describing ideal duration, intensity, and frequency.
    - Encourage patients to find a variety of forms of activity that can done with ease and frequency.
    - Limit non-academic screen time to <2 hours a day:
        - Discourage the presence of video screens and television sets in children's bedrooms.
- N.B. Medication dosage may need to be adjusted, especially if the patient is receiving insulin, when starting a vigorous physical activity programme.

Nutritional interventions [8]:

- Should only be provided by a healthcare professional (e.g. dietician) who has the relevant expert knowledge and experience in growth and development in children.
- Specific recommendations should be tailored to the individual and include assessment of:
    - Food preferences.

    - Meal and snack times and locations.
    - Food preparation.
    - Readiness to change behaviour.
- Regular re-evaluation is essential if weight loss interventions are to succeed.

12.3 Metformin

Initial treatment is determined by the symptoms and severity of hyperglycaemia and the presence or absence of ketosis or ketoacidosis [1,3].

Initial treatment is typically with metformin and lifestyle intervention at the time of diagnosis of T2DM, unless the patient also requires insulin therapy (see below) [1].

Gastrointestinal adverse effects of metformin therapy [1]:

- Are common at initiation of medication, but are transient.
- Include:
    - Abdominal pain.
    - Bloating.
    - Loose stools.
- Can be minimised by:
    - Starting the drug at a low dose of 500mg daily and:
        - Increasing by 500 mg every 1-2 weeks;
        - Titrating up to an ideal and maximum dose of 2000 mg daily in divided doses.
    - Taking metformin with food.

In adolescents with PCOS [8]:

- Treatment with metformin may normalise ovulatory abnormalities and increase the risk of unplanned pregnancy.
- Pre-conception and pregnancy counselling is therefore an important part of treatment.

12.4 Insulin Therapy

Insulin therapy at initial presentation:

- Insulin should be used for patients presenting with [1,3,9]:
    - Ketosis.
    - Diabetic ketoacidosis (DKA) or hyperglycaemic hyperosmolar state (HHS).
    - In whom the distinction between T1DM and T2DM is unclear.
    - Who have RBS or FBS ≥13.9 mmol/L (250 mg/dL).
    - Whose HbA_{1C} is ≥8.5%.
- Metformin therapy may be used as an adjunct after resolution of ketosis/ketoacidosis.

Insulin therapy in patients started on metformin [1–3]:

- Should be considered when glycaemic targets are not achieved with lifestyle measures and metformin therapy [2] [**L1**].
- Insulin therapy is required until fasting and postprandial glycaemia have been restored to normal or near-normal levels.
- Many patients diagnosed with T2DM may be slowly weaned from insulin therapy and subsequently managed with metformin and lifestyle modification.
- Should be supervised by a physician with experienced in insulin treatment in diabetic patients.

If the glycaemic targets are not met using metformin alone or using combined therapy, a glucagon-like peptide 1 receptor agonist (liraglutide) can be initiated in children ≥10 years (see *Section 12.5*) [3].

12.5 Liraglutide Injections

Incretin mimetics such as liraglutide help the pancreas to release the right amount of insulin when blood sugar levels are high.

It is indicated for children [10–12] [**L1, RGA**]:

- >10 years old with T2DM; and
- HbA_{1C} 7-11% if treated with diet and exercise alone or HbA_{1C} 6.5-11% if treated metformin (with or without insulin); and
- BMI >85th percentile for age and gender.

It is contraindicated in patients [11,12] [**L1, RGC**]:

- Who have had medullary thyroid carcinoma.
- Who have pancreatitis.
- Who have multiple endocrine neoplasia syndrome type 2.
- With family members who have had medullary thyroid carcinoma.

12.6 Glucose Targets and Monitoring

Treatment targets for T2DM are as follows [3]:

- Blood glucose range:
    - 5.0-7.2 mmol/L (90-130 mg/dL) before meals.
    - 5.0-8.3mmol/L (90-150 mg/dL) 2 hours after meals.
    - Blood glucose (BG) targets should be modified in children with frequent hypoglycaemia or hypoglycaemia unawareness.
    - Postprandial blood glucose values should be measured when there is a discrepancy between pre-prandial BG values and HbA_{1C} levels and to assess pre-prandial insulin doses in those on basal–bolus regimens.

- HbA_{1C} of ≤7.0% across all patient age groups [1].
    - HbA_{1C} concentrations should be monitored every 3 months [1,5]:
        - Patients whose HbA_{1C} concentrations remain relatively stable may only need to be tested every 6 months [1].

Treatment should be intensified if treatment goals for BG and HbA_{1C} concentrations are not being met. Intensification activities may include, but are not limited to [1]:

- Increasing the frequency of clinic visits.
- Engaging in more frequent BG monitoring.
- Adding further antidiabetic agents.
- Meeting with a registered dietitian and/or diabetes educator.
- Increasing attention to diet and exercise regimens.

Successful treatment with lifestyle and pharmacotherapy is defined as [1,8]:

- Cessation of excessive weight gain with normal linear growth.
- Near-normal fasting BG values (≤7.0 mmol/L (126 mg/dL)).
- Near-normal HbA_{1C} (≤7%).

12.7 Diabetes Self-Management Education and Support

All children with T2DM should receive [1,3,9]:

- Comprehensive Diabetes Self-Management Education (DSME):
  - To facilitate the knowledge, skills, and abilities necessary for diabetes self-care.
  - Should include teaching self-monitoring of blood glucose (SMBG).
- Diabetes Self-Management Support (DSMS):
  - To assist with implementing and sustaining skills and behaviours needed for ongoing self-management, both at diagnosis and as needed thereafter.
- Technology-assisted tools including Internet-based social networks, distance learning, DVD-based content, and mobile applications can be useful elements of effective lifestyle modification to prevent diabetes [3] [**L2**].

12.7.1 Self-Monitoring of Blood Glucose

Advise children and adolescents with T1DM to regularly monitor capillary BG concentrations and that this should be a combination of fasting, pre-prandial and post-prandial measurements [1,8].

In most children and adolescents with T2DM [1]:

- Capillary BG monitoring should be performed at least 3 times a day when using multiple insulin injections or insulin pump therapy.
- Capillary BG monitoring may be useful to identify success of therapy in patients using less-frequent insulin injections, non-insulin therapies, or medical nutrition therapy alone.
- Less frequent measurements are needed with metformin, compared with insulin therapy or sulfonylureas, due to the reduced risk of hypoglycaemia.

For newly-diagnosed T2DM patients [8]:

- Capillary BG monitoring should be performed before meals (including a morning fasting concentration) and at bedtime until a good blood sugar control is achieved, after which monitoring frequency can be reviewed.
- However, those patients who are at risk of episodes of severe hypo- or hyperglycaemia will need continued frequent blood sugar testing.

12.8 Psychological and Social Issues

The following psychosocial issues apply to children and young people with diabetes [3,5]:

- Children and young people with T2DM have a greater risk of emotional and behavioural difficulties.
- A lack of adequate psychosocial support has a negative effect on various outcomes, including BG control, and can also reduce self-esteem.
- Offer children and adolescents with T2DM and their family members or carers:
  - Timely and ongoing access to mental health professionals.
  - Emotional support after diagnosis, which should be tailored to their emotional, social, cultural and age dependent needs.
  - Screening for anxiety and depression to patients who have persistently suboptimal BG control.
  - Prompt referral for those with suspected anxiety and/or depression to child mental health professionals.

View Pathway

12.9 Immunisation

All children with T2DM should receive the standard vaccinations in childhood. In addition, the MOPH Public Health department recommends the following [23,24]:

- Pneumococcal vaccination:
    - 1 dose of PPSV23 at ≥2 years of age and at least 8 weeks after last dose of PCV13.
        - Revaccination with PPSV23 is not required.
- Annual influenza vaccination prior to the start of the influenza season.

13 Screening and Prevention of Type 2 Diabetes

13.1 Risk Factors for Screening and Testing in Asymptomatic Patients

Screening for diabetes and prediabetes should be undertaken in those individuals who are overweight or obese, and who have any two of the following risk factors [3]:

- Family history of T2DM in a first- or second-degree relative.
- High-risk ethnicity.
- Signs of insulin resistance or conditions associated with insulin resistance:
    - Acanthosis nigricans.
    - Hypertension.
    - Dyslipidaemia.
    - PCOS.
    - Small-for-gestational age birth weight.
- Maternal history of diabetes or gestational diabetes mellitus during the child's gestation.

Timing of screening test should [3]:

- Start at 10 years of age or at the onset of puberty, if puberty starts at a younger age.
- Use either FBS or OGTT as screening tests, as appropriate [**R-GDG**].
- If testing was normal, repeat screening tests every 3 years [**R-GDG**].
- Those with prediabetes should be tested annually.
    - In patients with prediabetes, identify and if appropriate treat, other atherosclerotic cardiovascular disease (ASCVD) risk factors.

Evaluation of patients at risk should incorporate a global risk factor assessment for both diabetes and ASCVD [14].

13.2 Prevention of Type 2 Diabetes

Approaches can target [8]:

- General population of children, or
- Identification of high-risk individuals:
    - Need to identify those at increased risk and provide the required services.

Intervention can take place at [8]:

- An early stage when BG levels are still normal, or
- At the stage of IGT or IFG.

Prevention of T2DM may include [1,3,9]:

- Weight management.
- Patient education:
    - T2DM and its complications.
    - The role of diet and exercise in preventing diabetes.
- Encouragement of health eating.
- Regular physical activity.

14 Management of Comorbidities of Type 2 Diabetes

14.1 Obesity

Body Mass Index (BMI)[25]:

- The BMI measurement (once it has been adjusted for age and gender) can be used as a surrogate and simple marker of adiposity, but this is not a direct measure of adiposity.

Weight loss through diet alone is not recommended, as it is vital that diet is part of a varied approach, including exercise and psychological support with trained professionals [25].

Encourage parents or carers to take responsibility for children (especially if younger than age 12 years) and also to lose weight themselves, if they are obese [25].

Drug treatment with orlistat is only recommended in the following [25]:

- Children ≥12 years in whom lifestyle intervention has failed and who have:
    - Physical comorbidities e.g.:
        - Orthopaedic comorbidities.
        - Sleep apnoea.
    - Severe psychological comorbidities.
- If prescribed by a paediatric diabetologist in a multi-disciplinary setting [**R-GDG**].

Surgical intervention is not advised as a routine procedure in children or young people with diabetes[25] [**L1**].

- Bariatric surgery should only be considered in exceptional circumstances and where physiology maturity has, or nearly, been achieved.
- Surgery for obesity should be undertaken only by a multidisciplinary team that can provide paediatric expertise [**R-GDG**].

14.2 Non-Alcoholic Fatty Liver Disease

Non-alcoholic fatty liver disease (NAFLD) [25] [**L2**]:

- Do not use routine liver function tests to exclude NAFLD.
- Offer a liver ultrasound to test children and young people for NAFLD if they:
    - Have T2DM or metabolic syndrome; and
    - Do not misuse alcohol.
- Refer children with suspected NAFLD to a relevant paediatric specialist in hepatology in tertiary care.
- Diagnose children and young people with NAFLD if:
    - Ultrasound shows they have fatty liver; and
    - Other suspected causes of fatty liver have been excluded.
- Offer liver ultrasound to retest children and young people for NAFLD every 3 years.

14.3 Hypertension

14.3.1 Monitoring of Hypertension

Monitoring:

- Blood pressure (BP) should be measured at each routine visit [3].
- Children and adolescents should have their BP confirmed on 3 separate days if they have [3]:

- High-normal BP:
  - Systolic blood pressure (SBP) or diastolic blood pressure (DBP) ≥90th percentile for age, sex, and height; or
- Hypertension:
  - SBP or DBP ≥95th percentile for age, sex, and height.

14.3.2 Management of Hypertension

NB: Refer all children and adolescents with hypertension to a paediatric nephrologist for evaluation [**R-GDG**]. The goal of BP treatment is to achieve a consistent BP of <90th percentile for age, sex and height [3].

Initial treatment [3,8]:

- Lifestyle modification:
  - Dietary modification,
  - Increased exercise, and
  - Weight control.
- Pharmacological treatment should be considered along with lifestyle changes as soon as hypertension is confirmed, with the following [3]:
  - Angiotensin converting enzyme (ACE) inhibitors or angiotensin receptor blockers should be considered initially.
  - ACE inhibitors are the first line of therapy in children with microalbuminuria.
  - Counselling on the potential teratogenic effects of both medication classes should be provided to female adolescents of reproductive age.
- The following may also be considered [8]:
  - Alpha-blockers.
  - Calcium antagonists (long-acting).
  - Low-dose diuretics.
- If normo-tension (for age and sex) is not achieved, combination therapy may be considered [3,8].

14.4 Dyslipidaemia

14.4.1 Screening

Obtain a fasting lipid profile in the following children and adolescents [3]:

- Patients ≥10 years of age; and
- Following the diagnosis of T2DM and after glucose control has been attained.

If the lipid profile is abnormal [3]:

- Annual monitoring is reasonable.
- If LDL cholesterol (LDL-C) values are within the accepted risk level (<100 mg/dL (2.6 mmol/L)), a lipid profile repeated every 3 years is reasonable [**R-GDG**].

14.4.2 Lifestyle Intervention

The following may be helpful for children and adolescents with T2DM who also have dyslipidaemia [8,26]:

- Weight loss.
- Increased activity.
- Improved glycaemic control.
- Changing food choices and their preparation:

- Intake of saturated fats, trans fats, and cholesterol should be limited, while LDL-C lowering macronutrient intake should include plant stanols/sterols (approximately 2 g/ day) and soluble fibre (10-25 g/day) [26] [**L1**].
- A reduced calorie diet is recommended, consisting of:
  - Fruits and vegetables (≥5 servings/day) [26] [**L1**].
  - Grains (≥6 servings/day, one-third of those as whole grains).
  - Fish and lean meats [26] [**L1**].

14.4.3 Pharmacotherapy

Pharmacotherapy is recommended for children and adolescents >8 years who do not respond sufficiently to lifestyle modification, and particularly for those satisfying the following criteria [26] [**L3**]:

- LDL-C of ≥4.9 mmol/L (190 mg/dL); or
- LDL-C of ≥4.1 mmol/L (160 mg/dL); and
  - The presence of 2 or more ASCVD risk factors, even after vigorous intervention; or
  - A family history of premature coronary artery disease (<55 years of age) or;
  - Overweight, obese, or other elements of the insulin resistance syndrome.

The goal of therapy is [3,26]:

- Patients with T2DM and no other ASCVD risk factors:
  - An LDL cholesterol value of <2.6 mmol/L (100 mg/dL).
- For patients with T2DM with ≥1 additional ASCVD risk factors:
  - The recommended LDL-C goal is <1.8 mmol/L (70 mg/dL).

15 Management of Complications of Type 2 Diabetes

15.1 Acute Complications

Patients with symptoms can deteriorate rapidly, irrespective of the underlying type of diabetes and require urgent assessment and appropriate treatment [**R-GDG**].

15.1.1 Hypoglycaemia

Hypoglycaemia is defined as [3]:

- Plasma glucose concentration of <3.9 mmol/L (70 mg/dL).

Mild to moderate hypoglycaemia is defined as [derived from [3]:

- Plasma glucose concentration of 2.2 – 3.9 mmol/L (40-70 mg/dL).
- Which does not require assistance from another person.

Severe hypoglycaemia is defined as [3]:

- Plasma glucose concentration of <2.2 mmol/L (40 mg/dL).
- Hypoglycaemia requiring assistance from another person.
- It is characterised by cognitive impairment that may be recognised or unrecognised and can progress to loss of consciousness, seizure, coma or death (symptoms may be non-specific in children).

Patients at risk for hypoglycaemia should be asked about symptomatic and asymptomatic hypoglycaemia at each encounter [3].
Patients should be aware of situations in which they have an increased risk of hypoglycaemia, such as [**R-GDG**]:

- Fasting e.g.:
  - For medical tests or procedures.
  - During Ramadan or for other religious purposes.
- During or after intense exercise.
- During sleep.

Treatment [3]:

- Glucose (15–20g) is the preferred treatment for the conscious individual with hypoglycaemia, although any form of carbohydrate that contains glucose may be used.
- If SMBG shows continued hypoglycaemia 15 mins after treatment, repeat the treatment.
- Once SMBG returns to normal, the individual should consume a meal or snack to prevent recurrence of hypoglycaemia.
- Glucagon should be prescribed for all individuals at increased risk of severe hypoglycaemia.
- Caregivers, school personnel, or family members of these individuals should be instructed in its administration. Glucagon administration is not limited to health care professionals.

15.1.2 DKA and HHS

Refer all patients to the Paediatric Emergency Centre for evaluation and management with [**R-GDG**]:

- Intravenous (IV) fluids.
- IV insulin.
- Electrolyte monitoring.
- BG monitoring.
- Cerebral oedema prevention measures.

15.2 Chronic Complications

15.2.1 Diabetic Nephropathy

Screening:
Annual screening for albuminuria [3]:

- A random spot urine sample for albumin–creatinine ratio (ACR) should be considered once diabetes has been present for ≥5 years.
- Use the first urine sample of the day ('early morning urine') for screening, which reduces the risk of false positive results.
- Estimated glomerular filtration rate should be measured:
    - At initial evaluation and then,
    - Based on age, diabetes duration, and treatment.

Treatment:
Treatment is indicated when [3]:

- Elevated urinary ACR (>30 mg/g) is documented in at least 2 of 3 urine samples which have been obtained over a 6-month interval, following efforts to improve glycaemic control and normalise BP.
- Consider an ACE inhibitor titrated to normalisation of albumin excretion.

15.2.2 Retinopathy

Retinopathy screening [3]:

- Should be performed at age ≥11 years or after puberty has started (whichever is earlier), once the patient has had diabetes for 3-5 years [**R-GDG**].
- After the initial examination, routine follow-up is generally recommended every 2 years.
- Less frequent examinations, every 4 years, may be acceptable on the advice of an ophthalmologist.

15.2.3 Neuropathy

For children aged ≥10 years or who are post-puberty (whichever occurs first) [3]:

- Screen for neuropathy at the time of diagnosis of T2DM.
- Perform a comprehensive foot examination annually thereafter.

16 Advice for Fasting During Ramadan

Fasting during Ramadan:

- All children with diabetes are considered exempt from fasting on medical and religious grounds[27].
- If the child insists, a decision on fasting should be individualised to the patient and made in consultation with the patient's paediatric endocrinologist, 2-3 months prior to the start of Ramadan [**R-GDG**].
- Explain to the patient that [27]:
    - Going through a hypoglycaemic episode might be very dangerous.
    - Fasting may very rarely lead to hyperglycaemia which may lead to ketoacidosis (coma) and other serious health problems.
    - Fasting may lead to dehydration.

17 Key Considerations for Patient Preferences

Patient preferences refer to patient perspectives, beliefs, expectations, and goals for health and life, and to the steps employed by individuals in assessing the potential benefits, harms, costs, and limitations of the management options in relation to one another. Patients may have preferences when it comes to defining their problems, identifying the range of management options and selecting or ranking the outcomes used to compare these options.

It is important for healthcare professionals to develop an understanding of the patient as an individual and the unique way in which each person experiences a condition and its impact on their life.

The following recommendations are therefore made for physicians and other healthcare professionals regarding general principles of patient care in Qatar:

- **Respect Patients:** Treat patients with respect, kindness, dignity, courtesy and honesty. Ensure that the environment is conducive to discussion and that the patient's privacy is respected, particularly when discussing sensitive, personal issues. Ask the patient how they wish to be addressed and ensure that their choice is respected and used.

- **Maintain Confidentiality:** Respect the patient's right to confidentiality and avoid disclosing or sharing patients' information without their informed consent. In this context, students and anyone not directly involved in the delivery of care should first be introduced to the patient before starting consultations or meetings, and let the patient decide if they want them to stay.

- **Clarify Third-Party Involvement:** Clarify with the patient at the first point of contact whether and how they like their partner, family members or carers to be involved in key decisions about their care or management and review this regularly. If the patient agrees, share information with their partner, family members or carers.

- **Obtain Informed Consent:** Obtain and document informed consent from patients, in accordance with MOPH policy and guidance.

- **Encourage Shared Decision Making:** Ensure that patients are involved in decision making about their own care, or their dependent's care, and that factors that could impact the patient's participation in their own consultation and care including physical or learning disabilities, sight, speech or hearing impairments and problems with understanding, reading or speaking English are addressed.

- **Disclose Medical Errors:** Disclose errors when they occur and show empathy to patients.

- **Ensure Effective Communication:** Explore ways to improve communication including using pictures, symbols or involving an interpreter or family members. Avoid using medical jargon. Use words the patient will understand and confirm understanding by asking questions.

- **Ensure Continuity of Care:** Provide clear and timely sharing of patient information between healthcare professionals especially at the point of any transitions in care.

18 Performance Measures

A list of performance measures is given in the table below. Healthcare organisations are encouraged to monitor service performance using the indicator definitions below [28].

Number	Numerator	Denominator
DC01	Number in the denominator in whom the last HbA_{1c} <7.5% in the preceding 12 months.	Total number of diabetic patients aged <18 years who are treated as long term patients in the last 12 months.
DC02	Number in the denominator who have been offered a programme of diabetes education after diagnosis.	Total number of diabetic patients aged <18 years who are diagnosed in the last 12 months.

Table 18.1: Performance measures [28].

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Appendix: Detailed Description of the Literature Search

A systematic search for existing literature on diabetes mellitus in children and adolescents was performed in the period July 10th - August 24th, 2020. Review of additional literature based on GDG request was performed in the period February 8th - 9th.

All existing references were evaluated and where necessary and applicable, the latest version of the specific manuscript was used to update the guideline and replace the older reference. The search for clinical practice guidelines on the management of diabetes mellitus in children and adolescents was performed in the *PubMed* database and websites of relevant organisations and societies including the *UK NICE*, the *Supreme Council of Health (Qatar),* the *International Society for Paediatric and Adolescent Diabetes* and the *American Association for Clinical Endocrinologists*. The present guideline is primarily based on *UK NICE* and the *American Diabetes Association* guidelines and is supplemented with other relevant studies.

Peer-reviewed scientific publications were found in PubMed and via *Google Scholar* Internet search engine. Non-peer reviewed studies were identified in *bioRxiv*. Books were checked on *Amazon* and via *Google* and *Google Scholar* search engines.

The included publications were identified using the terms "*Diabetes*" and specified with the following terms in combinations:

Guideline, child, adolescent, glucose, type 1, type 2, classification, prevalence, epidemiology, risk, presentation, examination, complication, investigation, diagnosis, multidisciplinary, referral, specialist, prediabetes, admission, ketoacidosis, hyperglycaemia, hypoglycaemia, self-management, education, nutrition, exercise, psychosocial, autoimmune, immunisation, prevention, obesity, fatty liver, hypertension, dyslipidaemia, therapy, pharmacological, insulin, types, regimens, administration, multi-dose, insulin pump, metformin, pancreas, transplantation, complication, fasting, neuropathy, retinopathy, nephropathy, follow-up.

Figure A.1 on the next page demonstrates graphically the results of the search and application of exclusion criteria.

View Pathway

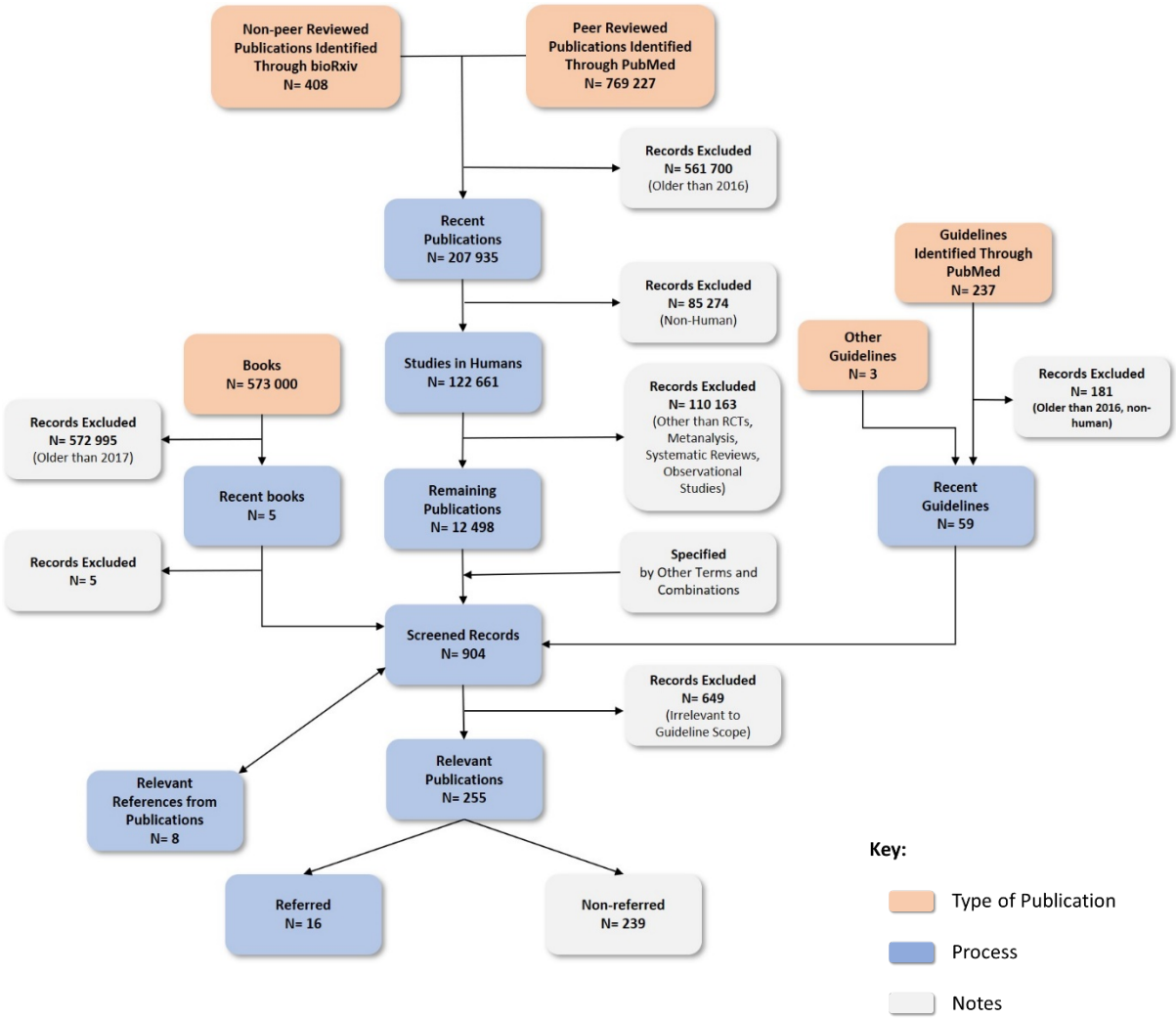

Fig A.1: Literature search results and application of exclusion criteria.

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