

National Diabetes Guidelines
United Arab Emirates
2009



صاحب السمو الشيخ خليفة بن زايد آل نهيان - رئيس دولة الإمارات العربية المتحدة



صاحب السمو الشيخ محمد بن راشد آل مكتوم - نائب رئيس الدولة
رئيس مجلس الوزراء. حاكم دبي

FOREWORD

تقديم

بسم الله الرحمن الرحيم

Diabetes is a recognised debilitating disease which threatens individuals and community health. Recent research has confirmed the accelerated spread of this disease, both internationally and in our local environment.

The Ministry of Health is devoting special importance to this subject, in line with the instructions from the wise political leadership of his highness Sheikh Khalifa Bin Zayed Al Nahyan, President of the UAE, and his brother, his highness Sheikh Mohammad Bin Rashid Al Maktoum, Vice President, Prime Minister and Ruler of Dubai. These guidelines offer the optimal, up-to-date best practice procedures in healthcare, for both local and expatriates living in our community.

As part of this directive, the National Diabetes Committee has been established. The members of the committee have participated in putting together a national strategy to combat this deadly disease, as well as set the goals and tasks which will prevent the progression of diabetes. In addition the National Diabetes Committee works to raise awareness in all age groups, highlighting the dangers of diabetes and helping to prevent its serious complications through early diagnosis.

Research, scientific studies and evidence-based medicine form the back-bone of the implementation plan of the national strategy, providing an objective and professionally outlined course of action, which has resulted in the adoption of the Diabetes Care Continuum (DCC) program, the practical means by which the strategic plan is being executed.

إن داء السكري من الأمراض الخطيرة التي أصبحت تشكل نوعاً من التهديد لصحة الفرد والمجتمع، بعد أن أكدت الدراسات تسارع معدلات انتشاره بشكل متزايد في الآونة الأخيرة على المستوى العالمي، وفي محيطنا المحلي أيضاً.

ولقد أولت وزارة الصحة هذا الموضوع الهام عناية خاصة، تنفيذاً لتوجيهات القيادة السياسية الرشيدة لصاحب السمو الشيخ خليفة بن زايد آل نهيان، رئيس الدولة، وأخيه صاحب السمو الشيخ محمد بن راشد آل مكتوم نائب رئيس الدولة، رئيس مجلس الوزراء، حاكم دبي، الداعية إلى تقديم أفضل سبل الرعاية الصحية لأفراد المجتمع من المواطنين والمقيمين على أرض الدولة.

ومن هذا المنطلق تم تشكيل اللجنة الوطنية لمكافحة داء السكري، التي أسهمت في وضع الاستراتيجية الوطنية لمكافحة هذا الداء الخطير، ووضعت ضمن أهدافها ومهامها الحيلولة دون انتشار المرض، والعمل على توعية الأفراد بمختلف فئاتهم السنية حول مخاطر هذا الداء ومن ثم كيفية تقادي الإصابة به.

وتنفيذاً لهذه الاستراتيجية، فقد أجريت دراسات بحثية وعلمية اتسمت بالموضوعية والجدية، مما أدى إلى اعتماد البرنامج المستمر لمكافحة داء السكري، والذي يمثل الوسيلة العملية لتنفيذ المخطط الاستراتيجي الذي وضع لهذا الغرض.

The document currently in your hands represents the first major piece of work of the DCC program. The “National Diabetes Guidelines” summarises the authorised framework for treatment of diabetes and the care of diabetics for all healthcare professionals in the UAE.

I fully support the admirable efforts being made and wholeheartedly show my appreciation and gratitude to all the members who have participated in developing the content of this book. I also extend my thanks to all the health authorities and companies who have helped in supporting this program.

I hope god will enable us and you to benefit our country, providing a safe and secure healthcare system for the people of our beloved community.

Minister of Health
Humaid Al-Qatami

وها هي أول ثمار هذا البرنامج بين أيدينا الآن، في شكل (الدليل الوطني لمعالجة الداء السكري)، الذي سيصبح الإطار المعتمد في دولة الإمارات العربية المتحدة لعلاج داء السكري ورعاية المرضى المصابين به من قبل جميع العاملين في المجال الصحي.

وإنني إذ أضع ثقتي في هذا الجهد الطيب، أسجل أيضاً امتناني لكافة الأعضاء الذين شاركوا في تطوير محتوى هذا الدليل وكذلك أتقدم بالشكر لكل الهيئات الصحية والشركات التي ساهمت في دعم هذا البرنامج.

وفقنا الله وإياكم لما فيه مصلحة البلاد وتحقيق الأمن والسلامة في المجال الصحي لأفراد مجتمعتنا الحبيب.

وزير الصحة
حميد القطامي

MEMBERS OF THE DIABETES GUIDELINES COMMITTEE

Bachar AFANDI, Twam Hospital, Al-Ain
Elham ALAMIRI, Al Qassemi Hospital, Sharjah
Fatheya ALAWADHI, Dubai Hospital, Dubai
Omniyat ALHAJERI, Sh.Khalifa Medical City, Abu-Dhabi
Khalid ALJABRI, Al-Mafraq Hospital, Abu-Dhabi
Jamal ALJUBEH, Sh.Khalifa Medical City, Abu-Dhabi
Jumaa ALKAABI, UAE University, Al Ain
Abdulrazzaq ALMADANI, Dubai Hospital, Dubai
Nawal ALMUTAWA, Al Qassemi Hospital, Sharjah
Ali BAKIR, Imperial College London Diabetes Center, Abu Dhabi
Salem BESHYAH, Sh.Khalifa Medical City, Abu-Dhabi
Stephen COLAGIURI, Sidney, Australia
Asma DEEB, Diabetes Centre, Imperial College, Abu-Dhabi
Ali ELHOUNI, Twam Hospital, Al-Ain
Mohammad FARGHALY, Primary Health Care, Dubai
Ahmad HASSOUN, Zayed Military Hospital, Abu-Dhabi
Walid KAPLAN, Twam Hospital, Al Ain
Ali KHALIL, Sh.Khalifa Medical City, Abu-Dhabi
Iyad KSSIERY, Welcare Hospital, Dubai
Harold LEBOVITZ, New York, United States of America
Husein SAADI, UAE University, Al Ain
Bashir SALI H, Corniche Hospital, Abu-Dhabi



ACKNOWLEDGEMENTS

With gratitude we acknowledge the continuous encouragement and support of His Excellency Humaid Mohammed Al Qutami, Minister of Health, which have enhanced the effort to improve diabetes care.

We also acknowledge His Excellency Dr. Ali Shaker, General Manager of MOH for his great and continuous support to the National Diabetes Guideline.

We are grateful for the valuable contribution of the members of the guideline group in preparing the National Diabetes Guideline.

Copyright

The copyright of this document is held by the National Diabetes Committee, we welcome use and reproduction of this document, or parts of the document, for non-commercial activities and with acknowledgement.

Correspondence in relation to guideline: Dr. Abdulrazzaq Al Madani, Dubai Hospital, Dubai, aaalmadani@dohms.gov.ae



PREFACE

The number of people with diabetes in the United Arab Emirates (UAE) has increased dramatically during the last 3 decades, and with the further development of the country more and more people will be diagnosed with diabetes. As seen in the studies carried out in 2000, the prevalence of diabetes among the citizens of the UAE is the second highest in the entire world.

Unfortunately, a big number of people with diabetes in the UAE do not receive the optimal care, and the glycaemic levels of the majority of people are not within the goals of the glycaemic targets set by the International Diabetes Federation (IDF) and other major international diabetes organizations (e. g. American Diabetes Association (ADA)). Therefore the prevalence of long term diabetes complications, specially, cardiovascular, renal and ophthalmic complications are high among people with diabetes in the UAE.

In order to improve the quality of life and reduce the long term complications of diabetes, the National Diabetes Committee (NDC) has developed these guidelines to ensure optimal diabetes management, which every person with diabetes deserves.

These guidelines use the evidence, analysis of IDF and ADA guidelines, as well as local experience obtained over the years. Thus the guidelines are customised to suit the culture and the style of living in the UAE, ensuring a reliable and efficient method for the management of diabetes.

NDC highly recommends these guidelines to be followed by anyone involved in the management of people with diabetes in UAE.



CONTENT

Introduction	19
Classification of diabetes	21
Criteria for the diagnosis of diabetes	23
Criteria for screening for diabetes in asymptomatic adults	25
Criteria for Screening for type 2 diabetes in children	27
Management of pre-diabetes	29
Initial evaluation of adults with diabetes	31
Management of diabetes mellitus	33
Treatment	35
Diet and nutritional recommendations	35
Physical activity	36
Smoking cessation	37
Oral hypoglycaemic agents	38
Insulin therapy	43
Treatment recommendation for people with type 2 diabetes	47
Acute complications of diabetes	51
Hypoglycaemia	51
Diabetic ketoacidosis (DKA)	54
Hyperglycaemic Hyperosmolar State (HHS)	58
Prevention and management of diabetes complications	61
Cardio vascular disease screening and treatment	61
Nephropathy screening and treatment	63
Diabetic retinopathy screening and treatment	64
Foot care in people with diabetes	64



Follow up care plan	67
Guideline for diabetes care and criteria for referral.....	68
Diabetes and pregnancy	71
Special considerations	75
Care of elderly with diabetes.....	75
Sick day management.....	75
Diabetes Care in Children and Adolescents	77
Diabetes Care in the School and Day Care Setting	77
Hypoglycemia.....	80
Assessment of glycaemic control.....	86
Glycemic Control Recommendations.....	88
Screening and management of chronic complications.....	92
Diabetic Ketoacidosis Guidelines in Children and Adolescents with Type 1 Diabetes.....	93
Monogenic Diabetes in Children.....	102
Management of children with diabetes undergoing surgery ..	104
Management of children with diabetes during intercurrent illness	107
Treatment of Type 1 Diabetes in Children and Adolescents ..	109
Management of people with diabetes during Ramadan	113
Pregnancy and fasting during Ramadan	116
Management of hypertension and dislipidaemia during Ramadan	116
Reference	117



INTRODUCTION

Diabetes is a chronic disease that requires continuing medical care and patient self-management education to prevent acute complications and to reduce the risk of long term complications. Diabetes is a metabolic disorder of multiple aetiology, characterized by chronic hyperglycemia with disturbances in carbohydrate, fat, and protein metabolism, resulting from either defect of insulin secretion or action or both. The long-term effects of chronic hyperglycemia, traditionally divided into micro- and macrovascular complications, results in dysfunction, damage, or failure of various organs:

1. Microvascular complications:

Eyes	(retinopathy, cataract, glaucoma, blindness)
Kidneys	(nephropathy, renal failure)
Nervous system	
Peripheral neuropathy	(foot ulcer, amputation)
Autonomic neuropathy	(sexual dysfunction, ortostatic hypotension, diabetic enteropathy, diabetic gastroparesis, gustatory sweating)

2. Macrovascular complications:

Cardiovascular	(coronary artery disease, congestive heart failure, peripheral artery disease, cerebrovascular disease)
-----------------------	---

Prevalence of diabetes and impaired glucose tolerance (IGT) in the UAE

The ENDCAD study (The Emirates National Diabetes Study & Screening for Coronary Artery Disease Risk Factors), conducted jointly by the World Health Organization and the UAE Ministry of Health between the years 1998-2000 on 6,609 male and female individuals above the age of 21 years, (2,363 UAE nationals and 4,246 expatriates showed the prevalence of Diabetes and Impaired glucose tolerance (IGT) as follows:

Total	DM 19.6%,	IGT 15.2%
UAE nationals	DM 24%,	IGT 17.9%
Expatriates	DM 17.4%,	IGT 13.4%



CLASSIFICATION OF DIABETES

The classification of diabetes includes four clinical classes:

1. TYPE 1 Diabetes: < 10%

Type 1 diabetes results from β -cell destruction, usually leading to absolute insulin deficiency

- Type 1A - Immune mediated (> 90% of Type 1 diabetes)
- Type 1B - Idiopathic (< 10% of Type 1 diabetes)

2. TYPE 2 Diabetes: > 90%

Heterogenic type results from a progressive decline of β -cell function on the background of insulin resistance.

3. Gestational diabetes mellitus (GDM):

Diagnosed during pregnancy.

4. Other types:

- Pancreatic disease, e.g. chronic pancreatitis, pancreatectomy
- Endocrine disease, e.g. Cushing's syndrome, thyrotoxicosis, acromegally
- Genetic syndromes (Down's syndrome, Klinefelter's syndrome, Turner's syndrome etc)
- Drug induced, e.g. steroids, interferon etc
- Monogenic causes of diabetes (MODY, MIDD)



CRITERIA FOR THE DIAGNOSIS OF DIABETES

1. Symptoms of diabetes and casual plasma glucose ≥ 200 mg/dl (11.1 mmol/l). Casual is defined as any time of the day without regard to time since the last meal. The classic symptoms of diabetes include polyuria, polydipsia, and unexplained weight loss.

OR

2. Fasting plasma glucose (FPG) ≥ 126 mg/dl (7.0 mmol/l). Fasting is defined as no caloric intake for at least 8 hours.

OR

3. 2-h plasma glucose ≥ 200 mg/dl (11.1 mmol/l) during an oral glucose tolerance test (OGTT). The test should be performed as described by the World Health Organization, using a glucose load containing the equivalent of 75-g anhydrous glucose dissolved in water.

N.B:

1. In the absence of unequivocal hyperglycemia with acute metabolic decompensation, these criteria should be confirmed by repeated testing on a different day. The OGTT is not recommended for routine clinical use, but may be required in evaluation of people with impaired fasting glucose (IFG).
2. Normal fasting plasma glucose (FPG) < 100 mg/dl (5.6 mmol/l).
Normal random plasma glucose (RPG) < 140 mg/dl (7.8 mmol/l).
Normal glucose tolerance test (OGTT) 2hrs post GTT < 140 mg/dl (7.8 mmol/l).
3. Hyperglycemia not sufficient to meet the diagnostic criteria for diabetes are categorized as:
Impaired fasting glucose (IFG) = FPG, 100 – 125 mg/dl (5.6 – 6.9 mmol).
Impaired glucose tolerance (IGT) = 2hrs post OGTT, 140 – 199 mg/dl (7.8 – 11.1 mmol).
4. HbA1C is not recommended for the diagnosis of diabetes.
5. Venous blood glucose concentration is lower than capillary blood.
6. The diagnostic criteria for children are the same as for the adults, however OGTT glucose dose in children is calculated per weight.



CRITERIA FOR SCREENING FOR DIABETES IN ASYMPTOMATIC ADULTS

As the UAE has a high prevalence of diabetes, screening should start as early as possible. Testing for diabetes should be considered in all individuals at age 30 years and above, if normal, it should be repeated at 3 year intervals.

Testing should be considered at a younger age or be carried out annually in individuals who have or are:

- Overweight (BMI ≥ 25 kg/m²), especially adolescents and physically inactive.
- A family history of diabetes (a first-degree relative with diabetes).
- Hypertension (BP $\geq 140/90$ mmhg) or being treated for hypertension.
- Dyslipidaemia: HDL cholesterol level ≤ 35 mg/dl (0.90 mmol) and/or a triglyceride level ≥ 250 mg/dl (2.82 mmol/l).
- Previous gestational diabetes or have delivered a baby weighing > 4 kg.
- Polycystic Ovarian Syndrome (PCOS).
- IGT or IFG.
- A history of CVD (cardio vascular disease).
- Other clinical conditions associated with insulin resistance (e.g. acanthosis nigrians, steroid treatment).



CRITERIA FOR SCREENING FOR TYPE 2 DIABETES IN CHILDREN

Overweight (BMI > 85th percentile for age and sex), weight for height > 85th percentile, or weight more > 120% of ideal (50th %) weight for height.

Plus any of the following risk factors:

1. Family history of type 2 diabetes in a first or second-degree relative.
2. Signs of insulin resistance or condition associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidemia or PCOS).
3. Ethnic background: Arabs, Asians, Africans, Hispanics.
4. Maternal history of gestational diabetes mellitus.

Age of initiation: Age 10 years or at onset of puberty, if puberty occurs at a younger age.

Frequency: Every 2 years.

Test: Fasting plasma glucose preferred. Some authorities recommend a 2-hour postprandial glucose value as a more sensitive index of evolving diabetes.



MANAGEMENT OF PRE-DIABETES

Abnormalities in insulin secretion/action are present long before type 2 diabetes develops. Clinical progression from normal glucose tolerance to diabetes takes years and logically involves an intermediate stage of impaired glucose tolerance (IGT) and/or impaired fasting glucose (IFG). Early intervention is justified based on the fact that it can delay the onset of type 2 diabetes and its treatment; and the likelihood that complications will be delayed or prevented.

Diabetes can be prevented or delayed in high risk population through lifestyle modification or pharmacological interventions. This information has to be translated into well defined strategies for screening and treating high risk population. Prevention of the disease is the only chance to alleviate the ever growing burden of diabetes mellitus.

Optimal strategies for disease modification at the stages of pre-diabetes and early diabetes remain to be defined. However, existing information is sufficient to begin to sort out the relative effectiveness of interventions and to make some recommendations for clinical care:

1. Subjects with pre-diabetes, both IFG and IGT, need to be screened and treated.
2. Identification of women with gestational diabetes mellitus would allow:
 - Postnatal clinical interventions in those with diabetes persisting after delivery.
 - The option to use preventive methods to reduce the risk of type 2 diabetes.
3. Screening can be performed with fasting plasma glucose or preferably with 2-hour glucose tolerance test as diabetes in the UAE is highly prevalent.
4. Lifestyle intervention is the most powerful tool that needs to be addressed to prevent diabetes in high risk population.
5. Regular physical activity is recommended to reduce the risk of type 2 diabetes. (approximately 150 minutes per week).
6. Since obesity is associated with an increased risk of type 2 diabetes, interventions to reduce obesity may reduce the risk of type 2 diabetes.
7. Individuals at risk of developing type 2 diabetes should have dietary intake assessed and should receive individualized dietary advice and continued dietetic support.
8. Pharmacological interventions with Metformin, Thiazolidinediones & Acarbose have shown benefits in adjunct or as alternative to lifestyle modification program in reducing the risk of type 2 diabetes development. Metformin is preferred especially in young and obese patients.
9. Aggressive management of other cardiovascular risk factors (hypertension, cigarettes smoking and dyslipidemia).



INITIAL EVALUATION OF ADULTS WITH DIABETES

Personal history

Extensive personal history including family history of diabetes, other endocrine disorders, auto-immune diseases, eating disorders, and cardio vascular disease. Symptoms of hyperglycaemia (polydipsia, polyuria, weight loss, skin infections, blurred vision) and diabetes complications (e.g. numbness of feet, sexual dysfunction, visual difficulty, h/o chest pain suggestive of CAD and symptoms of intermittent claudications).

Identify cardiovascular risk factors

- Smoking.
- Hypertension.
- Dyslipidaemia.
- Sedentary life style.
- Obesity.
- Contraception.

Initial physical examination

- Height, weight, BMI (weight in kg / height in meters x 2).
- Blood pressure.
- Fundus examination.
- Oral cavity examination.
- Thyroid palpation.
- Cardiac assessment (including examination for carotid bruit).
- Peripheral pulses.
- Feet examination.
- Skin.
- Neurological examination, sensation, vibration, proposition, deep tendon reflexes.

Initial Investigations

- Fasting blood glucose / random blood glucose
- Full blood count
- HbA1c
- Lipid profile
- Urea & electrolytes
- Creatinine
- Urine analysis
- TSH
- Microalbuminuria ACR (albumin creatinine ratio)
- Creatinine clearance (GFR)
- ECG
- LFT

MANAGEMENT OF DIABETES MELLITUS

The primary aims of the treatment for all types of diabetes are:

- To alleviate symptoms of hyperglycaemia.
- To improve the quality of life.
- To achieve target metabolic goals.
- To prevent acute complications and to reduce long term complications.
- To reduce mortality.

The treatment plan for all types of diabetes includes:

- Patient and family education.
- Diet and nutritional recommendations.
- Exercise.
- Treat obesity (obese: ≥ 30 kg/m²).
- Oral anti hyperglycaemic agents.
- Insulin.
- Management of associated conditions and complications

Table 1: Treatment goals

	Ideal target levels
Plasma glucose	
Pre-prandial glucose level	80 – 120 mg/dl (4.4 - 6.6 mmol/l)
2hrs post-prandial	< 160 mg/dl (8.8 mmol/l)
Bedtime glucose level of	100 – 140 mg/dl (5.5 – 7.7 mmol/l)
HbA1C	< 7% mmol (normal 4-6%)
Blood pressure	< 130/80 mmhg
In presence of diabetic nephropathy	< 120/75 mmhg
Lipids	
LDL	< 100 mg/dl (2.6 mmol/l)
Triglycerides	< 150 mg/dl (1.7 mmol/l)
HDL men	> 45 mg/dl (1 mmol/l)
women	> 55 mg/dl (1.3 mmol/l)

Table 2: Plasma blood glucose and HbA1C goals for type 1 diabetes by age-group

Plasma blood glucose goal range mg/dl (mmol/l)				
Values by age (years)	Before meals	Bedtime/overnight	HbA1C	Rationale
Toddlers and preschoolers (0–6)	100-180 mg/dl (5.5-10 mmol/l)	110–200 mg/dl (6.1-11.1 mmol/l)	<8.5% (but >7.5%)	High risk and vulnerability to hypoglycaemia
School age (6–12)	90–180 mg/dl (5-10 mmol/l)	100–180 mg/dl (5.5-10 mmol/l)	<8%	• relatively low risk of complications pre- puberty • Risk of severe hypoglycaemia • Developmental and psychological issues • lower goal (<7.0%) is reasonable if can be achieved without excessive hypoglycaemia
Adolescents and young adults (13–19)	90–130 mg/dl (5-7.2 mmol/l)	90–150 mg/dl (5-8.3 mmol/l)	<7.5%	

Key concepts in setting glycaemic goals:

- Goals should be individualized and lower goals may be reasonable based on benefit-risk assessment.
- Blood glucose goals should be higher than those listed above in children with frequent hypoglycaemia or hypoglycaemia unawareness.
- Postprandial blood glucose values should be measured when there is a discrepancy between pre-prandial blood glucose values and HbA1C levels.

Diet and nutritional recommendations

1. Patient and family education

Education is a vital part of the care for people with diabetes. Diabetes education and learning is an interaction where information is shared, and best done by a diabetes educator and a nutritionist

- Knowledge and understanding of diabetes care and treatment, including how to treat hypoglycaemia, diet, exercise, foot care and good hygiene.
- Practical skills of injection technique and self monitoring of blood glucose.

N.B: Education is not part of the treatment, it is THE treatment.

2. Diet and nutritional recommendations

The first line of treatment is a healthy diet combined with exercise if possible.

A. Goals of diet therapy

1. To provide adequate amounts of all nutrients.
2. To achieve and maintain ideal body weight.
3. To normalize blood glucose and blood lipids.
4. To prevent or delay the complications of diabetes.

B. Recommendations

1. Calories should be prescribed according to the individual requirements, taking into account the age, activity and body weight. Weight loss of 5% is sufficient to improve insulin sensitivity.
2. Encourage people with type 2 diabetes to eat:
 - Less fat;
 - More complex carbohydrates;
 - A moderate amount of protein;
 - A small amount of sugar, salt and alcohol.
3. Provide people with educational materials about the dietary management of diabetes.
4. Consider referral to dietitian to ensure detailed education.

Table 3: Daily carbohydrates, fat and proteins recommendations

Recommendations	1000 cal/day (obese)	1500 cal/day (medium built)	2000 cal/day (thin built)
Proteins 15% of total calories	38 g/day	56 g/day	75 g/day
Carbohydrates 55 – 60% of total calories	138 – 150g/day	206 –225g/day	275 – 300 g/day
Fat 25 – 30 % of total calories	28 – 33 g/day	42 – 50 g/day	56 – 67 g/day

Physical activity

Physical activity is extremely important in the management of diabetes because of its effect on the blood glucose and free fatty acids. Physical activity burns calories and helps to control weight, ease stress and tension, and maintain a feeling of well-being. Regular physical activity improves the body's response to insulin and makes oral hypoglycaemic drugs and insulin more effective. It also promotes circulation, lowers cholesterol and triglyceride levels, thus reducing the risk of cardiovascular disease. Before starting any exercise programme a thorough physical examination should be done to find out whether or not it is safe to exercise.

The FITT formula guidelines for exercise may be advocated to provide maximum benefit with minimum risks.

F	Frequency:	(3 – 5) days a week, even daily if of low intensity
I	Intensity:	(65%) of maximum heart rate (till the person feels warm or sweats)
T	Time:	(20 – 60) minutes each time fairly continuously
T	Type:	Aerobic, walking, swimming, cycling and ball and racket games.

The person with diabetes should be advised to:

- Start activities slowly and then work up to a goal over a 6 – 8 week period.
- Wear proper foot wear and other appropriate protection equipment.
- Avoid exercise in extreme hot conditions and immediately after heavy meals (2 hours wait is essential).
- Avoid heavy resistance and isometric exercises.
- Maintain good hydration during and after prolonged exercise.
- Avoid exercise during periods of severe hyperglycaemia.
- Reduce medication prior to exercise when necessary (Insulin in people with type 1 diabetes and take precautions in people with type 2 diabetes on sulfonylureas or on insulin).

- Additional precautions should be taken for people with complications.
- For people who are unfit or have not been active for some time, low intensity exercise like walking should be started.
- Non weight-bearing exercise (e. g exercise bike) may be recommended for people with co-morbidities or foot complications.
- Moderate to heavy exercise should not be advised in people with uncontrolled diabetes or in people with complications (e. g. severe retinopathy or neuropathy with decreased sensation).

Smoking cessation

- Advise all people not to smoke.
- Include smoking cessation counselling and other forms of treatment as a routine component of diabetes care.

Oral hypoglycaemic agents

A. BIGUANIDES (METFORMIN)

- Starting dose: 500mg twice daily, maximum dose 2.5 gm daily.
- 90% excreted by kidney after 12 hrs.
- The UKPDS confirmed that Metformin is the drug of choice for obese people.
- Can be used with Sulfonylureas, Acarbose, Meglitinides, Thiazolidinediones and Insulin.
- Do not use Metformin in patients with kidney disease.

Names	Duration	Tablet strengths	Daily dose
Metformin (Glucophage)	12 hrs	500 mg, 850 mg and 1 gram	1000-2550 mg

Mechanism of action:

- Metformin acts by reducing hepatic glucose production (gluconeogenesis).
- Reduces gastrointestinal absorption of glucose.
- Stimulation of anaerobic glycolysis.
- Stimulation of peripheral glucose uptake.
- Enhance insulin receptor binding.

Adverse effects:

- Hypoglycaemia is rare.
- Causes weight loss of 1 – 2 kg/year.
- Nausea, diarrhoea, indigestion and loss of appetite mainly in the first few days of use. Metformin should be given with or after meals to minimise gastrointestinal side-effects.
- Metformin should be given with or after meals to minimise gastrointestinal side-effects.
- Lactic acidosis (more frequent in patients with renal or hepatic impairment, if the serum creatinine is 1.4mg or above Metformin is not recommended).
- Macrocytic anaemia due to Vit.B12 deficiency.

Contraindications & Precautions:

- Renal disease or renal dysfunction.
- Congestive heart failure requiring pharmacologic treatment.

- Known hypersensitivity to Metformin Hydrochloride.
- Acute or chronic metabolic acidosis, including diabetic ketoacidosis, with or without coma.

B. SULFONYLUREAS

- Mainly indicated in people who are lean or losing weight.
- Can be used as monotherapy or combined with Metformin, Acarbose, Thiazolidinediones or insulin.
- Should not be used with other Sulfonylureas or Meglitinides.
- May cause hypoglycaemia.

Names	Duration	Tablet strength	Daily dose
Glibenclamide (Daonil)	up to 24 hrs	5 mg	2.5 mg – 20 mg
Gliclazide (Diamicon MR)	up to 24 hrs	30 mg	30 mg – 120 mg
Glimepiride (Amaryl)	24 hrs	1 mg/2 mg /4 mg	1 mg – 8 mg

Mechanism of action:

- Mainly act by stimulating insulin release.

Adverse effects:

- Low blood glucose (hypoglycaemia).
- Weight gain.
- Gastrointestinal trouble, constipation, diarrhoea, heartburn, stomach fullness, lack of appetite, nausea, vomiting.
- Other side-effects include skin rashes.

Contraindications & precautions:

- People with ketoacidosis
- Have liver or kidney disease and in people with severe infectious diseases, trauma or during major surgery.

C. THIAZOLIDEDIONES: GLITAZONES (TZD)

Can be used with Biguanides, Sulfonylureas, Acarbose, Meglitinides.

Can be combined with insulin and thereby getting reduction in daily insulin requirement however oedema is seen more often with the combination of insulin and TZD's.

Names	Duration	Tablet strengths	Daily dose
Rosiglitazone (Avandia):	Up to 24 hrs	4 mg	4-8 mg
		8 mg	
Pioglitazone (Actos)		15 mg 30 mg	30-45 mg
Rosiglitazone + Metformin (Avandamet)	Up to 12 hrs	2 mg/500 mg	4 mg/1000 mg- 8 mg/2000 mg
		4 mg/500 mg	
		2 mg/1000 mg	
		4 mg/1000 mg	
Rosiglitazone + Glimepiride (Avandaryl)	Up to 24 hrs	4 mg/1 mg	4 mg/1 mg - 8 mg/4 mg
		4 mg/2 mg	
		4 mg/4 mg	

Mechanism of action:

- Enhances insulin sensitivity at adipose tissue, skeletal muscle and liver by activation of PPAR gamma receptors.
- The glucose lowering effect is gradual in onset with maximal reductions in fasting plasma glucose following approximately 8 weeks of therapy.
- Have no effect on insulin secretion, so no or rare hypoglycaemia is observed, however hypoglycaemia can be seen with Avandaryl (see Sulfonylureas, adverse effects).
- TZD's could be used with caution in renal failure patients; however Avandamet is contraindicated in patients with renal failure (see Biguanides, contraindications).

Adverse effects:

- Weight gain.
- Peripheral oedema.
- Bone fracture in female.

Contraindications & Precautions:

- They are contraindicated in people with existing class III/IV heart failure as defined by the New York Heart Association (NYHA).
- Not recommended in people with recent acute cardiac ischemia.
- Co-administration of Rosiglitazone and insulin is not recommended.
- TZDs should not be initiated in patients with ALT >2.5 times of upper normal.

D. ALPHA-GLUCOSIDASE INHIBITORS

- Can be used as first line therapy in association with diet or in combination with Sulfonylureas, Biguanides and insulin.
- Dosage should be increased gradually.
- Are less effective than Biguanides and Sulfonylureas.

Names	Duration	Tablet strengths	Daily dose
Acarbose (Glucobay).	14-24 hrs	25, 50 and 100 mg	50-300 mg
Miglitol (Glyset)	14-24 hrs	25, 50 and 100 mg	50-300 mg

Mechanism of action:

- Acts by inhibiting the action of alpha-glucosidase, an enzyme in the small intestine involved in the digestion of disaccharides. Acarbose delays the breakdown of disaccharides to monosaccharides and thus reduces the rise in postprandial blood glucose levels.

Adverse effects:

- Flatulence, abdominal distension, and diarrhoea. These effects can be reduced by gradual increase of 50mg once daily to 100mg tds over a 6 week period.

Contraindications & Precautions:

- Contraindicated in people with hepatic and renal impairment.

E. MEGLITINIDES

- May be used in combination therapy with Biguanides, TZDS or Alpha-Glucosidase inhibitors.

Names	Duration	Tablet strengths	Daily dose
Repaglinide (Novonorm)	3-4 hrs	0.5 mg	16 mg
Nateglinide (Starlix)	3-4 hrs	60 mg	120 mg

Mechanism of action:

- Short-acting agent. Has action similar to Sulfonylureas but on different subunit of SU -receptors on the surface of β cells. Has a quicker onset and shorter duration of action than SU drugs. Should be taken only when a person eats a meal as it works within 1 hour.

Adverse effects:

- Hypoglycaemia and weight gain.

Contraindication & Precautions:

- People with diabetic ketoacidosis.
- People with severe infectious diseases, trauma or during major surgery.

Insulin therapy

Indication for insulin therapy

- Type 1 diabetes.
- Gestational diabetes when the diet has failed to achieve optimal blood glucose levels.
- Type 2 diabetes if it cannot be controlled by diet and hypoglycaemic drugs.
- During stressful situations like the presence of infection, trauma, surgery and myocardial infarction.
- Presence of ketones in urine with hyperglycaemia.

Guidelines for combination therapy

- Continue oral anti diabetic agents.
 - Intermediate-acting/long-acting insulin in the morning or at night.
 - Initial dose approx. 0.2 units/kg.
 - Monitor fasting blood glucose and pre-prandial blood glucose.
 - Adjust insulin by 2-4 units after at least three days.
 - Aim of fasting blood glucose should be individualized.
1. Rapid acting insulin = insulin analogues: Clear in appearance
 - Insulin Lispro (Humalog)
 - Insulin Aspart (Novorapid)
 - Insulin Glulisine (Apidra)
 2. Short acting insulin: Clear in appearance
 - Regular/soluble
 3. Intermediate acting insulin: Cloudy in appearance
 - NPH – Isophane.
 - Lente.
 4. Long acting Insulin: Cloudy
 - Ultralente.
 - Glargine (Lantus) (clear in appearance).
 - Detemir (Levemir) (clear in appearance).
 5. Mixed insulin preparation (short and intermediate acting)

Table 4: Insulin action

Type of Insulin preparation	Onset of action	Peak	Duration
• Insulin Analogues:			
• Lispro (Humalog)		30 -90 min	3 – 5 hrs
• Insulin Aspart (Novorapid)			
• Insulin Glulisine (Apidra)		30 -90 min	2 – 4 hrs
• Short acting, with rapid onset of action			
• Regular/soluble (clear)	30 – 60min.	50 –120 min	5 – 8 hrs
• Intermediate-acting:			
• NPH Humalin N / Novolin N	1 – 3 hrs	8 hrs	20 hrs
• Humalin L / Novolin L	1 – 2.5 hrs	7 – 15 hrs	18 – 24 hrs
• Long-acting			
• Ultralente	4 – 8 hrs	8 – 12 hrs	36 hrs
• Glargine (Lantus)	3 – 5 hrs	Almost peakless	24 hrs +
• Detemir (Levemir)	3 - 5 hrs	Almost peakless	24 hrs
• Mixed Insulin: • Humalin M2,M3 • Mixtard: mixture of NPH + Regular with different percentage • Novomix –30% Aspart & 70 % protaminated Aspart • Novomix - 50% Aspart & 50 % protaminated Aspart	Depends on the intermediate and short or rapid –acting components		

Types of insulin preparations

The species and dosages of insulin used should be consistent, and the person's injection technique should be reviewed periodically with the diabetes care team.

The effective use of insulin in order to obtain the best metabolic control requires an understanding of the duration of action of the various types of insulin, the site of injection, correct injection technique, and the relationship of blood glucose levels to exercise, food intake, intercurrent illness, certain medications, and stress either physical (illness or surgery) or mental. Self monitoring of blood glucose is essential and the person with diabetes should learn how to adjust insulin dosages in order to achieve optimal glycaemic control in corporation with the diabetes care team.

Other drugs

GLP-1 analogues (incretin mimetics)

GLP-1 analogues modifies glucose homeostasis through potentiation of glucose-stimulated insulin secretion and suppression of glucagon secretion, gastric emptying, and food intake.

These actions are glucose-dependent; thus, the risk of hypoglycaemia with GLP-1 administration is low.

Can be used with Metformin, a Sulfonylurea, or a Thiazolidinediones.

New treatment principle; so far, there are no data on patient-oriented parameters like mortality, or diabetic complications, and additional long-term data on the safety GLP-1 analogues are necessary.

Names	Duration	Preparation	Daily dose
Exenatide (Byetta)	5 hrs	prefilled pens (5 mcg or 10 mcg)	5 mcg or 10 mcg, twice a day

Exanatide is injected, twice a day, at any time within 1 hour before morning and evening meals (or before the two main meals of the day, approximately 6 hours or more apart).

Exenatide is not indicated for use in monotherapy or combination with insulin.

GLP-1 analogues should not be used in people with type 1 diabetes.

Adverse effects:

- Nausea, vomiting, diarrhoea, dizziness, headache, feeling jittery and acid stomach. Nausea decreases over time in most people.
- Reduce appetite, food intake, and body weight. No changes in dose are needed for these side effects.
- There are no adequate and well-controlled studies in pregnant women. GLP-1 analogues should not be used during pregnancy.

Contraindications & precautions:

- Should not be used in people severely impaired renal function or gastro-intestinal diseases.
- Post marketing cases of acute pancreatitis have been reported in patients treated with exenatide. Patients should be informed that persistent severe abdominal pain, which may be accompanied by vomiting, is the hallmark symptom of acute pancreatitis.

DPP- 4 Inhibitors (incretin enhancers)

- Inhibits the inactivation of GLP-1 and GIP by DPP-4, allowing GLP-1 and GIP to potentiate the secretion of insulin in the beta cells and suppress glucagon release by the alpha cells of the islets of Langerhans in the pancreas.
- Can be used with Metformin, a sulfonylurea, or a Thiazolidinediones. DPP- 4 Inhibitors has not been studied in combination with insulin.
- New treatment principle; so far, there are no data on mortality, or diabetic complications, and additional long-term data on the safety of these drugs are necessary.

Names	Duration	Tablet strengths	Daily dose
Sitagliptin (Januvia)	Up to 24 hrs	100 mg	100 mg once daily
Sitagliptin + Metformin		50 mg / 850 mg	50 mg/850-1000 mg
(Janumet)		50 mg / 1000 mg	twice daily
Vildagliptin (Galvus)	Up to 24 hrs	50 mg	50 mg twice daily
Vildagliptin + Metformin (Eucreas)		50 mg / 850 mg	50 mg/850-1000 mg
		50 mg / 1000 mg	twice daily

Adverse effects:

- Headache; diarrhoea; upper respiratory infection.
- There are no adequate and well-controlled studies in pregnant women. Therefore, DPP-4 Inhibitors should be used during pregnancy.

Contraindications & Precautions:

- Should not be used in people with severe hepatic and renal impairment (lack of data). Combinations with Metformin are contraindicated in people with renal dysfunction.
- There have been post marketing reports of serious allergic and hypersensitivity reactions in patients treated with DPP-4 inhibitors such as anaphylaxis, angioedema, and exfoliative skin conditions including Stevens-Johnson syndrome. In such cases, promptly stop the drug, assess for other potential causes, and institute appropriate monitoring and treatment, and initiate alternative treatment for diabetes.

Treatment recommendation for people with type 2 diabetes

Step 1 (life-style intervention and Metformin):

- Lifestyle changes with limit caloric intake, exercise and proper nutrition to decrease weight and increased activity provide broad benefits. Unfortunately, it often fails in the first year, in part related to inadequate intervention or follow-up by practitioners as well as poor adherence of people with diabetes. Lifestyle interventions reduce HbA1C by 1- 2 %.
- Metformin is inexpensive and not associated with weight gain or hypoglycaemia and has demonstrated benefits in numerous studies making it the logical first-line pharmacotherapy in people with obese type 2 diabetes patients. Therefore, Metformin should be initiated concurrently with lifestyle intervention at diagnosis.
- Average HbA1C reduction by Metformin as monotherapy, ~1.5%.

Step 2 (additional medications):

- Sulfonylureas (SU) may give rise to weight gain and hypoglycaemia. However, severe hypoglycaemia is relatively uncommon with Sulfonylurea therapy and the weight gain generally modest.
- Average HbA1C reduction with SU monotherapy is ~1.5%.
- Thiazolidinediones (TZD) improves insulin resistance and glycaemic control with modest effect on lipid profile. Average HbA1C reduction as monotherapy is 0.5% to 1.5%.
- In a long term clinical trial (ADOPT), a TZD (Rosiglitazone) has shown better and longer term glycaemic control compared to Sulfonylureas and Metformin.
- Insulin, which has no dose limit, and improves the lipid profile, particularly triglycerides. However, it requires injections, capillary glucose monitoring and may be associated with hypoglycaemia and weight gain.

Step 3 (further adjustment):

Treatment of type 2 diabetes should be individualized and take account of the individuals lifestyle, peoples wishes and needs and technical abilities. Local expertise of healthcare providers should also be considered. These issues can be barriers to insulin therapy. However, achieving treatment targets are important to avoid complications and insulin is arguably the most effective glucose lowering agent available. Tight glycaemic control, particularly with insulin, may be associated with severe hypoglycaemia. People initiating insulin therapy should be advised about the benefits of regular blood glucose monitoring, as well as the signs and symptoms and the prevention and treatment of hypoglycaemia. Analogue insulin, though generally substantially more expensive than human insulin, is associated with a modestly lower incidence of hypoglycaemia in clinical trials.

- Basal insulin: The addition of basal insulin should be taken at diagnosis or immediately after treatment with Metformin and lifestyle interventions if hyperglycaemia is profound or at any time if oral antihyperglycaemic agents are not able to achieve treatment targets. Reasonable options for adding bedtime basal insulin to oral agents include NPH human

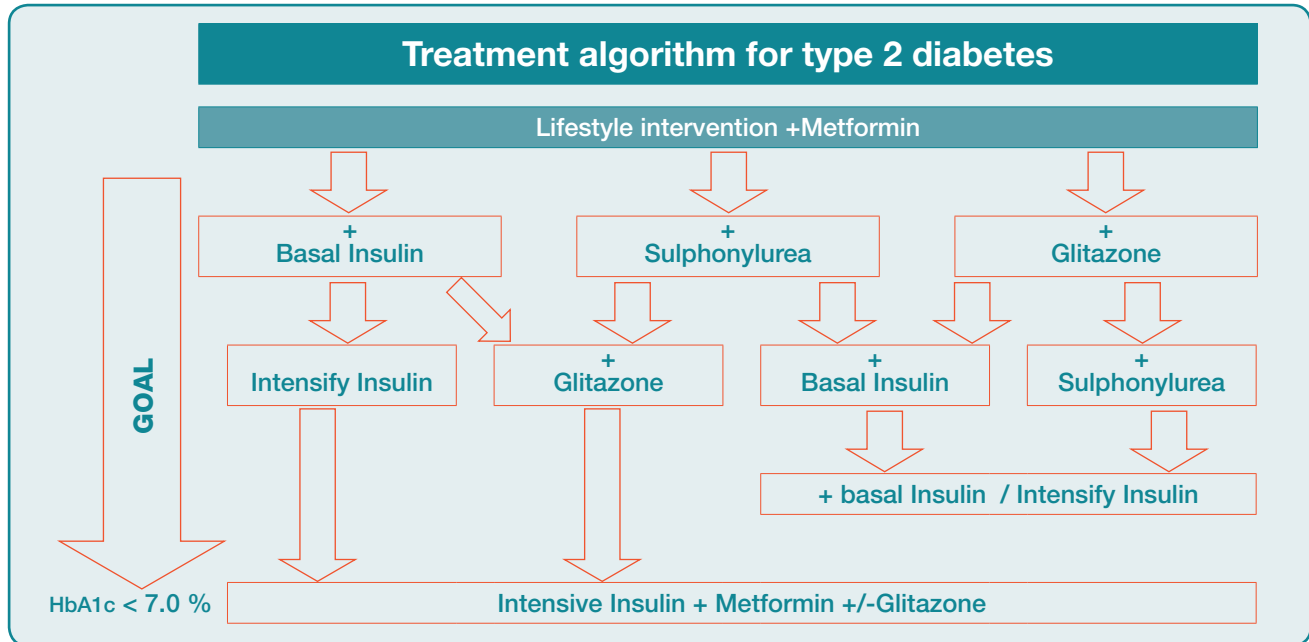
insulin or one of the long acting insulin analogues (Glargine and Detemir). NPH human insulin is a relatively low cost option and is as effective as long-acting analogs in HbA1C reduction.

- Intensified insulin: The combination of basal insulin with meal-associated rapid acting insulin should be used in people who are unable to achieve glycaemic control on basal insulin with or without oral antihyperglycaemic therapies.
- The type of insulin used should reflect the person's glycaemic profile (postprandial and fasting) as well as the individual lifestyle. People can continue to take insulin with Metformin with or without Glitazones but should stop taking secretagogues when rapid acting insulin is added to the regimen.
- The so called basal-bolus therapy provides the most physiological glycaemic control and optimal flexibility for people with diabetes to adjust therapy to match lifestyle choices such as changes in physical activity or the timing or carbohydrate content of meals. Alternatively, premixed insulin (NPH plus regular human insulin or rapid acting analog insulin) can be used in one or more daily doses, generally before supper, before breakfast and supper or prior to each meal. This approach is generally effective in people with very consistent lifestyles and in those who are less capable of managing a basal-bolus titration regime.

Other drugs

- The Glinides (Nateglinide and Repaglinide) are short half-life agents which bind to the sulfonylurea receptor. They require three times daily dosing. Repaglinide is more effective at lowering HbA1C, 1-1.5%, than is Nateglinide which is the secretagogues with the lowest risk of severe hypoglycaemia.
- Alpha-glucosidase inhibitors are weight neutral but have frequent gastrointestinal adverse effects, and generally require three times daily dosing. They are less effective in lowering glycaemia than Metformin, SU or TZD, reducing HbA1C by 0.5 - 0.8%.
- The Glucagon - like peptide 1 agonist Exenatide (Byetta) is associated with modest weight loss in addition to glucose lowering but has the disadvantages of high cost, twice daily injections for administration and frequent gastrointestinal adverse effects at initiation of therapy; ~40% of people experience intermittent nausea, vomiting or diarrhoea which is generally mild to moderate in intensity. Exenatide is associated with average HbA1C reduction of 0.4 – 0.8%.
- DPP-4 inhibitors, Sitagliptin (Januvia), Vildagliptin (Galvus) interfere with the degradation of GLP-1 by blocking the action of the DPP-4 enzyme and therefore raise GLP-1 levels 2- to 3-fold. Vildagliptin and Sitagliptin are administered orally and are generally well tolerated. They lower HbA1C by 0.5 - 0.9%.

Figure 1: Treatment algorithm for type 2 diabetes



Ten steps to get more people with type 2 diabetes to goal

1. Aim for good glycaemic control, defined as HbA1C < 7%.
2. Monitor HbA1C every 3 months in addition to regular glucose self-monitoring.
3. Aggressively manage hyperglycaemia, dyslipidaemia and hypertension with the same intensity to obtain the best patient outcome.
4. Full assessment of all newly diagnosed patients in diabetic mini clinic where possible.
5. Address the underlying pathophysiology, including the treatment of insulin resistance.
6. Treat patients intensively so as to achieve target HbA1C < 7%* within 6 months of diagnosis.
7. After 3 months, if patients are not at target HbA1C < 7%,* consider combination therapy.
8. Initiate combination therapy or insulin immediately for all patients with HbA1C > 9% at diagnosis.
9. Use combinations of oral anti-diabetic agents with complementary mechanisms of action.
10. Implement a multi- and interdisciplinary team approach to diabetes management to encourage patient education and self-care and share responsibility for patients achieving glucose goals.

* Or fasting/pre-prandial plasma glucose < 110 mg/dl (6.0 mmol/l) where assessment of HbA1C is not possible.



ACUTE COMPLICATIONS OF DIABETES

Hypoglycaemia

Hypoglycaemia is defined as a blood glucose level of less than 63mg/dl (3.5mmol/l).

Blood glucose of 72 mg/dl (4 mmol/l) should be considered as a warning sign for hypoglycaemia.

The most common reason for hypoglycaemia is an imbalance between the amount of insulin and glucose in the blood. This occurs if:

- Meals are missed or delayed, or the meal does not contain sufficient carbohydrates.
- Extra activity results in increased use and demand for glucose and can cause hypoglycaemia if extra carbohydrates are not taken.
- Alcohol is known to potentate the effect of insulin and sulfonylureas and therefore increases the risk of hypoglycaemia; this is particularly true if it is taken when the blood glucose levels are already low, for example before a meal or on an empty stomach.
- If none of the above reasons can be identified as the cause of the hypoglycaemia, then it is probably that the dose of insulin or oral anti-diabetic agent is too high.

Signs and symptoms of hypoglycaemia

Neurogenic (autonomic)	Neuroglycopenic
Trembling	Difficulty concentrating
Palpitations	Confusion
Sweating	Weakness
Anxiety	Drowsiness
Hunger	Vision changes
Nausea	Difficulty speaking
Tingling	Headache
	Dizziness
	Tiredness

The symptoms of hypoglycaemia vary with each individual. Many people experience one or only a few of these symptoms; some experience no warning signs especially people who are on beta-blockers and people having autonomic neuropathy.

Severity of hypoglycaemia

Mild:	Autonomic symptoms are present. The individual is able to self-treat.
Moderate:	Autonomic and neuroglycopenic symptoms are present. The individual is able to self-treat.
Severe:	Individual requires assistance of another person. Unconsciousness may occur. Plasma glucose is typically <50 mg/dl (2.8 mmol/l).

Short-term risks:

- Dangerous at work (e.g. driving, operating machinery).
- Transient neurological symptoms such as paresis, convulsions and encephalopathy.

Long-term complications:

- Studies show that long term untreated hypoglycaemia for more than 6 hours may lead to intellectual impairment and permanent neurological sequelae such as hemiparesis and pontine dysfunction.
- Fear, anxiety, injury, accidents, decreased performance and behavioural changes.
- In people with longstanding diabetes and macrovascular complications, very tight glucose control should not be implemented as recent studies have described adverse cardiovascular effects.

Prevention of hypoglycaemia

- Adequate education of the person with diabetes and the family: recognizing the risk factors for hypoglycaemia, symptoms and the appropriate steps to correct hypoglycaemia.
- Self monitoring of blood glucose is required in people taking insulin or insulin secretagogues.
- Avoid long acting, renally excreted, Sulfonylureas such as Glibenclamide particularly in elderly people or people with renal impairment.
- Recognize and pay special attention to high risk people such as those with high alcohol intake, hepatic or renal impairments or hypoglycaemic unawareness.
- Adequate knowledge to avoid absolute or relative excess of insulin by the proper use of medications versus the dietary practices and physical activities.
- In type I diabetes avoid trying to achieve unrealistic goals such as normal HbA1C values. This may lead to frequent hypoglycaemic episodes.

- Avoiding severe hypoglycaemia by detecting and treating a low blood glucose level promptly by using an intervention that provides the fastest rise in blood glucose to a safe level. It is also important to avoid over-treatment, since this can result in rebound hyperglycaemia and weight gain.
- In hospitalized patients, efforts must be made to ensure that patients using insulin have ready access to an appropriate form of glucose at all times, particularly when NPO for diagnostic or surgical procedures.

Treatment of hypoglycaemia

By the person with diabetes / family members / health care providers:

- Clinical evidence or presumption is sufficient to initiate therapy.
- Blood glucose measurement is needed to confirm the diagnosis.
- Clinical conscious adults should be given sweetened drink (½ cup of fruit juice) and repeat amounts if necessary.
- Recent evidence suggests that 15 g of glucose (monosaccharide) is required to produce an increase in blood glucose of approximately 2.1 mmol/l (38 mg/dl) within 20 minutes, with adequate symptom relief for most people.
- In an unconscious person give 50-100 ml of 20% glucose intravenously. If this is not available, give 100mls of 10% dextrose intravenously. Alternatively, you can use 1mg glucagon intramuscularly. People should be observed and monitored for 24 hours before discharge.
- Check blood glucose levels and repeat treatment if symptoms have not resolved.
- In children, administer 20% glucose, 2ml/kg as an intravenous bolus, followed by intravenous infusion of 5% glucose 5ml/kg/hour. The dose and the rate of glucose infusion will be adjusted according to the blood glucose levels. If intravenous therapy is not possible, give glucagon 1mg IM for grown up children and 0.5mg for children below 3 years.
- Glucagon should be prescribed for all people with diabetes at significant risk of severe hypoglycaemia and does not require a health care professional for its administration.
- When consciousness returns give a quick acting carbohydrate (sweet drink) followed by a long acting carbohydrate (bread, sandwich or biscuits).
- Always use glucagon in people with type 1 diabetes.

Diabetic ketoacidosis

A true medical emergency secondary to severe insulin deficiency and characterized by hyperglycemia, ketosis, dehydration and metabolic acidosis.

Diabetic ketoacidosis (DKA) is most frequently seen in type 1 diabetes and seldom in type 2 diabetes. In particular younger and thin people are at higher risk.

Precipitating causes

- Insufficient insulin
- Medication non adherence
- Infection
- 1st presentation of diabetes
- Stressful conditions:
 - Myocardial infarction
 - Cerebrovascular accident
 - Acute GIT bleeding
 - Trauma
 - Surgery
 - Emotional stress
- Medications (corticosteroids, thiazides atypical antipsychotic)
- Drugs (cocaine)
- Idiopathic

Signs and symptoms of ketoacidosis

- Polyuria, nocturia
- Polydipsia
- Generalized weakness
- Malaise, lethargy
- Nausea, vomiting
- Abdominal pain
- Decreased perspiration
- Coma

- Confusion
- Fever
- Anorexia or increased appetite

Complications

- Cerebral edema
- Pulmonary edema
- Vascular thrombosis
- Hypokalemia
- Cardiac dysrhythmia
- Myocardial infarction
- Acute gastric dilatation
- Late hypoglycaemia
- Erosive gastritis
- Infection
- Mucormycosis
- Respiratory distress
- Hypophosphatemia

Prevention

- Close monitoring of glucose during periods of stress, infection, and trauma.
- Careful control of blood glucose levels.
- Close control of body temperature during periods of infection and trauma.
- Educational program for sick-day management instructions.

Diagnosis

- Initial Lab Tests:
 - Blood glucose CBC, electrolytes, blood urea nitrogen (BUN), Cr
 - Serum β -HB Plasma osmolarity, serum ketones
 - Arterial blood gases
 - Additional: Culture of urine, sputum, and blood, serum lipase and amylase.

- ECG (may show myocardial infarct or electrolyte abnormalities).
Usually shows sinus tachycardia.
- Imaging
Chest radiograph to rule out pulmonary infection.

Table 5: Diagnostic criteria in DKA (diabetic ketoacidosis) and HHS (hyperglycaemic hyperosmolar state)

	DKA			HHS
	Mild	Moderate	Severe	
Diagnostic criteria & classification				
Plasma glucose	>250 mg/dl (13.9 mmol/l)	>250 mg/dl (13.9 mmol/l)	>250 mg/dl (13.9 mmol/l)	>600 mg/dl (33.3 mmol/l)
Arterial pH	7.25 – 7.3	< 7- 7.25	< 7	> 7.3
Serum bicarbonate (mEq/l)	15–18	10 - <15	<10	>15
Urine ketones	+	+	+	Small
Serum ketones	+	+	+	Small
Effective serum osmolality	Variable	Variable	Variable	>320 mOsm/kg
Anion gap	> 12	> 12	> 12	< 12
Mental status	Alert	Alert/drowsy	Stupor/coma	Stupor/coma

From Kitabchi AE, Umpierrez GE, Murphy MB, et al. Hyperglycaemic crisis in diabetes. Diabetes Care 2004;27:S94–102; with permission.

- a) Nitroprusside reaction method.
- b) Calculation: 2 [measured Na (mEq/L)] + glucose (mg/dl)/18.
- c) Calculation: (Na) – (Cl + HCO3) (mEq/L).

All but mild cases require inpatient management; severe DKA requires an ICU setting.

Goals

1. Fluid resuscitation
2. Correction of ketoacidosis and hyperglycemia
3. Correction of electrolytes
4. Treating precipitating factor
5. Prevention of cerebral edema and other complication

Treatment

- Pre-Hospital
 1. Oxygen and airway management
 2. Establish IV access
 3. Finger stick glucose testing
 4. Start isotonic crystalloid solution (0.9% saline)
 5. Consider insulin
- Diet
 1. NPO initially
 2. Advance to pre-ketotic diet when nausea and vomiting are controlled
- Activity
 1. Bed rest

Laboratory testing during management

1. Serum glucose q1–2h until stable
2. Electrolytes, phosphorous, blood ketones and venous pH q4–6h prn

There is still no evidence that rapid IV hydration is a cause of cerebral edema.

Pediatric Considerations

For Pediatric consideration refer to Pediatric DKA guidelines instead.

Geriatric considerations

Must be careful with impaired renal function or CHF when correcting fluid and electrolyte abnormalities.

Pregnancy considerations

Pregnancy itself is diabetogenic. It also results in a compensated respiratory alkalosis ($\text{HCO}_3^- \approx 19\text{--}20$) with theoretically reduced buffering capacity. Therefore, pregnant women are more susceptible to DKA.

- Euglycaemic DKA
- Increased risk of pre-eclampsia and fetal death
- β -tocolytics, corticosteroids can trigger DKA
- Perinatal mortality is between 9% and 35%

Hyperglycaemic hyperosmolar state

Hyperglycaemic hyperosmolar state (HHS) is one of the most serious life-threatening complications of type 2 diabetes. HHS occurs primarily in people with type 2 diabetes. In 30%–40% of cases, HHS is the initial presentation of a person's diabetes. Significantly less common than DKA with an incidence of <1 case per 1,000 person-years.

Precipitating causes:

- Stress, infection, stroke, acute infarction, drugs (Steroids, Diuretics), non adherence with medications, dietary indiscretion, and alcohol and cocaine abuse.
- Dehydration impaired glucose excretion is a contributory factor in people with decrease in renal function or pre-renal azotemia.

Complications

- Thromboembolic events cerebral and myocardial infarction (mesenteric thrombosis, pulmonary embolism, disseminated intravascular coagulation).
- Adult respiratory distress syndrome.
- Cerebral edema.

Diagnosis

Clinical findings

- Patients are usually older and sicker than in DKA.
- In contrast to DKA, the onset of HHS is usually insidious.
- Several days of deteriorating glycaemic control are followed by increasing lethargy.
- Clinical evidence of severe dehydration is the rule.
- Some alterations in consciousness and focal neurological deficits may be found at presentation or may develop during therapy.

Laboratory findings (see Diagnostic criteria in DKA and HHS table 5)

- Pre-renal azotemia and lactic acidosis can develop.
- If patients have detectable urine ketones workup for metabolic acidosis is recommended. Lactic acidosis may develop from an underlying infection or other cause.

Goals

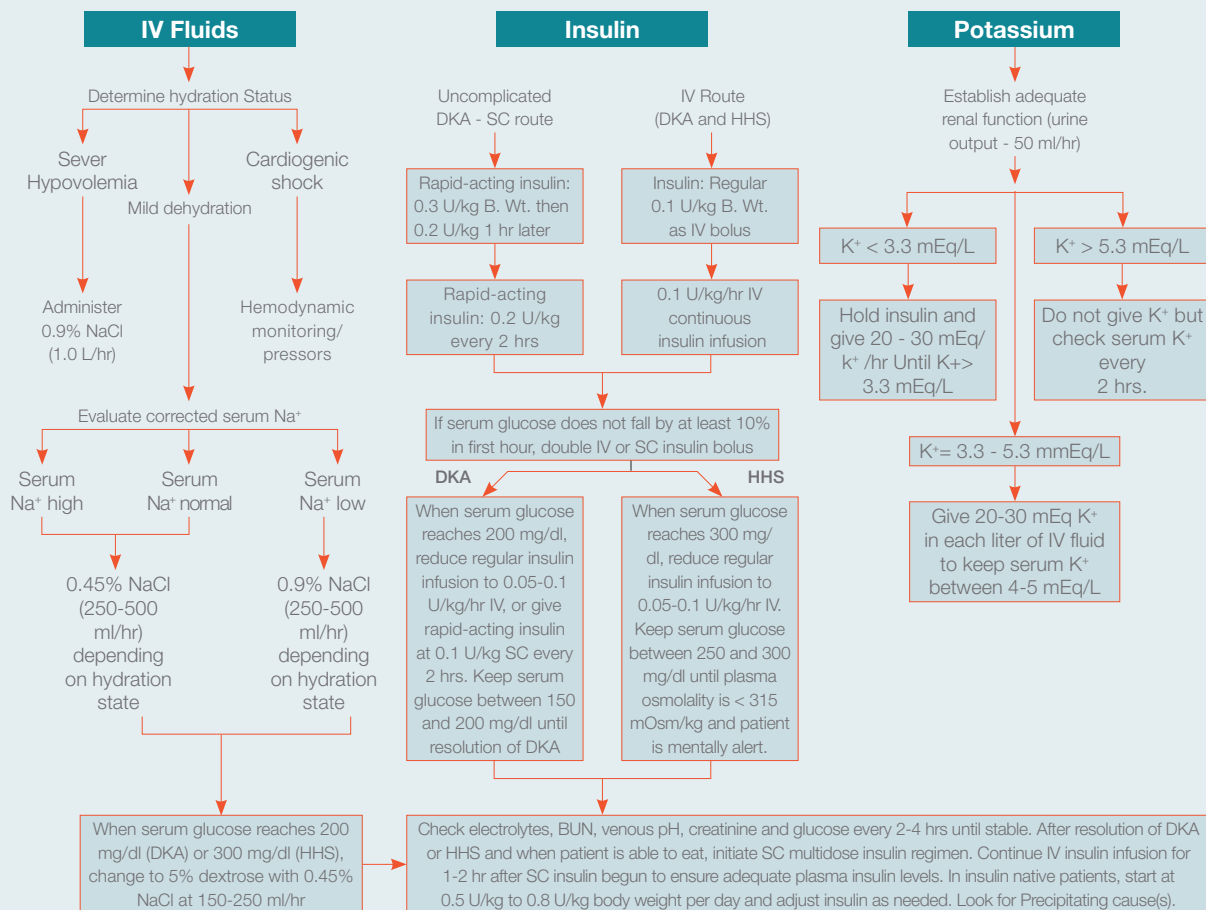
- Restoration of hemodynamic stability and intravascular volume by fluid replacement.
- Correction of electrolyte abnormalities.
- Gradual correction of hyperglycemia and hyperosmolarity with fluid replacement and insulin therapy.
- Detection and treatment of underlying disease states and precipitating causes.
- Preventing complications.

Initial treatment

1. Therapy must be individualized based on the degree of dehydration and underlying cause (sepsis, renal and cardiac function).
2. Rapid vein access is essential and monitor urine output.
3. Restoration of intravascular volume is the first aim followed by correction of total body water deficit.
4. Compared to DKA, patients with HHS may require more fluid replacement and less insulin treatment.
5. Consider anticoagulant therapy with low dose heparin unless contraindicated.

Figure 2: Treatment algorithm for DKA

Complete initial evaluation. Check capillary glucose and serum/urine ketones to confirm hyperglycemia and ketonemia/ketonuria. Obtain blood for metabolic profile. Start IV fluids: 1.0 L of 0.9% NaCl per hour.*



PREVENTION AND MANAGEMENT OF DIABETES COMPLICATIONS

Cardio vascular disease screening and treatment

Cardio vascular disease (CVD) is the major cause of mortality for people with diabetes.

Blood pressure control

Hypertension (HTN) (Blood pressure (BP) $\geq 140/90$ mmHg) is a common co-morbidity of diabetes, affecting 20 – 60% of people with diabetes.

Hypertension is also a major risk factor for CVD and microvascular complications such as retinopathy and nephropathy.

In type 1 diabetes, hypertension is often the result of underlying nephropathy. In type 2 diabetes, hypertension is likely to be present as part of the metabolic syndrome (i.e., obesity, hyperglycaemia, dislipidaemia) that is accompanied by high rates of CVD.

Goal: BP < 130/80 mmHg

Screening

- Measure blood pressure after a minimum of 5 minutes sitting with an appropriate sized cuff and preferably a mercury sphygmomanometer.
- Blood pressure should be measured at every routine visit to the clinic. People found to have systolic blood pressure ≥ 130 or diastolic blood pressure ≥ 80 mmHg should have BP confirmed on a separate day.
- Orthostatic measurement of BP should be performed to assess for the presence of autonomic neuropathy.

Treatment

- People with systolic BP of 130 – 139 mmHg or a diastolic BP of 80 – 89 mmHg should be given lifestyle and behavioural therapy alone for a maximum of 3 months and then, if targets are not achieved, in addition, should be treated pharmacologically.
- People with hypertension: BP $\geq 140/90$ mmHg should receive pharmacological therapy in addition to lifestyle and behavioural therapy.
- ACE inhibitors, ARBs, β -blockers, and diuretics have been repeatedly shown to be particularly beneficial in reducing CVD events and are therefore the preferred agents for initial therapy.

- If ACE inhibitors are not tolerated, ARBs may be used.
- If ACE inhibitors or ARBs are used, monitor renal function and serum potassium levels.
- In people with type 1 diabetes with or without HTN with any degree of albuminuria, ACE inhibitors have been shown to delay the progression of nephropathy.
- In people with type 2 diabetes, hypertension, and microalbuminuria, ACE inhibitors and ARBs have been shown to delay the progression of renal disease.
- In people with microalbuminuria or overt nephropathy, in whom ACE inhibitors or ARBs are not well tolerated, a non-DCCB or β -blocker should be considered.
- In people with a recent myocardial infarction, β -blockers, in addition, should be considered to reduce mortality.
- In elderly hypertensive people, BP should be lowered gradually to avoid complications.

Lipid management

Lipid management aimed at lowering LDL cholesterol, rising HDL cholesterol, and lowering triglycerides has been shown to reduce macrovascular disease and mortality in people with type 2 diabetes, particularly people who have had prior cardiovascular events. Thus, statin treatment – irrespectively of lipid levels - is recommended in all people with type 2 diabetes and cardiovascular complications or cardiovascular risk factors, i.e. in the vast majority of people.

Lipids		
LDL		< 100 mg/dl (2.6 mmol/l)
Triglycerides		< 150 mg/dl (1.7 mmol/l)
HDL	Men	> 45 mg/dl (1 mmol/l)
	Women	> 55 mg/dl (1.3 mmol/l)

Screening

In adult people, test for lipid disorders at least annually and more often if needed to achieve goals. In adults with low risk lipid values (LDL < 100mg/dl, HDL > 60mg/dl, triglycerides < 150mg/dl) repeat lipid assessments every 2 years.

Treatment

- People who do not achieve lipid goals with lifestyle modifications require pharmacological therapy.
- Statins should be used as first-line pharmacological therapy for LDL lowering.
- Fibrates are indicated in people with isolated hypertriglyceridemia and low HDL.

Anti-platelet therapy in diabetes

Consider beginning aspirin therapy (75 – 325 mg/day) for primary prevention in people ≥ 40 years of age with diabetes and one or more other cardiovascular risk factors.

Do not use aspirin in people < 21 years of age because of increased risk of Reye's syndrome.

Consider aspirin therapy for people between 30 and 40 years of age with other cardiovascular risk factors.

Nephropathy screening and treatment

Definition of abnormalities in albumin excretion		
	24-hrs urine sample	Albumin: creatinine ratio (ACR)
Normal	< 30 mg/24hrs	< 2.5 mg/mmol (male) < 3.5 mg/mmol (female)
Microalbuminuria	$30 - 299$ mg/24hrs	2.5 mg- 25 mg/mmol (male) 3.5 mg- 35 mg/mmol (female)
Macroalbuminuria	≥ 300 mg/24hrs	> 25 mg/mmol (male) > 35 mg/mmol (female)

N.B.: At least two of three tests measured within a 6 month period should show elevated levels before a person is labelled as having microalbuminuria.

Goal: Reduce the risk and/or slow the progression of nephropathy, optimize the glucose control and the blood pressure control.

Screening

- Perform an annual test for the presence of microalbuminuria in:
 - People with type 1 diabetes with diabetes duration of ≥ 5 years and in.
 - All people with type 2 diabetes, starting at diagnosis.

Treatment

- In the treatment of both micro- and macroalbuminuria, either ACE inhibitors or ARBs should be used.
- In people with type 1 diabetes with or without hypertension with any degree of albuminuria, ACE inhibitors have shown to delay the progression of nephropathy.
- In people with type 2 diabetes, hypertension, and microalbuminuria, ACE inhibitors and ARBs have been shown to delay the progression to macroalbuminuria.

- In people with type 2 diabetes and microalbuminuria or overt nephropathy, in whom ACE inhibitors or ARBs are not well tolerated, β -blockers should be considered.
- With the presence of nephropathy, initiate protein restriction to $\leq 0.8\text{g/kg}$ body weight/day (~10% of daily calories).

Diabetic retinopathy screening and treatment

Goal: Optimal glycaemic and blood pressure control can substantially reduce the risk and progression of diabetic retinopathy.

Screening

People with type 1 diabetes should have an initial comprehensive eye examination by ophthalmologist within 3 – 5 years after the onset of diabetes, while people with type 2 diabetes should have the same examination shortly after diagnosis. Subsequent examination for both type 1 and type 2 diabetes should be repeated annually.

Treatment

During the first stages of diabetic retinopathy, no treatment is needed but glycaemic control and blood pressure control should be optimized in order to prevent progression, and examination intervals could be shortened. Proliferative retinopathy (primarily seen in type 1 diabetes) is treated with scatter laser surgery and vitrectomy is considered in case of bleeding. Macular edema (mainly observed in type 2 diabetes) is treated with focal laser surgery.

Foot care in people with diabetes

Amputation and foot ulceration are the most common consequences of diabetic neuropathy and major causes of morbidity and disability in people with diabetes. Early recognition and management of independent risk factors can prevent or delay adverse outcomes.

Risk of ulcers or amputations is increased in people who have had diabetes >10 years, are male, have poor glucose control, or have cardiovascular, retinal, or renal complications.

Foot-related risk conditions are associated with an increased risk of amputation

- Peripheral neuropathy with loss of protective sensation.
- Altered biomechanics (in the presence of neuropathy).
- Evidence of increased pressure (erythema, haemorrhage under a callus).
- Bone deformity.
- Peripheral vascular disease (decreased or absent pedal pulses).

- A history of ulcers or amputation.
- Severe nail pathology.

Recommendations

- Provide general foot self-care education to all people with diabetes.
- Perform a comprehensive foot examination annually on people with diabetes to identify risk factors predictive of ulcers and amputations.
- The foot examination can be accomplished in a primary care setting and should include the use of a monofilament, tuning fork, palpation, and a visual examination.
- A multidisciplinary approach is recommended for individuals with foot ulcers and high-risk feet, especially those with a history of prior ulcer or amputation.
- Refer people who smoke or with prior lower-extremity complications to foot care specialists for ongoing preventive care and life-long surveillance.
- Initial screening for peripheral arterial disease (PAD) should include a history for claudication and an assessment of the pedal pulses. Consider obtaining an ankle-brachial index (ABI), as many people with PAD are asymptomatic.
- Refer people with significant claudication or a positive ABI for further vascular assessment and consider exercise, medications, and surgical options.
- Inspect the feet (whole foot, nails, between the toes) to identify active foot problems and the ‘high risk foot’.

Examination of persons’ feet should include

- Testing of foot sensation using a 10 gram monofilament or vibration (using tuning fork).
- Palpation of foot pulses.
- Inspection for any foot deformity.
- Inspection of footwear.

Monofilaments should not be used to test more than ten people in one session and should be left for at least 24 hours to “recover” (buckling strength) between sessions.

Classify foot risk as

- Low current risk (normal sensation, palpable pulses).
- At increased risk (neuropathy or absent pulses or other risk factor).
- At high risk (neuropathy or absent pulses plus deformity or skin changes or previous ulcer).
- Ulcerated foot.

Care of people at low current risk of foot ulcers

- To improve knowledge and understanding, encourage beneficial self-care, and minimize inadvertent self-harm, healthcare professionals should discuss and agree with people a management plan that includes appropriate foot care education.

Care of people at increased risk of foot ulcers

- People with risk factors for ulceration should be referred.
- Arrange regular review, 3 to 6 monthly.

At each review:

- Inspect person's feet.
- Review need for vascular assessment.
- Evaluate footwear.
- Enhance foot care education.

Care of people at high risk of foot ulcers

- People at high risk for ulceration should be referred.
- Arrange frequent review, 1 to 3 monthly.
- Inspect person's feet.
- Review need for vascular assessment.
- Evaluate provision and provide appropriate:
 - Intensified foot care education.
 - Specialised footwear.
 - Skin and nail care.

Care of people with foot ulcers

- For a new foot ulcer, urgent (within 24 hours) assessment by an appropriately trained health professional should be arranged.
- Ongoing care of an individual with an ulcerated foot should be undertaken without delay.

FOLLOW UP CARE PLAN

Every Visit	
	• Blood pressure and weight recording • Blood glucose levels • Asking about his/her smoking status • Asking about physical activity • Asking about eating habits • Asking about any foot problems • Foot inspection
Every 3 – 6 months	
	• HbA1C • Lipid profile if still not controlled • Blood glucose levels during different times • Visual acuity
Annually	
	• Fundus examination • Neurological examination • Cardiac assessment • Peripheral pulses • Complete feet inspection and examination • ECG • Lipid profile if it is well controlled • U/E • Creatinine clearance • Micro- albuminuria test or 24 hrs urine for protein • Injection sites

Review and reinforce	Enquire about
• Goals of care	• Hospital admission
• Smoking cessation	• Erectile dysfunction
• Action plan (Self monitoring blood glucose «SMBG»)	• Symptoms of hypoglycaemia, hyperglycaemia and complications.
• Exercise & Medication	

Guideline for diabetes care and criteria for referral

Referral and multidisciplinary team approach

Diabetes management team

- In the diabetes management team the person with diabetes and the family are the central members.
- Good communication between team members is important so that advice is consistent and not confusing for the person with diabetes.
- Team members are:
 - Family physician.
 - Nurse case manager.
 - Dieticians.
 - Diabetes educator.

Criteria for referral of people with diabetes to dietitians/nutritionists

- Initial diagnosis of diabetes.
- Change in management.
- Episodes of hypoglycaemia.
- Dyslipidaemia.
- Pregnancy.
- Uncontrolled diabetes.
- Renal complications.

Criteria for referral of people with diabetes to diabetes educators

- Initial diagnosis of diabetes.
- Change in the management of diabetes.
- Social changes.
- Poor management by the person.

Criteria for referral of people with diabetes to endocrinologists

- Initial diagnosis of diabetes in children.
- Uncontrolled diabetes.

- If existing co morbidities require review i.e. peripheral vascular disease, symptomatic neuropathy, ulcer or significant infection, impaired renal function etc.
- If pregnant or considering pregnancy.

Criteria for referral of people with diabetes to vascular surgeon

- Ischemia → immediate surgical referral
- Previous foot ulceration.
- Partial or total foot amputation.
- Intermittent claudications.
- Rest pain.
- Foot ulcer.
- Foot abnormality.
- Warm oedematous foot.
- Peripheral vascular disease.
- Muscle waste in the lower limb.
- Increased plantar pressure (erythema, warmth, callus, bony deformities such as hammer toes or Charcot's foot).

Criteria for referral of people with diabetes to ophthalmologist

- Initial diagnosis of diabetes.
- If any retinopathy suspected or detected.
- If subsequent examinations detect declining visual acuity.
- If clear view of retina is not obtained.

Criteria for referral of people with diabetes to oral health professionals

- Dental and periodontal problems are common in people with diabetes who need referral.
- Initial diagnosis of diabetes.
- To see a dentist regularly (yearly).



Pre-existing diabetes

Pre-pregnancy counselling

1. Identify possibility of pregnancy annually by direct questioning in all fertile women of child-bearing age with diabetes. Provide contraceptive advice where appropriate.
2. Offer pre-pregnancy advice to all women so identified, including as appropriate:
 - Education on the management of pregnancy with diabetes.
 - Optimization of blood glucose control (pre-conception target DCCT-aligned HbA1C <6.1 %).
 - Stopping oral glucose-lowering drugs (Metformin may still be indicated), and starting insulin where appropriate.
 - Optimization of blood pressure control (to <130/80 mmHg).
 - Stopping ACE-inhibitors and ARBs (use Methyldopa, Nifedipine MR, Labetalol).
 - Stopping statins and fibrates.
 - Assessment of eye and kidney damage (see Eye screening, Kidney damage); discuss and manage identified problems.
 - Assessment of thyroid function.
 - Advice on alcohol and smoking.
 - Folic acid therapy.

Gestational diabetes mellitus

Develops in 2% to 5% of all pregnancies.

Carbohydrate intolerance of varying degrees of severity with onset or first recognition during pregnancy.

Screening for undiagnosed or new (gestational) diabetes in pregnancy

1. In women at high risk of diabetes (previous gestational diabetes, obesity – especially abdominal obesity, population with high prevalence of diabetes, strong family history of type 2 diabetes, delivery of large-for-gestational-age infant, presence of glycosuria, diagnosis of PCOS) provide healthy lifestyle advice (nutrition and physical activity) from first pre-natal visit; check for hyperglycaemia at first pre-natal visit; perform 75-g OGTT if indicated.
2. In all women, measure plasma glucose at first visit after week 20; perform 75-g OGTT if abnormal.

Table 6: Recommended glycaemic targets for preconception and during pregnancy

	Ideal target levels
Pre-pregnancy HbA1C	≤ 7%
During pregnancy	
Fasting and pre-prandial PG	69 – 94 mg/dl (3.8 – 5.2 mmol/l)
1 h postprandial PG	100 – 140 mg/dl (5.5 – 7.7 mmol/l)
2 h postprandial PG	89 – 120 mg/dl (5.0 - 6.6 mmol/l)
HbA1C	< 6%

Management during pregnancy

3. Review understanding of management of diabetes in pregnancy, current drug therapy (refer to point 2), blood glucose control, status of diabetes complications, and presence of other medical conditions. Involve and empowerment the woman in the management of her diabetes.
4. Offer medical nutrition therapy and education. If overweight, advise a diet suitable for someone of optimal weight. Encourage moderate exercise such as walking.
5. Review frequently, depending on achievement of blood glucose control targets, and management of other diabetes-associated and obstetric problems.
6. Aim for DCCT-aligned HbA1C <6.0 %, or lower if safely achievable, using self-monitoring of blood glucose to 3.3 - 6.7 mmol/l (60-120 mg/dl), four times daily (pre-breakfast and 1-2 h after each meal), and insulin therapy (meal-time + basal regimen) if indicated.
7. Manage insulin therapy through careful and intensive self-monitoring and dose adjustment, expecting a rise in insulin requirements as pregnancy proceeds. Insulin requirements may be further disturbed by hyperemesis or use of steroid therapy, and in-patient care may be needed.

8. Monitor weight gain and blood pressure and advise/treat accordingly. Blood pressure should be <130/80 mmHg, avoid the use of renin-angiotensin system blocking drugs.

Labour and delivery

1. Use intravenous insulin (if on insulin or if needed) during labour.
2. Anticipate changed insulin requirements, and thus need for more frequent glucose monitoring, if continuing insulin postpartum and during lactation.
3. Provide appropriate care and facilities for the newborn.
4. At 45 to 60 days after pregnancy, screen for diabetes in women who developed new diabetes in pregnancy. If then non-diabetic, advise on the high risk of future diabetes, and preventative lifestyle measures. Advise check for diabetes annually.



SPECIAL CONSIDERATIONS

Care of elderly with diabetes

Elderly people can be treated with the same drug regimens as younger people, but special care is required in prescribing and monitoring drug therapy:

- Metformin is often contraindicated in elderly because of the high risk of renal insufficiency or heart failure.
- Sulfonylureas and insulin secretagogues can cause hypoglycaemia.
- Insulin can also cause hypoglycaemia as well as requiring good visual and motor skills and cognitive ability of the person or the caregiver.
- Drugs should be started at the lowest dose and titrated up gradually until targets are reached or side effects develop.

Sick day management

- Increase frequency of self blood glucose monitoring, check of body temperature and check for ketones in the urine.
- Increase insulin dose if blood glucose is rising.
- Drink plenty of fluid.
- Seek medical help if unable to drink fluids because of vomiting, ketones $\geq 2+$ or rising glucose despite increased insulin.
- Don't stop taking insulin and consult the health care providers for dose modification.



DIABETES CARE IN CHILDREN AND ADOLESCENTS

Diabetes care in the school and day care setting

The following recommendations are based on the ADA guidelines which set the standard of care for children with diabetes in the school and day care setting. The same standards can and should be applied in UAE. Achieving this goal requires collaboration between the diabetes care providers, the family and the school.

General guidelines for the care of the child in the school and day care setting:

I. Diabetes Medical Management Plan

An individualized Diabetes Medical Management Plan should be developed by the parent / guardian and the student's diabetes health care team. Inherent in this process are delineated responsibilities assumed by all parties, including the parent / guardian, the school personnel, and the student. These responsibilities are outlined in this position statement. The Diabetes Medical Management Plan should address the specific needs of the child and provide specific instructions for each of the following:

1. Blood glucose monitoring, including the frequency and circumstances requiring blood glucose checks.
2. Insulin administration (if necessary), including doses/injection times prescribed for specific blood glucose values, the storage of insulin, and, when appropriate, physician authorization of parent/guardian adjustments to insulin dosage.
3. Meals and snacks, including food content, amounts, and timing.
4. Symptoms and treatment of hypoglycaemia, including the administration of glucagon if recommended by the student's treating physician.
5. Symptoms and treatment of hyperglycaemia.
6. Checking for ketones and appropriate actions to take for abnormal ketones levels, if requested by the student's health care provider.

II. Responsibilities of the various care providers

A. The parent/guardian should provide the school or day care provider with the following:

1. All materials and equipment necessary for diabetes care tasks, including blood glucose monitoring, insulin administration (if needed), and urine or blood ketones monitoring.
2. Supplies to treat hypoglycaemia, including a source of glucose and a glucagon emergency kit, if indicated in the Diabetes Medical Management Plan.

3. Information about diabetes and the performance of diabetes-related tasks.
4. Emergency phone numbers for the parent/guardian and the diabetes health care team so that the school can contact these individuals with diabetes-related questions and/or during emergencies.
5. Information about the student's meal/snack schedule. The parent should work with the school to coordinate this schedule with that of the other students as closely as possible. For young children, instructions should be given for when food is provided during school parties and other activities.
6. In most locations and increasingly, a signed release of confidentiality from the legal guardian will be required so that the health care team can communicate with the school. Copies should be retained both at school and in the health care professionals' offices.

B. The school or day care provider should provide the following:

1. Training to all adults who provide education/care for the student on the symptoms and treatment of hypoglycaemia and hyperglycaemia and other emergency procedures. An adult and back-up adult(s) trained to 1) perform finger stick blood glucose monitoring and record the results; 2) take appropriate actions for blood glucose levels outside of the target ranges as indicated in the student's Diabetes Medical Management Plan; and 3) test the urine or blood for ketones, when necessary, and respond to the results.
2. Immediate accessibility to the treatment of hypoglycaemia by a knowledgeable adult. The student should remain supervised until appropriate treatment has been administered, and the treatment should be available as close to where the student is as possible.
3. If indicated, an adult and back-up adult(s) trained in insulin administration.
4. An adult and back-up adult(s) trained to administer glucagon, in accordance with the student's Diabetes Medical Management Plan.
5. A location in the school to provide privacy during blood glucose monitoring and insulin administration, if desired by the student and family, or permission for the student to check his or her blood glucose level and to take appropriate action to treat hypoglycaemia in the classroom or anywhere the student is in conjunction with a school activity, if indicated in the student's Diabetes Medical Management Plan.
6. An adult and back-up adult(s) responsible for the student who will know the schedule of the student's meals and snacks and work with the parent/guardian to coordinate this schedule with that of the other students as closely as possible. This individual also will notify the parent/guardian in advance of any expected changes in the school schedule that affect the student's meal times or exercise routine. Young children should be reminded of snack times.
7. Permission for the student to see the school nurse and other trained school personnel upon request.
8. Permission for the student to eat a snack anywhere, including the classroom or the school bus, if necessary to prevent or treat hypoglycaemia.
9. Permission to miss school without consequences for required medical appointments to monitor the student's diabetes management. This should be an excused absence with a doctor's note, if required by usual school policy.

10. Permission for the student to use the restroom and have access to fluids (i.e., water) as necessary.
11. An appropriate location for insulin and/or glucagon storage, if necessary.
12. Information on serving size and caloric, carbohydrate, and fat content of foods served in the school.

III. Expectations of the student in diabetes care

Children and youths should be able to implement their diabetes care at school with parental consent to the extent that is appropriate for the student's development and his or her experience with diabetes. The extent of the student's ability to participate in diabetes care should be agreed upon by the school personnel, the parent/guardian, and the health care team, as necessary. The ages at which children are able to perform self-care tasks are very individual and variable, and a child's capabilities and willingness to provide self-care should be respected.

1. Preschool and day care. The preschool child is usually unable to perform diabetes tasks independently. By 4 years of age, children may be expected to generally cooperate in diabetes tasks.
2. Elementary school. The child should be expected to cooperate in all diabetes tasks at school. By age 8 years, most children are able to perform their own finger-stick blood glucose tests with supervision. By age 10, some children can administer insulin with supervision.
3. Middle school or junior high school. The student should be able to administer insulin with supervision and perform self-monitoring of blood glucose under usual circumstances when not experiencing a low blood glucose level.
4. High school. The student should be able to perform self-monitoring of blood glucose under usual circumstances when not experiencing low blood glucose levels. And should be able to administer insulin without supervision.

At all ages, individuals with diabetes may require help to perform a blood glucose check when the blood glucose is low. In addition, many individuals require a reminder to eat or drink during hypoglycaemia and should not be left unsupervised until such treatment has taken place and the blood glucose value has returned to the normal range.

Monitoring blood glucose in the classroom:

It is best for a student with diabetes to monitor a blood glucose level and to respond to the results as quickly and conveniently as possible. A student should be permitted to monitor his or her blood glucose level and take appropriate action to treat hypoglycaemia in the classroom or anywhere the student is in conjunction with a school activity, if preferred by the student and indicated in the student's Diabetes Medical Management Plan. However, some students desire privacy for blood glucose monitoring and other diabetes care tasks and this preference should also be accommodated.

Hypoglycaemia

- Hypoglycaemia is the most frequent acute complication in type 1 diabetes.
- Mild hypoglycaemia may cause a variety of reversible signs and symptoms. characteristic of neurological dysfunction, from transient dizziness or cognitive impairment to excitation of peripheral nerves or even temporary hemiplegia.
- Severe prolonged hypoglycaemia with convulsions has the potential, particularly in young children, to cause permanent CNS impairment.
- Hypoglycaemia provokes significant anxiety in children, adolescents, parents and other care givers.
- Hypoglycaemia is an important limiting factor in attempts to achieve near-normoglycemia.

Definition

There is no consistent or agreed definition of hypoglycaemia for the diabetic child.

- In theory, hypoglycaemia is the level of BG at which physiological neurological dysfunction begins.
- In practice, neurological dysfunction can be symptomatic or asymptomatic, and the level at which it occurs:
 - varies between individuals.
 - may vary with time and circumstances.
 - is affected by antecedent hypoglycaemia.

Clinically, hypoglycemia causes signs and symptoms of:

- **Autonomic activation** (hunger, trembling of hands or legs, palpitations, anxiety, pallor, sweating).
- BG threshold for autonomic (counter-regulatory) activation.
 - experimentally has been shown to be at a higher BG level in children than adults.
 - varies with level of metabolic control
 - poor control — threshold for autonomic activation is at a higher BG level
 - good control — threshold for autonomic activation is at a lower BG level
 - may be lowered by antecedent hypoglycaemia.
 - is lowered by sleep.
- **Neuroglycopenia** (impaired thinking, change of mood, irritability, dizziness, headache, tiredness, confusion and later convulsions and coma).
- BG threshold for cognitive impairment is usually between 47 and 63 mg/dl (2.6 and 3.5 mmol/l).
- Neuroglycopenia may occur before autonomic activation (causing hypoglycaemic unawareness).

Recommendation

- The level of BG should be maintained above 72 mg/dl (4 mmol/l).

Severity of hypoglycaemia

Mild:	Child or adolescent is aware of, responds to and self-treats the hypoglycaemia
Moderate:	Child or adolescent cannot respond to hypoglycaemia and requires help from someone else, but oral treatment is successful
Severe:	Child or adolescent is semi-conscious or unconscious or in coma ± convulsions and may require parenteral therapy (glucagon or IV glucose)

Predisposing factors

Hypoglycaemia is the result of a mismatch between insulin, food and exercise

- Altered routine (missed or erratic meals, changes in physical activity, alterations or errors in insulin dosage or absorption)
- Younger age (<6 years).
- Lower HbA1C.
- Total deficiency of endogenous insulin.
- Antecedent hypoglycaemic episodes.
- Hypoglycaemic unawareness.
- Defective glucagon and catecholamine counter-regulation (longer duration).
- Alcohol ingestion.

Consequences

- **Brain dysfunction**
 - Severe prolonged episodes with convulsions in younger children have the potential to harm the developing brain including the occurrence of secondary epilepsy.
 - Transient episodes have important implications for school and social wellbeing including:
 - decreased awareness and cognitive deficits.
 - injury or accident during an episode.
 - fear of hypoglycaemia with consequent deterioration of glycaemic control.
 - The development of hypoglycaemic unawareness should raise the possibility of antecedent unrecognized hypoglycaemia, particularly during the night.

- **Nocturnal hypoglycaemia**

- Is frequent, often prolonged, usually asymptomatic and does not necessarily disturb sleep patterns.
- Counter-regulatory responses may be impaired during sleep.
- Should be suspected if:
 - pre-breakfast BG is low.
 - confusional states, nightmares or seizures occur during the night, or impaired thinking, lethargy, altered mood or headaches are experienced on waking.
- Can only be confirmed by BG tests at regular intervals during the night.
- The association with subsequent hypoglycaemic unawareness may be reversed by maintaining BG above 5 mmol/l during the night.
- Is not regularly predictable on the basis of a bedtime BG level (predictability is improved by BG measurement towards midnight).

Although many parents of younger children gain reassurance by maintaining bedtime BG > 6 mmol/l (108 mg/dl) and ensuring that a bedtime snack is eaten, this should not be at the expense of causing high overnight BG levels.

Exercise and hypoglycaemia

- When adequate insulin levels are present, muscular activity lowers BG during, immediately after, and/or several hours after exercise.
- The BG-lowering effect is extremely variable and its severity depends on many factors.
- When BG levels are high because of inadequate insulin levels, exercise may lead to a further rise in BG.
- Recommendations for individuals can only be made on the basis of their age, size, individual experience and 'trial and error'.

Light or brief exercise

- A small intake of rapidly absorbed carbohydrate is usually recommended prior to exercise.

Intensive, strenuous or prolonged exercise

- Careful monitoring of BG levels is recommended to help in matching insulin and food to the intensity of exercise.
- Reduction of insulin should be considered.
- Extra slowly absorbed complex carbohydrate will be necessary especially at bedtime following strenuous exercise in the afternoon or evening.
- The bedtime snack also containing fat and protein may help to prevent nocturnal hypoglycaemia.

High-risk and/or high-activity exercise or sport when hypoglycaemia would be potentially dangerous

(e.g. water sports, climbing, running, football playing, skiing, diving, etc).

- BG monitoring is extremely valuable.
- BG targets for near-normoglycemia may be temporarily relaxed.
- Extra rapidly absorbed carbohydrate must be available throughout the period of strenuous exercise.
- Reduction of insulin dose should be considered.
- Delayed and nocturnal hypoglycaemia may be prevented by special attention to increased snacks especially before sleep.

Before and during activities such as riding bicycles in traffic or driving vehicles, the prevention of hypoglycaemia is extremely important.

Recommendations

- BG monitoring should be performed to provide information about glycaemic levels during and after exercise or sport to enable individual algorithms to be devised.
- Young people with diabetes should perform strenuous exercise in the presence of a companion or supervisor familiar with the recognition and treatment of hypoglycaemia and with an immediate supply of rapidly absorbed carbohydrate.

Prevention

- **Education** of young people, their parents and other care givers with particular attention to:
 - early warning signs and symptoms.
 - the usefulness of BG monitoring.
 - effects of increased exercise.
- preventative effects of higher fibre, higher carbohydrate foods and snacks.
- management of hypoglycaemic episodes.
- review of individual insulin management.
- taking special care when routines are altered, such as holidays, travel or changes of season.
- repeated advice that a source of glucose or sucrose must always be immediately available.
- **Assessment** of episodes, particularly:
 - food intake (daytime and bedtime snacks; pre- and post-exercise carbohydrate intake).
 - insulin action profiles (e.g. rapid-acting insulin analog to reduce post-meal or nocturnal hypoglycaemia; splitting evening short/rapid and bedtime intermediate-acting insulin doses).
 - nocturnal (2.00–4.00 am) BG measurements.

- **Review** of glycaemic targets for those at high risk (e.g. young children and those with hypoglycaemic unawareness).

Treatment

Mild and moderate:

- Immediate oral rapidly absorbed simple carbohydrate e.g.:
 - 5–15 g glucose or sucrose (tablets/sugar lumps).
 - 100 ml sweet drink (glucose/sucrose drinks, cola, etc).
- Wait 10–15 min..... if no response ...
 - Repeat oral intake as above.
- As symptoms improve or normoglycemia is restored, the next meal or oral complex carbohydrate should be ingested (e.g. fruit, bread, cereal, milk).
- BG measurements are the only way to confirm hypoglycaemia if the diagnosis is uncertain, for example in children who may mimic the symptoms of hypoglycaemia in order to be allowed to eat sweet foods. BG measurements also confirm the return of BG towards normal after hypoglycaemia.

Severe:

- Treatment is **urgent**
- Severe hypoglycaemia with loss of consciousness $\pm$ convulsions (particularly if there is vomiting) is most safely and rapidly reversed by injection of Glucagon:
 - 0.5 mg for age <12 years.
 - 1.0 mg for age 12+ years.
 - [or 0.1–0.2 mg/10 kg body weight] best given IM (or deep SC).
- If glucagon is unavailable or recovery is inadequate, IV glucose should be administered slowly by trained personnel over several minutes to reverse the hypoglycaemia.
- If the hypoglycaemia is not associated with vomiting nor severe enough to remove the swallowing, spitting or gag reflexes, it is usually effective to give concentrated sugar as glucose gel/syrup/honey/jam carefully by mouth.

In the recovery phase after severe hypoglycaemia

- Close observation and BG monitoring are essential because vomiting is common and recurrent hypoglycaemia may occur. The child will then usually require:
 - additional oral carbohydrate
and/or
 - IV infusion of glucose
e.g. glucose 10% 2–5 mg/kg per min (1.2–3.0 ml/kg per h).

Recommendations

- An immediate source of glucose or sucrose must always be immediately available to young people with diabetes.
- Equipment for BG measurement must be available to all young people with diabetes for immediate confirmation and safe management of hypoglycaemia.
- Children, adolescents, parents, schoolteachers and other care givers should receive education on the recognition and management of hypoglycaemia.
- Glucagon should be readily accessible to all parents and care givers, especially when there is a high risk of severe hypoglycaemia. Education on administration of glucagon is essential.
- Children and adolescents with diabetes should wear some form of identification or warning of their diabetes.

Note: The following guidelines are general recommendations to provide guidance for health care professionals caring for children with diabetes in UAE. They should not replace clinical judgment based on individual patient needs. These guidelines are directly quoted from ADA and ISPAD clinical practice recommendations in 2006/2007.

Assessment of glycaemic control

Aims

- To assess with accuracy and precision the level of glycaemic control achieved by each individual so that they may benefit from attaining their most realistic glycaemic targets.
- To help in preventing both the acute complication of hypoglycaemia and the chronic complications of microvascular and macrovascular diseases.
- To minimize the effect of hypoglycaemia and hyperglycaemia on cognitive function and mood.
- To collect data on glycaemic control from each diabetes centre for comparison with stated local, national, and international standards so that the performance and standards of the interdisciplinary Diabetes Care Teams may be improved.

General principles determining glycaemic targets

- Measurement of immediate glycaemic control is best determined by self-monitoring of blood glucose (SMBG) as this provides immediate documentation of hyperglycaemia and hypoglycaemia.
- HbA1C is the only measure of glycaemic control for which robust outcome data are available. Elevated HbA1C predicts long-term microvascular and macrovascular outcomes. However, HbA1C has limitations as a measure of glycaemic control.
- HbA1C can only be one of the several measures of optimal glycaemic control, along with documented hypoglycaemia, type of treatment, patient's age, and quality of life.

Experts agree that at present, safest recommendation for improving glycaemic control generally in all children is to achieve the lowest HbA1C that can be sustained without disabling or severe hypoglycaemia while avoiding prolonged periods of significant hyperglycaemia (BG levels 270 – 360 mg/dl (15–20 mmol/l)) and episodes of diabetic ketoacidosis (DKA) and that these goals can only be achieved by some form of frequent glucose monitoring.

Monitoring of glycaemic control

- helps to determine immediate and daily insulin requirements;
- helps guide insulin adjustments to decrease fluctuations in BG levels;
- detects hypoglycaemia and assists in its management;
- assists in the safe management of hyperglycaemia.

Timing of SMBG

BG is best measured

- at different times in the day to show levels of BG after the overnight fast, during the night to detect unnoticed

hypoglycaemia and hyperglycaemia, in response to the action profiles of insulin (at anticipated peaks and troughs of insulin action), and after food intake (1–2 h after a meal), and in association with vigorous sport or exercise (during and several hours after) so that changes may be made in management to improve BG profiles;

- to confirm hypoglycaemia and to monitor recovery;
- during intercurrent illness to prevent hyperglycaemic crises.

The number and regularity of SMBG should be individualized depending on:

- Availability of equipment;
- Type of insulin regimen;
- Ability of the child to identify hypoglycaemia.
- The cost of BG monitoring, which could be very expensive relative to the cost of living. However, all centres caring for young people with diabetes should urge nations and health care providers to ensure that children and adolescents with diabetes have adequate glucose monitoring equipment available to them. It must be recognized that without accurate monitoring, the risks of acute crises and long-term vascular and other damaging complications are greatly increased leading to high levels of health care costs and personal disability.

Monitoring of urinary or blood ketones

- Urine or blood ketones measurement should be monitored during episodes of uncontrolled hyperglycaemia, insulin deficiency, intercurrent illness (sick days), and impending ketoacidosis.
- Blood ketones determination has been shown to be more helpful in avoiding emergency room visits than urine ketones determinations.

Recommendations for ketones testing

- Illness with fever and/or vomiting.
- BG value above 14 mmol/l (250 mg/dl) in an unwell child (to be in accordance with the sick day guidelines).
- Persistent BG levels above 14 mmol/l (250 mg/dl), especially in a young child, insulin pump user, or a patient with a history of prior episodes of DKA.
- Persistent polyuria with elevated BG or urine glucose.
- Episodes of drowsiness.
- Abdominal pains or rapid breathing.

Record keeping of glycaemic control

- It is common practice for a monitoring diary, logbook, or some type of electronic memory device to be used to record patterns of glycaemic control and adjustments to treatment.

- The record book is useful at the time of consultation and should contain time and date of:
 - BG levels;
 - insulin dosage.
- note of special events affecting glycaemic control (e.g., illness, parties, exercise, menses, etc.).
- hypoglycaemic episodes, description of severity, and potential alterations in the usual routine to help explain the cause for the event; and
- episodes of ketonuria / ketonemia.

Glycated haemoglobin

Glucose becomes irreversibly attached to the molecule of haemoglobin during the life cycle of the circulating red cell (approximately 120 d) forming glycated haemoglobin (HbA1 or HbA1C).

- HbA1C reflects levels of glycaemia over the preceding 4–12 wk, weighted toward the most recent 4 wk. However, the most recent week is not included because the most recent glycation is reversible.

Recommendations for HbA1C testing

- Facilities for the measurement of HbA1C should be available to all centres caring for young people with diabetes.
- Ideally, there should be four to six measurements per year in younger children and three to four measurements per year in older children.
- Adolescents with stable type 2 diabetes should have two to four measurements per year because adolescents may become insulin requiring more rapidly than adults.

Glycaemic Control Recommendations

Consider age when setting glycaemic goals in children and adolescents with type 1 diabetes, with less stringent goals for younger children.

Glycaemic goals need to be modified to take into account the fact that most children <6 or 7 years of age have a form of “hypoglycaemic unawareness.” Their counter-regulatory mechanisms are immature, and they may lack the cognitive capacity to recognize and respond to hypoglycaemic symptoms, placing them at greater risk for severe hypoglycaemia and its sequelae. In addition, and unlike the case in adults, children younger than 5 years of age are at risk for permanent cognitive impairment after episodes of severe hypoglycaemia.

In selecting glycaemic goals, the benefits on long-term health outcomes of achieving a lower HbA1C must be weighed against the unique risks of hypoglycaemia and the difficulties achieving near-normoglycemia in children and youth. Age-specific glycaemic and HbA1C goals are presented in the table 7.

Table 7: Plasma blood glucose and HbA1C goals for type 1 diabetes by age-group

Plasma blood glucose goal range mg/dl (mmol/l)				
Values by age (years)	Before meals	Bedtime/overnight	HbA1C	Rationale
Toddlers and preschoolers (0–6)	100–180 mg/dl (5.5–10 mmol/l)	110–200 mg/dl (6.1–11.1 mmol/l)	<8.5% (but >7.5%)	High risk and vulnerability to hypoglycaemia
School age (6–12)	90–180 mg/dl (5–10 mmol/l)	100–180 mg/dl (5.5–10 mmol/l)	<8%	• relatively low risk of complications pre- puberty • Risk of severe hypoglycaemia • Developmental and psychological issues • lower goal (<7.0%) is reasonable if can be achieved without excessive hypoglycaemia
Adolescents and young adults (13–19)	90–130 mg/dl (5–7.2 mmol/l)	90–150 mg/dl (5–8.3 mmol/l)	<7.5%	

Key concepts in setting glycaemic goals:

- Goals should be individualized and lower goals may be reasonable based on benefit-risk assessment.
- Blood glucose goals should be higher than those listed above in children with frequent hypoglycaemia or hypoglycaemia unawareness.
- Postprandial blood glucose values should be measured when there is a discrepancy between pre-prandial blood glucose values and HbA1C levels.

Screening and management of chronic complications

Nephropathy

Recommendations

- Annual screening for microalbuminuria, with a random spot urine sample for microalbumin-to-creatinine ratio, should be initiated once the child is 10 years of age and has had diabetes for 5 years.
- Confirmed, persistently elevated microalbumin levels on two additional urine specimens should be treated with an ACE inhibitor titrated to normalization of microalbumin excretion if possible.

Hypertension

Recommendations

- Treatment of high-normal blood pressure (systolic or diastolic blood pressure consistently above the 90th percentile for age, sex, and height) should include dietary intervention and exercise aimed at weight control and increased physical activity, if appropriate. If target blood pressure is not reached with 3–6 months of lifestyle intervention, pharmacologic treatment should be initiated.
- Pharmacologic treatment of hypertension (systolic or diastolic blood pressure consistently above the 95th percentile for age, sex, and height or consistently $>130/80$ mmHg, if 95% exceeds that value) should be initiated as soon as the diagnosis is confirmed.
- ACE inhibitors should be considered for the initial treatment of hypertension.

Hypertension in childhood is defined as an average systolic or diastolic blood pressure ≥ 95 th percentile for age, sex, and height percentile measured on at least three separate days. “High-normal” blood pressure is defined as an average systolic or diastolic blood pressure ≥ 90 th but < 95 th percentile for age, sex, and height percentile measured on at least three separate days. Normal blood pressure levels for age, sex, and height and appropriate methods for determinations are available online at www.nhlbi.nih.gov/health/prof/heart/hbp/hbp_ped.pdf.

Dyslipidaemia

Recommendations

Screening

- If there is a family history of hypercholesterolemia (total cholesterol >240 mg/dl) or a cardiovascular event before age 55 years, or if family history is unknown, then a fasting lipid profile should be performed on children >2 years of age soon after diagnosis (after glucose control has been established). If family history is not of concern, then the first lipid screening should be performed at puberty (≥ 10 years). All children diagnosed with diabetes at or after puberty should have a fasting lipid profile performed soon after diagnosis (after glucose control has been established).

- For both age groups, if lipids are abnormal, annual monitoring is recommended. If LDL cholesterol values are within the accepted risk levels (<100 mg/dl [2.6 mmol/l]), a lipid profile should be repeated every 5 years.

Treatment

- Initial therapy should consist of optimization of glucose control and MNT using a Step 2 American Heart Association diet aimed at a decrease in the amount of saturated fat in the diet.
- After the age of 10, the addition of a statin is recommended in patients who, after MNT and lifestyle changes, have LDL cholesterol >160 mg/dl (4.1 mmol/l) or have LDL cholesterol >130 mg/dl (3.4 mmol/l) and one or more CVD risk factors.
- The goal of therapy is an LDL cholesterol value <100 mg/dl (2.6 mmol/l).

People diagnosed with type 1 diabetes in childhood have a high risk of early sub-clinical and clinical CVD. Although intervention data are lacking, the American Heart Association (AHA) categorizes type 1 children in the highest tier for cardiovascular risk, and recommends both lifestyle and pharmacologic treatment for those with elevated LDL cholesterol levels. Initial therapy should be with a Step 2 AHA diet, which restricts saturated fat to 7% of total calories and restricts dietary cholesterol to 200 mg/day. Data from randomized clinical trials in children as young as 7 months of age indicate that this diet is safe and does not interfere with normal growth and development.

For children over the age of 10 with persistent elevation of LDL cholesterol despite lifestyle therapy, statins should be considered. Neither long-term safety nor cardiovascular outcome efficacy has been established for children. However, recent studies have shown short-term safety equivalent to that seen in adults, as well as efficacy in lowering LDL cholesterol levels, improving endothelial function, and causing regression of carotid intimal thickening. No statin is approved for use under the age of 10, and statin treatment should generally not be used in type 1 children before this age.

Retinopathy

Recommendations

- The first ophthalmologic examination should be obtained once the child is ≥10 years of age and has had diabetes for 3–5 years.
- After the initial examination, annual routine follow-up is generally recommended. Less frequent examinations may be acceptable on the advice of an eye care professional.

Although retinopathy most commonly occurs after the onset of puberty and after 5–10 years of diabetes duration, it has been reported in pre-pubertal children and with diabetes duration of only 1–2 years. Referrals should be made to eye care professionals with expertise in diabetic retinopathy, an understanding of the risk for retinopathy in the paediatric population, and experience in counselling the paediatric patient and family on the importance of early prevention/intervention.

Celiac disease

Recommendations

- People with type 1 diabetes who become symptomatic for celiac disease should be tested by measuring tissue transglutaminase or anti-endomysial antibodies, with documentation of normal serum IgA levels.
- Children with positive antibodies should be referred to a gastroenterologist for evaluation.
- Children with confirmed celiac disease should have consultation with a dietician and be placed on a gluten-free diet.

Celiac disease is an immune-mediated disorder that occurs with increased frequency in patients with type 1 diabetes (1–16% of individuals compared with 0.3–1% in the general population). Symptoms of celiac disease include diarrhoea, weight loss or poor weight gain, growth failure, abdominal pain, chronic fatigue, malnutrition due to malabsorption and other gastrointestinal problems, and unexplained hypoglycaemia or erratic blood glucose concentrations.

Hypothyroidism

Recommendations

People with type 1 diabetes should be screened for thyroid peroxidase and thyroglobulin antibodies at diagnosis.

Thyroid-stimulating hormone (TSH) concentrations should be measured after metabolic control has been established. If normal, they should be rechecked every 1–2 years, or if the patient develops symptoms of thyroid dysfunction, thyromegaly, or an abnormal growth rate. Free T4 should be measured if TSH is abnormal.

Auto-immune thyroid disease is the most common autoimmune disorder associated with diabetes, occurring in 17–30% of patients with type 1 diabetes. The presence of thyroid auto-antibodies is predictive of thyroid dysfunction (generally hypothyroidism, but less commonly hyperthyroidism). Sub-clinical hypothyroidism may be associated with increased risk of symptomatic hypoglycaemia and with reduced linear growth. Hyperthyroidism alters glucose metabolism, potentially resulting in deterioration of metabolic control.

“Adherence”

No matter how sound the medical regimen, it can only be as good as the ability of the family and/or individual to implement it. Family involvement in diabetes remains an important component of optimal diabetes management throughout childhood and into adolescence. Health care providers who care for children and adolescents, therefore, must be capable of evaluating the behavioural, emotional, and psychosocial factors that interfere with implementation and then must work with the individual and family to resolve problems that occur and/or to modify goals as appropriate.

Diabetic ketoacidosis guidelines in children and adolescents with type 1 diabetes

- DKA results from absolute or relative insulin deficiency, and the combined effects of elevated counter-regulatory hormones: catecholamines, cortisol and Glucagon.
- This creates an accelerated catabolic state with increased glucose production by the liver and kidney (glycogenolysis and gluconeogenesis), impaired glucose utilization resulting in hyperglycemia and hyperosmolarity, and increased lipolysis and ketogenesis, causing ketonemia and metabolic acidosis.
- DKA may occur in children with type 2 diabetes at diagnosis (6% to 33% of cases). A diagnosis of type 2 diabetes cannot be excluded based on the occurrence of DKA.
- DKA is the commonest cause of diabetes-related deaths in children; most deaths in DKA occur as a result of cerebral oedema.
- Deaths and neurological morbidity should be avoidable by:
 - A. Reducing the incidence of DKA by:
 - earlier diagnosis at onset.
 - appropriate management of diabetes during intercurrent illness.
 - recognition that recurrent DKA is often caused by insulin omission.
 - B. Optimal management of DKA

No protocol for DKA has been shown to eliminate the risk of cerebral oedema. These consensus guidelines are believed to be the safest available in the light of current evidence and clinical practice.

Recommendations

- In centres treating DKA, a clear, unambiguous, written protocol, adapted to local circumstances, should always be immediately available.
- A senior specialist/consultant physician with experience in managing DKA in children should be consulted for advice.

DKA definition

- Heavy glycosuria > 1000 mg/dl (>55 mmol/l) and ketonuria.
- Hyperglycaemia > 200 mg/dl (BG >11 mmol/l).
- pH <7.3, Bicarbonate <15 mmol/l **and** who are 5% or more dehydrated ± vomiting ± drowsy.
- In rare cases the BG is not elevated.
- Children <5% dehydrated and not clinically unwell usually tolerate oral rehydration and SC insulin.

Table 8: Diagnostic criteria in DKA (diabetic ketoacidosis) and HHS (hyperglycaemic hyperosmolar state)

	DKA			HHS
	Mild	Moderate	Severe	
Diagnostic criteria & classification				
Plasma glucose	>250 mg/dl (13.9 mmol/l)	>250 mg/dl (13.9 mmol/l)	>250 mg/dl (13.9 mmol/l)	>600 mg/dl (33.3 mmol/l)
Arterial pH	7.25 – 7.3	< 7- 7.25	< 7	> 7.3
Serum bicarbonate (mEq/l)	15–18	10 - <15	<10	>15
Urine ketones	+	+	+	Small
Serum ketones	+	+	+	Small
Effective serum osmolality	Variable	Variable	Variable	>320 mOsm/kg
Anion gap	> 12	> 12	> 12	< 12
Mental status	Alert	Alert/drowsy	Stupor/coma	Stupor/coma

From Kitabchi AE, Umpierrez GE, Murphy MB, et al. Hyperglycaemic crisis in diabetes. Diabetes Care 2004;27:S94–102; with permission.

a) Nitroprusside reaction method.

b) Calculation: $2 [\text{measured Na (mEq/L)}] + \text{glucose (mg/dl)}/18$.

c) Calculation: $(\text{Na}) - (\text{Cl} + \text{HCO}_3) (\text{mEq/L})$.

DKA emergency assessment:

- Characteristic history : polydipsia, polyuria.
- Biochemical confirmation : glycosuria, ketonuria, BG, pH.
- Clinical assessment:
 - full examination paying special attention to
- **Severity of dehydration**
 - 3% just detectable.
 - 5% dry mucous membranes, reduced skin turgor.
 - 10% capillary return 3 seconds or more, sunken eyes.
 - 10%+ shock, poor peripheral pulses.
- **Evidence of acidosis**
 - hyperventilation.

- **Assessment of conscious level** (and examine pupils and retinal fundi).
- Look for acanthosis nigricans suggesting insulin resistance and type 2 diabetes.

Recommendation

Optimal management of children with severe DKA (pH <7.1, hyperventilation, in shock, depressed level of consciousness, persistent vomiting, age <5 years) is in an intensive care unit or at least in a children's ward specializing in diabetes care.

Immediate investigation

- Weigh child whenever possible.
- Measure or estimate Height or length if calculation of body surface area is required.
- Capillary BG (often inaccurate in the presence of poor peripheral circulation and severe acidosis).
- Venous BG, electrolytes and urea.
- Capillary, venous or arterial blood gases.
- Check for ketones: Measure Blood β -Hydroxybutyrate concentration, or if not available, Urinary ketones.
- As indicated: full blood count (leukocytosis is a common feature of DKA), HbA1C, Calcium, Phosphorus, Magnesium, urine culture, throat swab, chest x-ray, blood cultures.

Resuscitation

In shock with poor peripheral pulses, or coma

- Oxygen 100% by face mask.
- Normal saline 0.9% 10 ml/kg over 1 hr (repeat if peripheral pulses remain poor but do not exceed 30ml/kg).
- Nasogastric tube to drain stomach if there is vomiting $\pm$ impaired consciousness.

In most DKA protocols the fluid for resuscitation is not included in the calculations for later deficit dehydration. If the child is in a location 1 h or more from a specialist centre, Normal saline 0.9% should continue at 10 ml/kg per h for 1–2 h (thereafter 5 ml/kg per h).

Clinical observations and monitoring

Careful and frequent clinical monitoring on a flow chart, to detect warning signs of complications is of paramount importance.

- **Hourly**
 - pulse rate, respiratory rate, blood pressure.
 - accurate fluid input and output (when level of consciousness is impaired a urinary catheter may be necessary).
Capillary blood glucose: cross-check with laboratory venous glucose.

- **Hourly or more frequent** neurological observations.
- **Lab test:** Blood Gas, U&E, Calcium, Phosphorus 2-4 hourly, or as indicated.
- **Anion Gap.**
- **Urine Ketones** until cleared, or β -Hydroxybutyrate every 2 hours.
- **ECG monitoring** in severe DKA to assess T-waves.

*Calculations: Anion Gap = $Na - (Cl + HCO_3)$; normal is 12 ± 2 mmol/L. in DKA the AG is typically 20-30 mmol/l
 Corrected Na = measured Na + $2 \times ([Plasma\ Glucose\ mmol/l - 5.5] / 5.5)$ or $Na + 1.6 \times ([Glucose\ mg/dl - 100] / 100)$
 Effective Osmolality mOsm/kg = $2 \times (Na + K) + Plasma\ Glucose\ mmol/l$.*

Goals of therapy in DKA

- Correct dehydration.
- Correct Acidosis and reverse Ketosis.
- Restore blood glucose to near normal.
- Avoid complications of therapy.
- Identify and treat any precipitating event.

Fluids

The cause of cerebral oedema during treatment remains unclear. However, too rapid reduction in intravascular osmolality may aggravate the process. It seems prudent therefore that rehydration should occur more slowly in children with DKA than in other causes of dehydration.

Proceed with urgency but with caution:

- The serum glucose concentration often decreases substantially with rehydration alone as a result of improvements in the GFR and decreased concentrations of counter-regulatory hormones. This decline early in treatment should not be interpreted as an indication of excessive insulin administration.
- Clinical estimate of the volume deficit are subjective and inaccurate; therefore, in mild DKA use 5-7%, and in severe DKA 7-10%.
- Begin with fluid replacement before insulin therapy.
- If needed, volume expansion (resuscitation) should begin immediately with 0.9% saline, typically 10-20 ml/kg over 1-2 hrs.
- Subsequent rehydration (deficit replacement) should be with 0.9% saline or Ringer's acetate for at least 4-6 hours.
- Thereafter, use a solution that has a tonicity $\geq 0.45\%$.
- The rate of fluid (IV and Oral) should be calculated to rehydrate evenly over 48 hours, at a rate rarely at excess of 1.5-2 times the usual daily maintenance.

- When the BG falls to 14–17 mmol/l (250–300mg/dl) or if BG falls very rapidly (>5 mmol/L/h)(>90 mg/dl/h)), the infusion should be changed to a fluid containing glucose, the most commonly recommended being saline 0.45% (or 0.9%) with glucose 5%.
- In addition to clinical assessment of dehydration, calculation of effective osmolality may be valuable to guide fluid and electrolyte therapy.
- Urinary losses should not routinely be added to the replacement fluid, but may be necessary in rare circumstances.
- The Na content of the fluid may need to be increased if measured serum Na is low and does not rise appropriately as the plasma glucose falls.
- The use of large amounts of 0.9% saline has been associated with hyperchloremic metabolic acidosis.

Oral fluids

- In severe dehydration and acidosis only allow sips of water or ice to suck.
- Oral fluids (e.g. sugar free drinks/oral rehydration solution) should only be offered after substantial clinical improvement and no vomiting.
- Oral fluid volume should be subtracted from the IV calculations.

Insulin

- Insulin should not be started until shock has been successfully reversed by emergency resuscitation and a saline/potassium rehydration regimen begun (this avoids sudden influx of potassium from plasma into cells, with danger of cardiac arrhythmia).
- During the first 60–90 min of initial rehydration the BG may fall substantially even without insulin treatment.
- Insulin by continuous low-dose IV infusion is the optimal method.
- An initial bolus of insulin is not recommended.
- A solution of soluble insulin 1 unit/ml made up in Normal saline is best by electronic pump. If pumps are not available a separate low-dose infusion may be given, e.g. soluble insulin 50 units in 500 ml Normal saline (i.e. 1 unit insulin per 10 ml saline), the bag being changed every 24 h to avoid inactivation of insulin.
- Recommended initial insulin dose = 0.1 units/kg per h.
- Some recommend 0.05 units/kg per h particularly for younger patients, or those show marked sensitivity to insulin, provided that metabolic acidosis continue to resolve.
- Because insulin adsorbs to intravenous tubing, 50 mL of the infusion should be run through the pump before beginning the infusion.
- When insulin infusion methods are not available, the use of hourly IM/SC soluble / rapid-acting insulin 0.1 U/kg has been shown to be effective.

- After resuscitation the typical rate of fall of BG is 2–5 mmol/l (36-90 mg/dl).
- When BG falls to 14-17 mmol/l (250-300 mg/dl), change to the glucose saline infusion to maintain BG in the desired range of 8–12 mmol/l (144-216 mg/dl).
- If BG falls to <10 mmol/l (<180 mg/dl), or falls too rapidly, increase the concentration of glucose to 10% (or even 12.5%) with added saline.
- The insulin infusion rate should only be decreased if the BG level remains below the target range despite glucose supplementation.
- Do not stop insulin infusion or decrease below 0.05 units/kg per h because a continuous supply of both insulin and glucose substrate is needed to promote anabolism and reduce ketosis.

If biochemical parameters of DKA (pH, Anion gap) do not improve, reassess the patient, review insulin therapy, and consider other possible causes of impaired response to insulin; e.g. infection, errors in insulin preparation.

Potassium

- Serum/plasma potassium may be low, normal or high.
- Despite normal or elevated initial K⁺ concentrations, total body K are depleted, often profoundly, and serum K⁺ concentrations usually drop rapidly with insulin treatment.
- If serum K⁺ is not available before the completion of resuscitation, ECG monitoring is recommended before adding K⁺ to the infusion fluid.
- Start potassium replacement as soon as resuscitation is completed and the ECG does not show elevated T-waves (or if serum K⁺ is not elevated).
- Potassium chloride KCl 40 mmol is usually added per litre of saline infusion. Subsequent replacement should be based on serum K⁺ level.
- If K⁺ is given with the initial rapid volume expansion, 20 mmol/L should be used.

[Phosphate or acetate salts of Potassium may also be used but there is no evidence that they are preferable]

Bicarbonate

Severe acidosis is reversible by fluid and insulin replacement; insulin stops further ketoacid production and allows ketoacids to be metabolized, which generates bicarbonate. Treatment of hypovolemia improves tissue perfusion and renal function increasing the excretion of organic acid.

There is no evidence that bicarbonate is either necessary or safe in DKA. Bicarbonate should not be used in the initial resuscitation.

- Potential hazards of bicarbonate therapy:
 - exacerbation of CNS acidosis

- hypokalaemia and altered calcium ionization.
- excessive osmolar load.
- tissue hypoxia.
- Persistent acidosis is likely to be caused by inadequate resuscitation, inadequate insulin effect or sepsis.
- Bicarbonate may be considered in severe acidemia ($\text{pH} < 6.9$) for treatment of impaired cardiac contractility in persistent severe shock, and patients with life-threatening hyperkalaemia.

[If bicarbonate is considered, cautiously give 1–2 mmol/kg bicarbonate over 60 min].

Sodium and osmolality

- Despite the depletion of total body sodium in DKA, the elevated osmolality in the hyperglycaemic state results in a dilutional effect on the measured sodium.
- If serum sodium fails to rise, and particularly if it falls, a careful re-evaluation of the fluid replacement is required. Consider increasing the concentration of sodium chloride and observe with increased vigilance for signs of cerebral oedema.
- An initial serum sodium >150 mmol/l might prompt an even slower rehydration rate than 48 hrs.

Urine output

If this is inadequate (< 1.5 ml/kg/h) the cause must be sought (e.g. acute renal failure, continuing shock, urinary obstruction, bladder retention). If fluid retention is occurring there is some evidence that a single dose of a loop diuretic might be helpful in promoting water diuresis.

Complications

Cerebral oedema

- Approximately 0.4–1% of children with DKA develop cerebral oedema with a high mortality/morbidity.
- Cerebral oedema most commonly occurs in the first 24 h after starting rehydration when the general condition of the child might seem to be improving. Vigilant observations throughout the 24 h must not diminish.
- In many cases warning signs/symptoms occur which should prompt the emergency administration of mannitol.

Warning signs/symptoms of cerebral oedema

- Headache and slowing of heart rate.
- Change in neurological status (restlessness, irritability, increased drowsiness, incontinence) or specific neurological signs (e.g. cranial nerve palsies).
- Rising blood pressure, decreased O₂ saturation.
- Convulsions, papilloedema and respiratory arrest are late signs associated with extremely poor prognosis.

Factors associated with increased risk of cerebral oedema

- Younger age < 5 y, new onset, and longer duration of symptoms.
- Greater hypocapnea, acidosis, and increased BUN at presentation.
- Bicarbonate administration.
- A fall in serum sodium, or even an attenuated rise during therapy.
- Greater volumes of fluid given in the first 4 h.
- Insulin administration during the first hour of fluid treatment.

Action

- Exclude hypoglycaemia.
- If warning signs occur at any time, give immediate IV mannitol 0.5-1 g/kg over 20 min (i.e. 5 ml/kg 20% solution) and repeat if no clinical improvement within 30 min to 2 hr.
- Reduce the rate of fluid administration by one-third.
- Hypertonic Saline 3%, 5-10 ml/kg over 30 min, may be an alternative to mannitol especially if there is no initial response to mannitol.
- Nurse with child's head elevated.
- Move to intensive care unit as soon as possible and if assisted ventilation is required maintain PCO₂ above 3.5 kPa.
- Cranial imaging should only be considered after child has been stabilized. Intracranial events other than oedema may occur, e.g. haemorrhage, thrombosis, infarction.

Other rare causes of morbidity/ mortality in DKA

- Hypoglycaemia, hypokalemia, and hypophosphatemia.
- Other CNS complications: Dural sinus thrombosis, basal artery thrombosis.
 - Aspiration pneumonia, pulmonary oedema/ ARDS/ pneumothorax ± pneumomediastinum, interstitial pulmonary oedema
- Continuing abdominal pain (due to liver swelling/gastritis/bladder retention/pancreatitis — but beware appendicitis).
- Peripheral venous thrombosis
- Sepsis.
- Unusual infections (e.g. TB, fungal infections).
- Rhabdomyolysis.
- Acute renal failure.
- Hyperosmolar hyperglycaemic non-ketotic coma, ketosis in type 2 diabetes.

Transition to SC insulin injections

- Oral fluids should be introduced only when substantial clinical improvement has occurred (mild acidosis/ketosis may still be present) and the patient indicate a desire to eat.
- Insulin by SC injection may be started when oral intake is tolerated.
- The dose and type of SC insulin given will depend on local circumstances.
- To prevent rebound hyperglycaemia do not stop the IV insulin infusion until 60 min after the first SC injection of short or rapid-acting insulin.

Monogenic diabetes in children

The following information is in the Clinical Practice Consensus Guidelines 2006-2007 of the International Society for Paediatric and Adolescent Diabetes (ISPAD, www.ispad.org).

Definition

Monogenic diabetes results from the inheritance of mutation or mutations in a single gene. It may be dominantly or recessively inherited or may be a de novo mutation. In children, almost all monogenic diabetes results from mutations in genes that regulate B-cell function, although diabetes can rarely occur from mutations resulting in very severe insulin resistance.

Diagnosis

The majority of patients with genetically proven monogenic diabetes are initially incorrectly diagnosed as having type 1 or type 2 diabetes mellitus. It is important to correctly diagnose monogenic for the following reasons:

- It can predict the clinical course of the patient.
- Explain other clinical features.
- Guide the most appropriate treatment.
- Provide appropriate genetic counselling for other family members.

Clinical presentation of monogenic diabetes

The diagnosis of monogenic diabetes should be considered in the following circumstances:

- Neonatal diabetes and diabetes diagnosed within the first 6 months of life.
- Familial diabetes with an affected parent.
- Mild (5.5-8.5 mmol/L (99-153 mg/dl)) fasting hyperglycaemia especially if young or familial.
- Diabetes associated with extra pancreatic features.

When to suspect a diagnosis of type 1 diabetes mellitus in children may not be correct?

The following are indications for reviewing the diagnosis of type 1 diabetes in children:

- A diagnosis of diabetes before 6 months. Diagnosis of type 1 diabetes at this age is rare and accounts for less than 1%.
- Family history of diabetes with a parent affected. In type 1 diabetes, only 2-4% of type 1 diagnosed children have a parent with type 1.
- Evidence of endogenous insulin production outside the 'honeymoon' phase with detectable C peptide (> 200 nmol) when glucose level is > 8 mmol (144 mg/dl).
- When pancreatic islet auto antibodies are absent.

When to suspect a diagnosis of type 2 diabetes mellitus in children may not be correct?

The following features in children diagnosed with type 2 should lead to consideration of monogenic diabetes:

- Not markedly obese or diabetic family members who are of normal weight.
- Acanthosis nigricans not detected.
- Ethnic background represents a race with low prevalence of type 2 diabetes, e.g., European Caucasian.
- No evidence of insulin resistance with fasting C-peptide within the normal range.

Management of children with diabetes undergoing surgery

The recommendations below are in the National Institute of Clinical Excellence (NICE) consensus guidelines for management of children and young people with diabetes. Guidelines are detailed in the ISPAD clinical practice consensus.

Children with type 1 diabetes should be offered surgery in centres that have dedicated paediatric facilities for the care of children and young people with diabetes. Careful liaison between surgical, anaesthetist and diabetes care teams should occur.

Children with type 1 diabetes who are undergoing elective surgery:

- Operations are best scheduled early preferably in the morning.
- Children should be admitted the day before surgery for morning and major operations, or early morning on the same day for minor operations.
- Earlier admission is recommended if glycaemic control is poor.
- Admission should be in a Paediatric unit.

Evening prior to elective surgery:

- Frequent blood glucose monitoring is important. Urinary ketones should also be checked.
- The usual evening or bedtime insulin should be given.
- Ketosis or severe hypoglycaemia should be corrected. Consider delaying surgery if correction was not complete.

Morning operations

- No solid food should be given from midnight.
- Monitor blood sugar hourly prior to operation and half hourly during operation until woken from anaesthesia.
- Monitor blood sugar hourly for 4 hours post-operatively.
- Aim to maintain blood sugar between 5-12 mmol (90-216 mg/dl).
- Continue intravenous fluids and insulin until the child tolerates oral fluids and snacks (may take 48 hours after major surgery).
- Change to usual subcutaneous insulin regimen before the first meal is taken.
- Stop insulin infusion 60 minutes after subcutaneous insulin is given.
- For minor operations, it might be possible to discharge from hospital after evening meal.

Afternoon operations

- The usual evening or bedtime insulin should be given.
- Allow light breakfast.

- Reduce the usual morning short acting insulin to a third or half if the operation is after the midday.
- Clear fluids may be allowed up to 4 hours preoperatively.
- For major/long operations, start intravenous fluids and insulin infusion at midday at the latest.
- Monitor the child the same way as for the morning operations.

Emergency surgery

- Keep the child nil per mouth.
- Secure intravenous access.
- Check weight, electrolytes, glucose, bicarbonate or PH and urinary ketones pre-operatively.
- If ketoacidosis is present, treat for diabetic ketoacidosis to correct the circulating volume and electrolyte deficit before surgery.
- If there is no ketoacidosis, start intravenous insulin and glucose infusion as for elective surgery.

The following are special considerations related to the type of insulin the child is on:

Patients on twice daily insulin regimens:

- For morning operations, give 50% of the usual morning dose of intermediate-acting insulin (NPH). Omit the short acting insulin.
- After surgery, start oral intake or continue IV glucose depending on the child's condition. Give small dose of short acting insulin to cover meal.
- The dinner or evening dose of insulin is given as usual.
- For afternoon operations, give 50% of usual dose of intermediate acting insulin in the morning the usual dose of short acting for breakfast.
- Alternatively, give 30-40% of the usual morning insulin dose of short acting (omit the intermediate acting insulin) and use intravenous insulin infusion at least 2 hours before operation.

Patients on basal-bolus insulin regimens

- Give the usual evening long acting insulin the evening before surgery, Consider reduction by 20-30% if there is a pattern of low blood glucose in the morning.
- Give 75-100% of the usual morning long acting insulin (glargine or detemir).
- Do not give short acting insulin on the morning of surgery unless necessary to correct hyperglycaemia.
- Alternatively, IV insulin infusion may be started in the morning with omitting all types of subcutaneous insulin.
- For afternoon operations, the child can eat breakfast. Usual dose of rapid short acting insulin should be given. The usual dose of basal intermediate- or long –acting insulin should also be given (if usually given at this time).

Patients on insulin pumps

- Subcutaneous infusion site should be secured to avoid dislodgement and interruption of insulin supply.
- For short general anaesthesia (less than an hour), the pump can be continued at the basal rate, keeping IV glucose 5% infusion at the maintenance rate. Omit the morning/meal bolus unless necessary to correct hyperglycaemia.
- Monitor blood glucose hourly preoperatively and half hourly during general anaesthesia.
- When necessary, correction doses can be given with the pump pre and postoperatively. Alternatively, give intravenous insulin to keep blood glucose within target.
- A meal bolus is given when the child is ready to eat.
- Alternatively, insulin pump can be discontinued and an intravenous insulin and glucose infusion commenced.

Children with type 2 diabetes undergoing surgery

If the child is on insulin, follow the above guidelines based on type of insulin regime.

Patients on oral treatment:

Metformin: discontinue 24 hours before the procedure for elective surgery, if less than 24 hours since the last dose for emergent surgery, it is essential to maintain hydration with intravenous fluid before, during and after the surgery.

Sulfonylureas or Thiazolidinediones: stop for the day of surgery.

Monitor blood glucose hourly and if greater than 180 mg/dl (10 mmol/l), treat with intravenous insulin for major surgery or subcutaneous insulin if it is a minor procedure.

Management of children with diabetes during intercurrent illness

The recommendations below are in the National Institute of Clinical Excellence (NICE) consensus guidelines for management of children and young people with diabetes. Majority of these recommendations are part of the International Society for Paediatric and Adolescent Diabetes (ISPAD) guidelines.

Illness associated with fever result in raising blood glucose due to higher levels of stress hormones. However, illness associated with vomiting and diarrhoea may lower blood glucose and may cause hypoglycaemia.

The diabetes care team should provide guidance on managing diabetes during intercurrent illness to avoid the complications of dehydration, ketoacidosis, hypoglycaemia and hyperglycaemia.

The guidance should include the following:

- Never stop insulin.
- The most common mistake in management of children with diabetes during the intercurrent illness is to stop insulin because the child is ill.
- Advice should be available on alteration of insulin dose and when to contact the diabetes care team or hospital.
- Careful monitoring is necessary during illness by performing frequent blood glucose testing and regular checks on urinary ketones.
- Children should have adequate supplies of blood glucose and urine ketone test strips.

The following are important considerations in management of children with diabetes during the sick days:

- If the child has loss of appetite, meals should be replaced with easily digestible food.
- Hydration should be maintained as hyperglycaemia, fever and glycosuria increase fluid loss. Children should be encouraged to increase their fluid intake. Persistent vomiting is an indication of hospital admission for intravenous fluid administration.
- Fever, malaise and headache should be treated with antipyretics such as paracetamol.
- Vomiting may be caused by the illness itself, but it might be a feature of diabetic ketoacidosis.

Management of infection associated with hyperglycaemia with or without ketosis:

- Recommend additional doses of short-acting insulin with careful monitoring to reduce blood glucose and prevent ketosis.
- The dose and frequency of insulin injection will depend on the age of the child, the level and duration of hyperglycaemia and the severity of ketosis.
- Initial extra short acting insulin should be around 10-20% of total daily insulin dose every 2-4 hours until blood glucose falls to < 15 mmol (< 270 mg/dl). Thereafter any additional doses might be 5-10% of total daily dose.

Infections associated with hypoglycaemia

- These infections are often associated with nausea and vomiting with or without diarrhoea.
- Replace meals with frequent small easily-digestible food and encourage fluid intake.
- Reduction of insulin dosage by 20-50% may be required.
- If hypoglycaemia persists, an injection of glucagon is useful to reverse the hypoglycaemia.

Urgent specialist medical advice must be obtained if:

- The diagnosis is unclear.
- Vomiting is persistent.
- Hypoglycaemia is severe.
- Ketonuria is heavy and persistent.
- The child becomes dehydrated or has severe abdominal pain.
- The younger the child, the more urgency it is to seek medical advice.

If sudden repeated episodes of hyperglycaemia with or without vomiting occur, it should be recognised that this may be due to omission or inadequate administering of insulin.

Treatment of type 1 diabetes in children and adolescents

Due to the complexity of treating type 1 diabetes, it is recommended that the care of children and adolescents with type 1 diabetes should be provided by a paediatric multidisciplinary team (paediatric endocrinologist, diabetic educator, nutritionist and psychologist). If this is not available, as it is the case in many centres, the treating team should be well experienced in childhood diabetes.

Children with diabetes differ from adults in many respects; they are more insulin sensitive, especially in the pre-pubertal period, have higher neurologic vulnerability to hypoglycaemia, do not have consistent eating habits especially in the toddler and early childhood ages and have limited ability to provide self-care.

At the time of initial diagnosis, patient and/or guardians must be taught about the general cause of diabetes, effects of insulin, diet and exercise on glucose, and the early signs of hypoglycaemia and DKA.

The indication and administration technique of intramuscular glucagon should be part of the initial education for all children and adolescents with type 1 diabetes.

To achieve glycaemic control in children, patient and/or guardians must be able to administer multiple daily injections of insulin, monitor blood glucose at least 4 times daily and maintain a balance between nutrition, medications and the level of activity. With the current availability of additional types of insulin, the treatment regimens have increased:

Table 9: Insulin action

Type of Insulin preparation	Onset of action	Peak	Duration
1 – Insulin Analogues:			
- Lispro (Humalog) - Insulin Aspart (Novorapid)		30-90 min	3 – 5 hrs
Insulin Glulisine (Apidra)		30-90 min	2 – 4 hrs
2 – Short acting, with rapid onset of action			
Regular/soluble (clear)	30 – 60 min	50 –120 min	5 – 8 hrs
3– Intermediate-acting :			
NPH Humalin N / Novolin N	1 – 3 hrs	8 hrs	20 hrs
Humalin L / Novolin L	1 – 2.5 hrs	7 – 15 hrs	18 – 24 hrs
4 – Long-acting			
Ultralente	4 – 8 hrs	8 – 12 hrs	36 hrs
Glargine (Lantus)	3 – 5 hrs	Almost peakless	24 hrs +
Detemir (Levemir)	3 - 5 hrs	Almost peakless	24 hrs
5 – Mixed Insulin:	Depends on the Intermediate and short or rapid –acting components		
Humalin M2,M3			
Mixtard: mixture of NPH + Regular with different percentage			
Novomix –30% Aspart & 70 % protaminated Aspart			
Novomix - 50% Aspart & 50 % protaminated Aspart			

1. Split-mixed (Conventional) regimen:

This regimen has been used for long time as the initial treatment for newly diagnosed patient. The total daily dose (TDD) of insulin ranges between 0.5-1 unit/kg, lower dose is used for younger children, while the higher range is indicated during pubertal development, during ketoacidosis or when patient is using steroids. 2/3 of this TDD is given before breakfast (2/3 as NPH and 1/3 as short acting insulin analogue), and 1/3 of it is given before dinner (1/2 NPH and 1/2 short acting insulin analogues). The main advantage of this regimen is its simplicity and the fewer daily injections. However, it is non-physiologic and provides little flexibility, if any, in term of meal time and CHO consumption. As a result, post lunch hyperglycemia and nocturnal hypoglycaemia are common complications. It is necessary to mention here that short acting insulin analogues have proven superior to Regular insulin in controlling the postprandial hyperglycemia and causing less pre-lunch and nocturnal hypoglycaemia.

Due to the different meal schedules in UAE, pre-dinner hyperglycemia is almost always encountered due to the prolonged period between breakfast and dinner. To minimize this effect, patient has either to schedule breakfast and dinner 10-12 hours apart so that the PM dose of insulin is administered before the complete wash out of the morning NPH, or an additional dose of short acting insulin must be administered with the lunch meal.

2. Basal- bolus insulin regimen

The DCCT demonstrated clearly the advantage of intensified insulin management over the conventional regimen in lowering the HbA1C and minimizing the risk of micro-vascular complications. Even though the HbA1C achieved in the adolescents group was >1% higher than the ADA recommendation, it was significantly better than that achieved with the traditional twice daily insulin injections.

Glycaemic goals need to be modified to take into account the fact that most children <6 or 7 years of age have a form of “hypoglycaemic unawareness,” in that counter-regulatory mechanisms are immature, and young children lack the cognitive capacity to recognize and respond to hypoglycaemic symptoms, placing them at greater risk for hypoglycaemia and its sequelae. In addition, extensive evidence indicates that near normalization of blood glucose levels is seldom attainable in children and adolescents after the honeymoon (remission) period.

In general, insulin used in children are rapid-acting insulin analogs, short-acting insulin, intermediate-acting insulin (NPH and Lente), and long-acting insulin analogs. These insulin are used in combination or individually and are delivered by syringe or a pen or pump.

Although there is no one established formula for determining a child's insulin requirement, insulin requirements are usually based on body weight, age, and pubertal status. Children with newly diagnosed type 1 diabetes usually require an initial total daily dose of 0.5–1.0 units/kg. In general, younger (and prepubertal) children require lower doses while the presence of ketoacidosis, use of steroids, and the hormonal changes of puberty all dictate higher doses. The small insulin needs of infants and toddlers may require diluted insulin to allow for more precise dosing and measurement of insulin in <1-unit increments.

It is common for a newly diagnosed child's diabetes to enter a honeymoon phase with an increase in insulin production within several weeks after the initiation of insulin therapy. During this phase of diabetes, insulin requirements may fall well below the initial dose of 0.5–1.0 units/kg per day needed to maintain blood glucose targets.

Children with diabetes often require multiple daily injections of insulin, using combinations of rapid-, short-, intermediate-, or long-acting insulin before meals and at bedtime to maintain optimal blood glucose control.

Cross-sectional epidemiological studies have been unable to document improved control with increasing numbers of insulin injections per day, indicating that the number of injections alone is not sufficient to achieve optimal glycaemic control.

For children with type 1 diabetes, four or more tests per day are generally necessary.



MANAGEMENT OF PEOPLE WITH DIABETES DURING RAMADAN

Major risks associated with fasting in people with diabetes

1. Hypoglycaemia
2. Hyperglycaemia
3. Diabetic ketoacidosis
4. Dehydration and thrombosis

Categories of people of high risk who fast during Ramadan

Very high risk

- Severe hypoglycaemia within the last 3 months prior to Ramadan
- People with a history of recurrent hypoglycaemia
- People with hypoglycaemia unawareness
- People with sustained poor glycaemic control
- Ketoacidosis within the last 3 months prior to Ramadan
- Type 1 diabetes
- Acute illness
- Hyperosmolar hyperglycaemic coma within the previous 3 months
- People who perform intense physical activity.
- Pregnancy
- Patients on chronic renal dialysis

High risk

- People with moderate hyperglycaemia (average blood glucose between 150 and 300 mg/dl, (8.3-18 mg/dl) HbA1C 7.5 – 9.0%)
- People with renal insufficiency
- People with advanced macrovascular complications
- People living alone who are treated with insulin or sulfonylureas
- People living alone
- People with comorbid conditions that present additional risk factors
- Old age with bad health
- Drugs that may affect mentation

Moderate risk

- Well-controlled people treated with short-acting insulin secretagogues such as Repaglinide or Nateglinide

Low risk

- Well-controlled people treated with diet alone, Metformin, or Thiazolidinediones

Management

1. General considerations:

- **Individualization:** Care must be highly individualized and therefore the management plan will differ for each individual.
- **Frequent monitoring of glycaemia.** It is essential that people have the means to monitor their blood glucose levels multiple times daily. This is especially critical in people treated with insulin.
- **Nutrition:** The diet during Ramadan should not differ significantly from a healthy and balanced diet. It should aim at maintaining a constant body mass. Ingestion of foods with simple carbohydrates may be more appropriate at the sunset meal [Iftar], while foods containing complex carbohydrates may be advisable at the predawn meal [suhur]. It is also recommended that the fluids intake is increased during non-fasting hours and that the suhur is taken as late as possible.
- **Exercise:** Normal levels of physical activity may be maintained. However, excessive physical activity may lead to higher risk of hypoglycaemia and should be avoided. If 'Tarawaih' prayer is performed, then this should be considered as part of the daily exercise program.
- **Breaking the fast:** All people should understand that they must always and immediately end their fast if hypoglycaemia (blood glucose of < 60 mg/dl [3.3 mmol/l]) occurs. The fast should also be broken if blood glucose reaches < 70 mg/dl [3.9 mmol/L] in the first few hours after the start of the fast especially if insulin, Sulfonylurea drugs, or Meglitinides are taken at predawn.
- The fast should be broken if blood glucose exceeds 300 mg/dl [16.7 mmol/l].

2. Pre-Ramadan medical assessment and educational counselling:

- Medical assessment should take place within 1 – 2 months before Ramadan. Specific attention should be devoted to the overall well-being of people and to the control of their glycaemia, blood pressure and lipids. Appropriate blood tests should be ordered and evaluated. Specific medical advice must be provided to each person individually concerning the potential risks they are accepting in deciding to fast, even if they fast against medical advice. During their assessment, necessary changes in their diet or medication treatment should be made, so that the person initiate fasting while being on a stable and effective treatment program.
- Educational counselling: It is essential that people with diabetes and their family receive the necessary education concerning self-care including signs and symptoms of hyper- and hypoglycaemia, blood glucose monitoring, meal planning, physical activity, medication administration and management of acute complications.

3. Management of people with type 1 diabetes:

- In general, people with type 1 Diabetes, especially if "brittle" or poorly controlled, are at a very high risk of developing severe complications and should strongly be advised not to fast during Ramadan. In addition, people who are unwilling

or unable to monitor their blood glucose levels multiple times daily are at high risk of developing severe complications and should be advised not to fast.

- It is unlikely that one injection of intermediate or long acting insulin administered before the evening meal would provide adequate insulin coverage for 24 hrs Typically people will need two daily injections of NPH as intermediate-acting insulin, administered before the predawn and sunset meals, in combination with short-acting insulin to cover food intake at the associated meals. However, there is an increased risk of hypoglycaemia around midday due to peaking of the early morning insulin dose. Using the long-acting insulin ultralente is an option, with twice-daily injections at around 12 hrs intervals to imitate basal insulin, and a rapid-or short-acting insulin should be added before the two meals.
- Another option would be to use one daily injection of the long-acting insulin analog Glargine or twice-daily injections of the insulin analog Detemir along with pre-meal rapid-acting insulin analogs.

4. Management of people with type 2 diabetes:

Recommended changes to treatment regimen in people with type 2 diabetes who fast during Ramadan	
Before Ramadan	During Ramadan
People on diet and exercise control	No change needed (modify time and intensity of exercise), ensure adequate fluid intake
People on oral hypoglycaemic agents:	Ensure adequate fluid intake
Biguanides, Metformin 500 mg three times a day, or sustained release Metformin (Glucophage R),	Metformin, 1,000 mg at the sunset meal (Iftar), 500 mg at the predawn meal (Suhur)
TZDs, Pioglitazone or Rosiglitazone once daily	No change needed
Sulfonylureas once a day, e.g., Glimepiride 4 mg daily, Gliclazide MR 60 mg daily	Dose should be given before the sunset meal (Iftar): adjust the dose based on the glycaemic control and the risk of hypoglycaemia
Sulfonylureas twice a day, e.g., Glibenclamide 5 mg or Gliclazide 80 mg, twice a day (morning and evening)	Use half the usual morning dose at the predawn meal (Suhur) and the full dose at the sunset meal (Iftar),
People on insulin	
70/30 premixed insulin twice daily,	Use the usual morning dose at the sunset meal (Iftar) and half the usual evening dose at predawn (Suhur), also consider changing to Glargine or Detemir plus Lispro or Aspart

The recommendations given in this table are for illustrative purposes and are largely based on expert clinical opinion and not on scientific data derived from clinical studies. The recommendations must be adjusted for each person individually.

Pregnancy and fasting during Ramadan

Pregnancy is a state of increased insulin resistance and insulin secretion and of reduced hepatic insulin extraction. Fasting glucose concentrations are lower but postprandial glucose and insulin levels substantially higher in healthy pregnant women than those who are not pregnant. Elevated blood glucose and HbA1C levels in pregnancy are associated with increased risk for major congenital malformations. Fasting during pregnancy would be expected to carry a high risk of morbidity and mortality to the foetus and mother, although controversy exists. While pregnant Muslim women are exempt from fasting during Ramadan, some with known diabetes (type 1, type 2 or gestational) however insist on fasting during Ramadan. These women constitute a high-risk group, and their management requires intensive care. In general, women with pre-gestational or gestational diabetes should be strongly advised not to fast during Ramadan. However, if they insist on fasting, then special attention should be given to their care.

Management of hypertension and dislipidaemia during Ramadan

Dehydration, volume depletion, and a tendency toward hypotension may occur with fasting during Ramadan, especially if the fast is prolonged and is associated with excessive perspiration. Hence, the dosage of antihypertensive medications may need to be adjusted to prevent hypotension.

Agents that were previously prescribed for the management of elevated cholesterol and triglycerides should be continued.

REFERENCE

- ADOPT study. *N Engl J Med* 2007; 356:1378-1380
- Alberti K.G.M.M, Zimmet P, Shaw J. International Diabetes Federation: a consensus on type 2 diabetes prevention. *Diabetes UK. Diabetic Medicine*; 24, 451-463. 2007.
- American Diabetes Association. Preconception Care of Women with Diabetes. (Position Statement). *Diabetes Care*, Vol. 27, Suppl. 1, S76-78. 2004.
- American Diabetes Association (ADA). Standards of Medical Care in Diabetes. *Diabetes Care*, Vol. 31, Suppl. 1, S1-S110. January. 2008.
- American Diabetes Association. Type 2 Diabetes in children and adolescents. *Diabetes care* 2000;23:381-389.
- Australian Guidelines for Diabetes management. 2002.
- Beshyad SA, Benbarka MM, Sherif IH. Practical Management of Diabetes during Ramadan Fast. *Libyan Journal of Medicine*.AOP: 071008. 2007.
- Betts P, Brink SJ, Swift PGF, Silink M, Wolfsdorf J, Hanas R. Management of children with diabetes requiring surgery. *Paediatric Diabetes* 2007;8:242-247.
- Brink S, Laffel L, Likitmaskul S, Liu L, Maguire AM, Olsen B, Silink M, Hanas R. Sick day management in children and adolescents with diabetes. *Paediatric Diabetes* 2007;8:401-407.
- Cox DJ, Penberthy JK, Zrebiec J et al. Diabetes and Driving Mishaps. Frequency and correlations from a multinational survey. *Diabetes Care*, Volume 26, No. 8, August 2003. P 2329-2334.
- DCCT. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *New England Journal of Medicine* 1993; 329: 977-986.
- Del Prato S, et al. *International Journal Clinical Pract* 2005; 59: 1345-13555.
- Eckel RH, Grundy SM, Zimmet PZ. (2005). The metabolic syndrome. *Lancet* 365(9468): 1415-28.
- Edmonds ME, Foster A, Sanders L. A practical manual of diabetes foot care.
- Gaede P, Vedel P, Larsen N, et al (2003). Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. *New England Journal of Medicine* 348; 383-93.
- Iafusco D, Stazi MA, Cotichini R et al. Permanent diabetes mellitus in the first year of life. *Diabetologia* 2002;45: 798-804.
- International Diabetes Federation, 2005. *Clinical Guidelines Task Force. Global Guideline for type 2 Diabetes*. ISBN 2-930229-43-8.
- International Diabetes Federation. *Guidelines for Management of Post meal glucose*. ISBN 2-930229-48-9. 2007.
- International Society for paediatric and adolescent diabetes. Consensus guidelines 2000. Consensus guidelines for the management of type 1 diabetes in children and adolescents.
- International Standards for Diabetes Education. International Diabetes Federation, 2003.
- Ministry of Health. United Arab Emirates. Ras Al Khaimah Medical District. Guidelines for the management of Diabetes Mellitus. Issued by Scientific Committee January 2007.
- Moller AM, Dalgaard LT, Pociot F, Nerup J, Hansen T, Pedersen O. Mutations in the hepatocyte nuclear factor-1 alpha gene in Caucasian families originally classified as having type 1 diabetes. *Diabetologia* 1998;41:1528-1531.
- Musso C, Cochran E, Moran SA et al. Conical course of genetic disease of the insulin receptor: a 30-year prospective. *Medicine* 2004;83:209-222.
- National Institute for Clinical Excellence (NICE)
- Position Statement. Smoking and Diabetes. American Diabetes Association. *Diabetes Care*, Vol. 27, Supplement 1, January 2004.
- Reviews/Commentaries/ADA Statements. ADA Workshop Report. Recommendations for the Management of Diabetes during Ramadan. Al-Arouj M, Bouguerra R, Buse J et al. *Diabetes Care*, Vol. 28, no. 9, September 2005.
- UK Prospective Diabetes Study (UKPDS) Group: Intensive blood-glucose control with sulfonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *The Lancet* 1998; 352: 837-853.
- Royal College of General Practitioners. Clinical guidelines for type 2 diabetes.
- Taher El Sharkawy, *Diabetes in the United Arab Emirates and Other Arab Countries: Need for Epidemiological and Genetic Studies, Genetic Disorders in the Arab World: United Arab Emirates (Volume 1, 2004), Centre for Arab Genomic Studies (CAGS)*.
- Tillil H, Khbberling J. age-corrected empirical genetic risk estimates for first-degree relatives of IDDM patients. *Diabetes* 1987;36:93-99.
- Tuomilehto J, Lindstrom J, Eriksen JG et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *New England Journal of Medicine* 344; 1343-50. 2001.
- WHO Guidelines in Diabetes management 2000.
- Williams G, Pickup JC. *Handbook of Diabetes*. Blackwell Publishing. Third edition. ISBN 1-4051-2052-5. 2004.
- www.eatlas.idf
- www.ispad.org
- www.racgp.org.au

