MANAGEMENT OF TYPE 1 DIABETES MELLITUS IN CHILDREN & ADOLESCENTS
1. Type 1 diabetes mellitus (T1DM) children & adolescents classically present with polyuria, polydipsia & weight loss over 2 - 6 weeks.

2. Patients with diabetic ketoacidosis (DKA) should be managed in hospitals with specialists experienced in the management of the condition.

3. Patients with severe DKA & at risk of cerebral oedema should ideally be monitored in an intensive care unit. Risk of cerebral oedema can be reduced by:
   - not giving large volumes of fluid after initial volume expansion
   - not administering insulin in the first hour of fluid treatment
   - not using bicarbonate to correct acidosis

4. Intensive insulin therapy is the preferred regimen in patients with T1DM.
   - Basal insulin constitutes about 40 - 60% of the total daily insulin dose (TDD); the remainder is pre-prandial rapid-acting/short-acting insulin.
   - Those using night-time intermediate-acting insulin, the basal insulin constitutes between 30% (if on short-acting insulin) & 50% (if on rapid-acting insulin) of TDD; the remainder is pre-prandial rapid-acting/short-acting insulin.

5. The goal of hypoglycaemia treatment is to restore blood glucose (BG) to normal level (5.6 mmol/L). Severe hypoglycaemia warrants urgent treatment.
   - In hospital, this can be treated by intravenous (IV) dextrose 10% (2 - 4 ml/kg).
   - If there is no IV access, subcutaneous/intramuscular glucagon can be given (0.5 mg for patients <12 years old & 1.0 mg for those >12 years old).

6. Carbohydrate (carb) counting should be a part of T1DM management.

7. Ideally, diabetes team should consist of paediatrician, diabetes educator, dietitian, pharmacist, psychiatrist/clinical psychologist/counsellor & medical social officer.

8. Physical activities should be performed regularly & in a safe manner in T1DM.

9. Self-monitoring of blood glucose (SMBG) should be performed 4 to 6 times a day & more frequent in certain conditions such as sick day or exercise.

10. Screening of thyroid function & measurement of antithyroid peroxidase antibody should be done at diagnosis of T1DM.

This Quick Reference provides key messages & a summary of the main recommendations in the Clinical Practice Guidelines (CPG) on Management of Type 1 Diabetes Mellitus in Children & Adolescents.

Details of the evidence supporting these recommendations can be found in the above CPG, available on the following websites:
Ministry of Health Malaysia: www.moh.gov.my
Academy of Medicine Malaysia: www.acadmed.org.my
Also available as a mobile app for Android & IOS platform: MyMaHTAS

CLINICAL PRACTICE GUIDELINES SECRETARIAT
Health Technology Assessment Section
Medical Development Division, Ministry of Health Malaysia
4th Floor, Block E1, Parcel E, 62590 Putrajaya
Tel: 603-8883 1229 E-mail: htmalaysia@moh.gov.my
Risks of cerebral oedema include:
- younger age, new onset diabetes
- longer duration of symptoms, greater hypocapnia at presentation after adjusting for degree of acidosis
- increased serum urea nitrogen, severe acidosis at presentation
- bicarbonate treatment for correction of acidosis
- marked early decrease in serum effective osmolality
- an attenuated rise in serum sodium concentration or an early fall in glucose-corrected sodium during therapy
- administration of insulin in the first hour of fluid treatment
- large volumes of fluid given in the first 4 hours

Warning signs & symptoms of cerebral oedema:
- headache (variable severity)
- change in neurological status (restlessness, irritability, increased drowsiness, incontinence)
- specific neurological signs (e.g. cranial nerve palsies)
- slowing of heart rate
- rising blood pressure
- decreased oxygen saturation

The guidelines on TDD are as follows:
- partial remission phase: <0.5 IU/kg/day
- pre-pubertal period: 0.7 - 1.0 IU/kg/day
- pubertal period: 1.2 - 2 IU/kg/day

Insulin dose adjustment may be done based on insulin to carbohydrate ratio (ICR) & insulin sensitivity factor (ISF) in patients with T1DM on basal bolus therapy.

- The 500 rule for rapid-acting insulin:
  \[ \text{ICR} = 500 \times \text{TDD insulin} \]
  *450 for short-acting insulin

- The 100 rule for rapid-acting insulin:
  \[ \text{ISF} = 100 \times \text{TDD insulin} \]
  *83 for short-acting insulin

T1DM can be misdiagnosed as:
- pneumonia or asthma
- urinary tract infection
- acute abdomen
- psychogenic polydipsia
- gastroenteritis or sepsis
- meningitis/encephalitis

**TARGET INDICATORS OF GLYCAEMIC CONTROL**

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Level of control</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Ideal (non-diabetic)</td>
</tr>
<tr>
<td><strong>Clinical assessment</strong></td>
<td></td>
</tr>
<tr>
<td>Symptoms of hyperglycaemia</td>
<td>No symptom</td>
</tr>
<tr>
<td>Symptoms of hypoglycaemia</td>
<td>No symptom</td>
</tr>
<tr>
<td><strong>Biochemical assessment</strong></td>
<td></td>
</tr>
<tr>
<td>SMBG values in mmol/L</td>
<td></td>
</tr>
<tr>
<td>AM fasting or pre-prandial</td>
<td>3.6 - 5.6</td>
</tr>
<tr>
<td>Post-prandial</td>
<td>4.5 - 7.0</td>
</tr>
<tr>
<td>Bedtime</td>
<td>4.0 - 5.6</td>
</tr>
<tr>
<td>Nocturnal</td>
<td>3.6 - 5.6</td>
</tr>
<tr>
<td>HbA1c DCCT (%)</td>
<td>&lt;6.5</td>
</tr>
<tr>
<td>HbA1c IFCC (mmol/mol)</td>
<td>&lt;48</td>
</tr>
</tbody>
</table>

DCCT= Diabetes Control and Complications Trial
IFCC=International Federation of Clinical Chemistry and Laboratory Medicine
Algorithm 1. Immediate Assessment in DKA

**Clinical history**
- Polyuria
- Polydipsia
- Weight loss
- Abdominal pain
- Tiredness
- Vomiting
- Confusion

**Clinical signs**
- Hydration status
- Deep sighing respiration
- Acetone-smell breath
- Lethargy/drowsiness ± vomiting

**Biochemical features & investigations**
- Ketonuria (>2+) or ketonaemia (>3.0 mmol/L)
- Hyperglycaemia (BG >11 mmol/L)
- Acidosis (venous pH <7.3 or bicarbonate <15 mmol/L)
- Blood urea & electrolytes
- Other investigations as indicated

**Confirmed DKA**
Contact specialist

**Resuscitation**
- Airway ± nasogastric tube
- Breathing (100% O2)
- Circulation 0.9% saline 10 - 20 ml/kg over 1 - 2 hours (rapid bolus if in shock) & repeat until circulation is restored but not >30 ml/kg

**IV fluid therapy**
- Calculate fluid requirements; correct over 48 hours, use saline 0.9%
- Do ECG for abnormal T-waves
- Add 20 mmol potassium for each 500 ml of fluid

**Therapy**
- IV infusion/SC insulin
- IV fluid/oral hydration

**Insulin therapy**
- IV insulin infusion (0.05 - 0.1 unit/kg/hour) started at 1 - 2 hours after initial fluid therapy

DKA is categorised by the severity of acidosis:
- mild (venous pH <7.3, bicarbonate <15 mmol/L)
- moderate (venous pH <7.2, bicarbonate <10 mmol/L)
- severe (venous pH <7.1, bicarbonate <5 mmol/L)
**Algorithm 2. Critical Observation in DKA**

**Critical observation**
- Hourly vital signs & neurological status
- Hourly BG
- Hourly fluid input & output
- 2 - 4 hourly ketone, blood gases & electrolytes after starting IV therapy
- Monitor ECG for T-wave changes

**Acidosis not improving, deterioration**

**BG 14 - 17 mmol/L OR BG falls >5 mmol/L/hour (after initial volume expansion)**

**Neurological Warning signs:** headache, slowing heart rate, irritability, decreased conscious level, incontinence, specific neurological signs

**Add 5% dextrose in the infusate**
- Adjust type of IV fluid based on serum sodium concentration after 4 - 6 hours

**Suspect cerebral oedema**

**Management**
- Give mannitol 0.5 - 1 g/kg or hypertonic solution
- Restrict IV fluid by one third
- Call specialist
- Transfer to ICU
- Consider cranial imaging only after patient treated and stabilised

**Transition to SC insulin**
- Start SC insulin, then stop IV insulin after an appropriate interval

**Improvement**
- Clinically well, tolerating oral fluids

**Re-evaluate**
- Recalculate IV fluid
- Review insulin delivery system & dose
- Assess for the need of additional resuscitation
- Consider treatment for sepsis

**No**

**Yes**
Cerebral Oedema

- Risks of cerebral oedema include:
  - younger age, new onset diabetes
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  - rising blood pressure
  - decreased oxygen saturation

Insulin Dose

- The guidelines on TDD are as follows:
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    *450 for short-acting insulin
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### QUICK REFERENCE FOR HEALTHCARE PROVIDERS
#### MANAGEMENT OF TYPE 1 DIABETES MELLITUS IN CHILDREN & ADOLESCENTS

**GUIDELINES FOR INSULIN ADJUSTMENT DURING SICK DAYS**

<table>
<thead>
<tr>
<th>Ketones (mmol/L)</th>
<th>Urine Ketones</th>
<th>Blood Glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood ketones</td>
<td>&lt;5.5</td>
<td>5.5 to 10</td>
</tr>
<tr>
<td>mmol/L</td>
<td>mmol/L</td>
<td>mmol/L</td>
</tr>
</tbody>
</table>
| Negative or trace| • Do not give extra insulin
• Recheck BG & ketones in 2 hours
No insulin adjustment needed | Add correction dose of insulin according to ISF
Give extra 5% of TDD or 0.05 IU/kg |
| 0.6 - 1.4 Trace, small to moderate | • Starvation ketones
• Extra carb & fluid are needed | • Starvation ketones
• Extra carb & fluid are needed
• No insulin adjustment needed |
| • Extra carb & fluid are needed | • Extra carb & fluid may be needed
• Give 5 - 10% of TDD or 0.05 - 0.1 IU/kg |
| Moderate to large | • High levels of starvation ketones
• Check BG meter
• Recheck BG & ketones
• Extra carb & fluid are needed | • High levels of starvation ketones
• Extra carb & fluid are needed
• Give 5% of TDD or 0.05 IU/kg; repeat insulin dose when BG has risen |
| >3.0 Large | • Very high levels of starvation ketones
• Check BG meter
• Recheck BG & ketones
• Extra carb & fluid are needed | • Very high levels of starvation ketones
• Extra carb & fluid are needed
• Give 5% of TDD or 0.05 IU/kg; repeat insulin dose when BG has risen |

There is an immediate risk of ketoacidosis if the blood ketone level is ≥3.0 mmol/L.
<table>
<thead>
<tr>
<th>Complications</th>
<th>Screening schedule</th>
<th>Screening methods</th>
<th>Risk factors</th>
<th>Potential interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retinopathy</td>
<td>• Start at age 10 or at onset of puberty if this is earlier, after 2 - 5 years' diabetes duration • Annually thereafter</td>
<td>• Fundal photography or • Mydriatic ophthalmoscopy (less sensitive)</td>
<td>• Hyperglycaemia • High blood pressure (BP) • Lipid abnormalities • Higher body mass index (BMI)</td>
<td>• Improved glycaemic control • Laser therapy</td>
</tr>
<tr>
<td>Nephropathy</td>
<td>• Start at age 10 or at onset of puberty if this is earlier, after 2 - 5 years' diabetes duration • Annually thereafter</td>
<td>• Urinary albumin: creatinine ratio or • First morning urinary albumin concentration or • Timed urine collections for albumin excretion rates</td>
<td>• Hyperglycaemia • High BP • Lipid abnormalities • Smoking</td>
<td>• Improved glycaemic control • Angiotensin converting enzyme inhibitor or angiotensin receptor blocker • BP control</td>
</tr>
<tr>
<td>Neuropathy</td>
<td>Unclear</td>
<td>History &amp; physical examination</td>
<td>• Hyperglycaemia • Higher BMI</td>
<td>Improved glycaemic control</td>
</tr>
<tr>
<td>Macrovascular disease</td>
<td>After age 10 years</td>
<td>• Lipid profile every 5 years • BP annually</td>
<td>• Hyperglycaemia • High BP • Lipid abnormalities • Higher BMI • Smoking</td>
<td>• Improved glycaemic control • BP control • Statins</td>
</tr>
</tbody>
</table>