PAEDIATRIC INTENSIVE CARE – CLINCIAL PRACTICE GUIDELINE

DIABETIC KETOACIDOSIS PROTOCOL
(Call consultant on admission)

1. Introduction

DKA is a potentially life-threatening medical emergency due to absolute or relative insulin deficiency coupled with counter-regulatory hormones excess.

2. Aim

To provide a guideline for management of the patient presenting with DKA.
The objective of this guideline is to:

- Recognise DKA early
- Correct metabolic disturbances (dehydration, ketoacidosis, hyperglycemia)
- Prevent complications
- Identify and treat precipitating events

3. Parameters of the guideline:

These guidelines are intended for the management of children who present with DKA

4. Definition:

A. DKA: Diabetes Ketoacidosis
Clinical & Biochemical Criteria

Clinical history	Clinical signs	Biochemical
Polyuria, polydipsia, polyphagia, wt loss or abdominal pain or vomiting	Varying degree of dehydration, Kussmaul respiration, fruity (acetone) smell, altered sensorium	RBS >11mmol/1, Venous Blood Gas (pH <7.3mmHg, HCO_3 <15 mmol/l), ketonemia or ketonuria and glycosuria

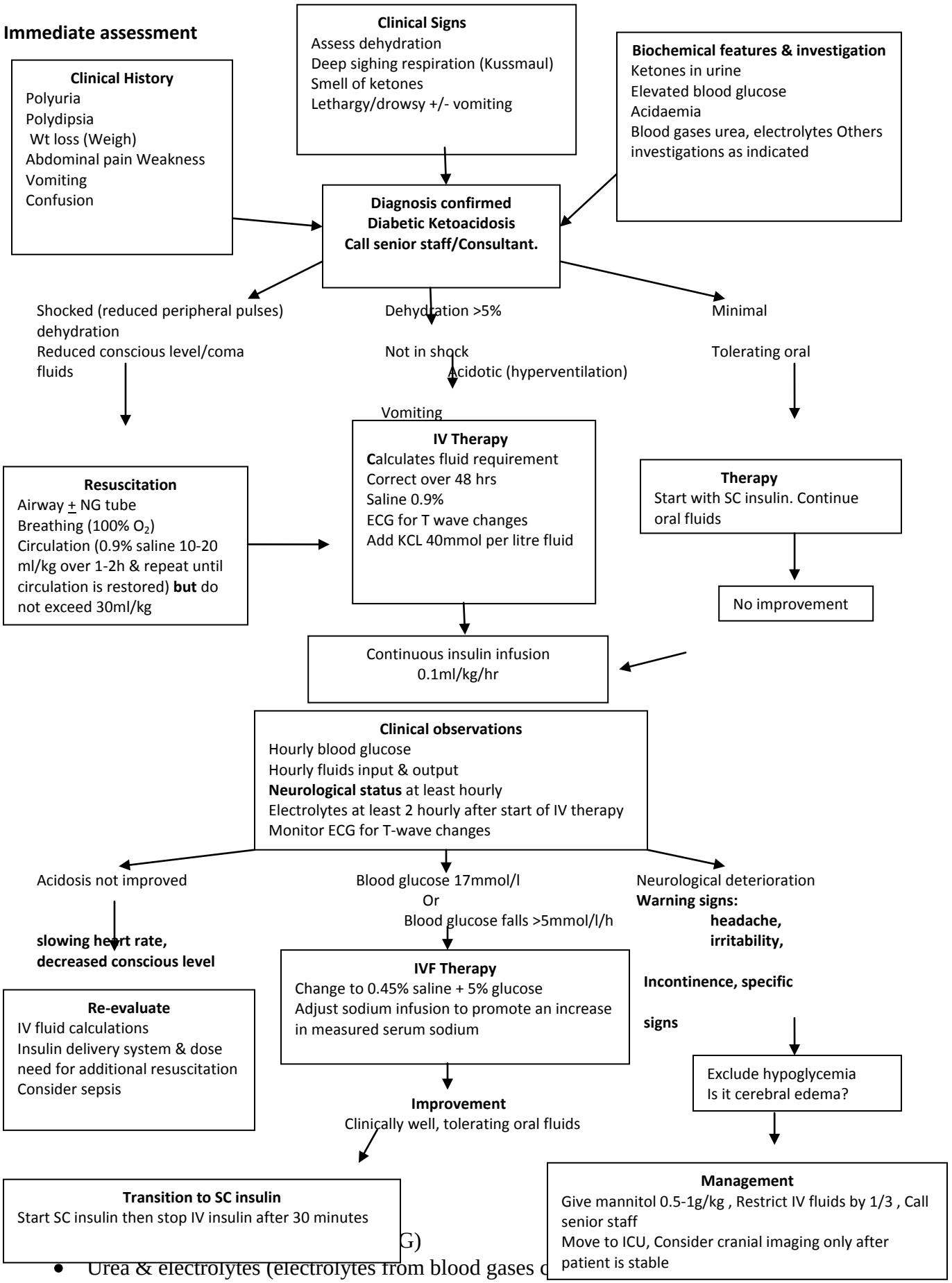
B. CBG – Capillary Blood Glucose

6. Emergency Management:

A. Resuscitation

Airway: If comatose, insert airways & NG tube
Breathing: Give oxygen via face mask (even if O_2 Sat > 95% in RA)
Circulation: Insert IV cannula ± IA line & take blood samples (see below)
Cardiac monitor (ECG for hypo/hyperkalemia)
+ IDC
If in shock, give 10ml/kg normal saline bolus ½-1hr, maximum of 30mls/kg to restore circulation. (***N.B. Discuss with the Consultant if the patient has received 30mls/kg***)

Algorithm for the management of diabetic ketoacidosis. Source: adapted from Dunger et al. Karger Publ. 1999



G)

- Urea & electrolytes (electrolytes from blood gases c
- Blood gases (venous give very similar pH & CO_2 to arterial)

- HbA1c
- Urine ketones and glucose **(*N.B. Blood ketones is more superior to urine ketones*)**
- Islet cell antibodies, insulin antibodies, GAD antibodies, antiendomyseal lgA antibodies and TFTs **for all newly diagnosed patients**.
- Other investigations **only if indicated**; FBC, Urinalysis, Chest X-Ray and Cultures (blood, urine, throat, CSF) then give appropriate antibiotics

(***N.B. leukocytosis is common in DKA and does not necessarily indicates sepsis, unless there is fever*)**

9. Management

A. Fluids

- Treat shock with bolus 10mls/kg 0.9% saline over 1/2-1hr, (max. of 30mls/kg), (***if further fluid boluses required at this stage, discuss with consultant***)
- After restoration of BP, all children with DKA and unequivocal signs of dehydration should be given the following amount of IVF (based on maintenance requirements of 80% of normal, and 3-5% of dehydration corrected over 48hrs) irrespective of their apparent degree of dehydration (see table below):

Wt (kg)	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**14**	**16**	**18**	**20**	**25**	**30**	**35**	**40**	**45**
(ml/hr)	**24**	**28**	**32**	**36**	**40**	**45**	**50**	**55**	**65**	**70**	**75**	**80**	**90**	**95**	**105**	**110**

(***N.B. this fluid rate (ml/hr) includes deficit AND maintenance fluid needs***)

- Fluid therapy should be reviewed if oliguria develops due to tubular necrosis caused by severe hypotension before resuscitation may require fluid restriction. But persistent hypovolemia may require extra fluids
- Initial fluids should be 0.9% saline or Lactated Ringers with 40mmol KCL in 1 L for the 1st 48 hrs (*see section on Potassium*).
- Change IVF to 5% dextrose (add 100mls of D50% in 900mls 0.9 N/S), you can increase the dextrose concentration to as high as 12.5% ***(discuss with consultant)***[1]
- Indications of adding glucose in the maintenance fluids:
  - Serum glucose is 14 mmol/l
  - Rapid drop in blood glucose level (>5-8 mmol/l per hr) even if the serum glucose is >14 mmol/l
  - Ketacidosis remains despite correction of hyperglycemia
- Give 2-5ml/kg D10% bolus if CBG 3-4mmol/l
- **Do not** change the IVF to 0.45% saline if the corrected Na level does not rise [1]
- Start oral fluids when clinically improved. **(*N.B these oral fluids should be subtracted from IVF if still within 48 hrs*)**

B. Insulin

- No initial insulin bolus
- Start insulin after 1 hr of initial IVF

- Add 50 units insulin "short acting" (regular) to 49.5mls of 0.9% saline to make **1units/ml solution. Prime giving set prior to commencing infusion**
- Run at 0.1unit/kg/hr, **(*N.B. in <5yrs and neonates start with 0.05unit/kg/hr*).**
- Correct ketoacidosis **first before** hyperglycemia.
- **Do not reduce or stop insulin infusion, instead add glucose in the IVF** (*see Fluids*
-)
- Blood glucose fall rate should be 3-5 mmol/l per hour
- Keep blood glucose at 8-12mmol/l
- The best time to change insulin infusion to SC is just before a meal, when the child is alert and metabolically stable (glucose 8-12mmol/l, pH >7.3 & HCO3 >15). The insulin infusion should only be stopped 30mins after the 1st SC insulin injection.

C. Potassium

- Start KCl at a concentration of 40-60mmol/l (40mmol if Body Wt <30kg, and 60mmol if >30kg)
- Extreme care should be taken if the initial serum K is >5.5mmol/l or if the patient is anuric. Check ECG monitor for peak T wavesECG monitor(***Discuss with Consultant***)

D. Bicarbonate

- Discuss with the Consultant.

E Monitoring & Observation

Hourly blood glucose Hourly fluid input and output Neurological status at least hourly Electrolytes and blood gases 2 - 4hourly after start of IV therapy BP, PR, RR 1-2 hourly & Temperature 4 hourly. Urine ketones and glucose 4 hourly or every voids Monitor ECG for T- wave changes

F. Complications of therapy

- Hypoglycemia
- Hypokalemia
- Aspiration pneumonia
- Cerebral oedema

10. Cerebral edema

- If suspected, exclude hypoglycemia and **inform Consultant immediately**.

- **Treatment:**
    1. Keep NBM, give 100% O_2, and elevate the head of the bed by 30º
    2. Reduce the rate of IVF to 2/3 of the calculated IVF
    3. Give mannitol 0.5-1g/kg IV over 20 mins, may repeat if no initial response in 30 mins to 2hrs.
    4. Hypertonic saline (2.7-3%) 5-10 ml/kg over 30mins may be an **alternative or a second line** of therapy if no initial response to mannitol
    5. Intubation and mechanical ventilation for impending repiratory failure, **avoid aggressive hyperventilation** (keep PCO_2 at 30-35 mmHg)

11. Transition from Insulin infusion to Subcutaneous:

Step1. Determine the Total daily Insulin Requirement using a Sliding Scale

- Subcutaneous insulin therapy is initiated with regular (short acting) insulin given in a dose of 0.2U/kg/dose, with the subsequent dose being adjusted every 6 h, depending on the response as judged by the blood glucose levels and ketonuria
- Monitor CBG 4 times/day (pre-meals & after midnight)
- Use Table Appendix 2 Column 1, 2 & 5 for **calculating and adjusting a sliding scale**

Step 2. Use Twice Daily Insulin Regimen

- Divide the Total daily Insulin Requirement into (2/3 before breakfast, 1/3 before dinner)

Step 3. Determine components of each dose

- 2/3 of each dose as intermediate-acting (Isophane) insulin.
- 1/3 as short-acting (Regular)
- If using mixtard insulin, give 2/3 dose in the morning and 1/3 in the afternoon

NOTE:

- CBG can still be fluctuating even after a fixed insulin-meal regimens as calculated above
- First exclude inter-current illness or stress etc.
- **Use "10% rule" for insulin dose changes** after determining the time at which abnormal CBG occurs.
- Modify insulin doses by 10 %, **e.g.** ***if CBG is persistently out of range before dinner then the dose modification applies only to the morning or lunch time insulin and the amount is determined by 10% of the morning dose.***

Appendix 1

- **Anion gap:** (12 ± 2mmol/l): (Na + K) – (Cl + HCO3).

- **Osmolality:** (280 – 300mmol/l): 2(Na + K) + Glucose(mmol/l) + Urea
- **Corrected Na:** measured Na + [2(plasma glucose (mmol/l) – 5.6)] ÷ 5.6 to calculate the corrected Na use this link Tools\correctedNA.pdf
- **Fluid calculation,** use this link for calculating fluid rates; http://www.bsped.org.uk/professional/guidelines /docs/DKACalculator.pdf

Appendix 2

TABLE1: Subcutaneous Insulin Dosing

				BOLUS INSULIN
AGE (YR)	**TARGET GLUCOSE (MMOL/L)**	**TOTAL DAILY INSULIN (U/KG/D) ***	**BASAL INSULIN, % OF TOTAL DAILY DOSE**	**Units Added per 5.5mmol/l above Target**
0–5	5.5-11.1	0.6–0.7	25–30	0.50
5–12	4.4-8.3	0.7–1.0	40–50	0.75
12–18	4.4-8.3	1.0–1.2	40–50	1.0–2.0[‡]

* ***Newly diagnosed children in the "honeymoon" may only need 60–70% of a full replacement dose. Total daily dose per kg increases with puberty.***

‡ ***For finer control, extra insulin may be added in 2.8mmol/l increments.***

TABLE2: A 6 Hourly Sliding Scale for SC insulin

Age (yrs)	**Insulin SC**	**CBG (mmol/l)**			
		5-10	**10-15**	**15-20**	**>20**
0-5	Insulin	0.15U/kg/dose	0.15U/kg/dose + 0.5Unit	0.15U/kg/dose + 1Unit	GO BACK TO INSULIN INFUSION
5-12	Insulin	0.2U/kg/dose	0.2U/kg/dose + 0.75Unit	0.2U/kg/dose + 1.5Units	
12-18	Insulin	0.25U/kg/dose	0.25U/kg/dose + 1Unit	0.25U/kg/dose + 2Units	

(***N.B. The above Sliding scale table is derived from Table 1***)

Appendix 3: Diagnostic criteria for Cerebral Edema in children with DKA

1. Diagnostic criteria for cerebral edema

- Abnormal motor or verbal response to pain
- Decorticate or decerebrate posture
- Cranial nerve palsy (especially lll, l V and Vl)
- Abnormal neurogenic respiratory pattern (e.g. grunting, Cheyne-Stroke respiration, apneoa)

2. Major criteria

- Altered mentation/fluctuating level of consciousness
- Sustained heart rate deceleration (decrease of >20 beats/min) not attributing to improved intravascular volume or sleep state.
- Age-inappropriate incontinence

3. Minor criteria

- Vomiting
- Headache
- Lethargy or not easily arousable
- Diastolic BP >90mmHg
- Age <5 years

To diagnose Cerebral Edema, the following criteria has to be met: *(N.B. These criteria has 92% sensitity & 4% false positive rate)*

- 1 diagnostic criterion OR
- 2 major criteria OR
- 1 major and 2 minor criteria.

References:

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Scope and Application	This CPG is intended for use by all health care workers in their daily care of paediatric patients

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Further Information	Paediatric CSN Chairperson

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