



Max
Healthcare

Caring for you... for life

**Diabetic Ketoacidosis
&
Severe Hyperglycemia**

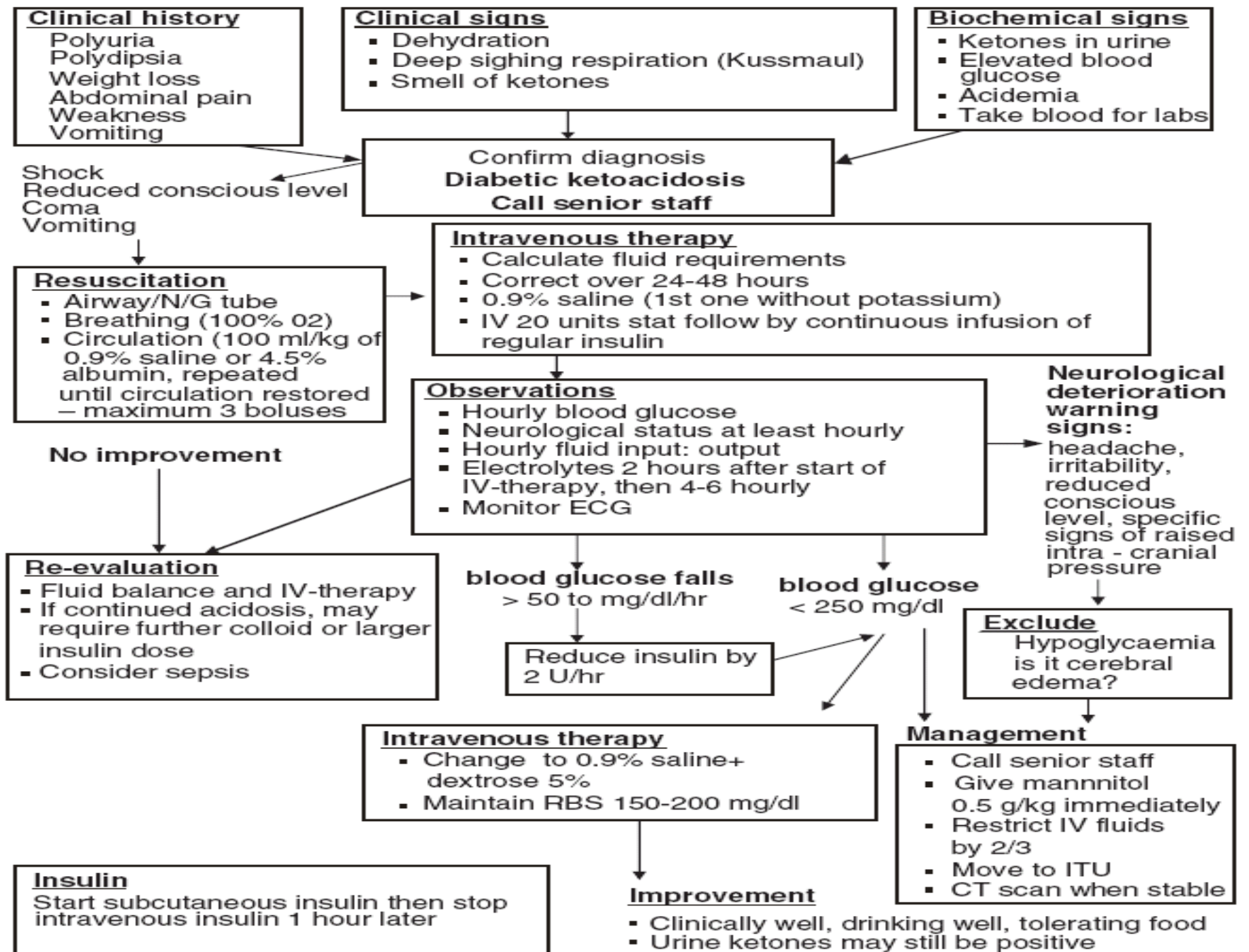


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Objective:

- For initial assessment (including the severity) of adults patients of established cases as well as for first timers presenting to with DKA/Acute severe hypoglycemia
- To plan management of patients accordingly

Use: In all clinical areas by clinicians/
endocrinologists/physicians



Diabetic Ketoacidosis

Diagnosis:

- Short history of polyuria, polydipsia, polyphagia, weight loss
- Vomiting
- Abdominal pain
- Dehydration
- Acidotic breathing
- Hypotension
- Tachycardia
- Hypotension
- Altered sensorium
- Hematemesis

Criteria:

- Plasma glucose >250 mg/dl
- Arterial pH <7.3
- $\text{HCO}_3^- < 18$ mEq/L
- Urine Ketones moderate to large
- Anion gap > 10



1st Step

- RBS by Glucometer (followed by Lab confirmation)
- IV Cannula
- ABG Analysis
- Urgent Lab test: BL Glucose, BUN, Creatinine, CBC, Na, K, ABG, Osmolality, c/s-blood/urine, CXR, ECG, Urine R/M and Ketones, HBA1c, LFT
- IV insulin 20U stat
- 1 L Normal Saline (without KCL)



2nd Step

- RT, if comatose/gastric distension
- CVP line, if in CHF or remain hypotensive
- Urinary catheter, if conscious, oliguric or in retention
- Connect to ECG monitor
- Antibiotics IV Broad Spectrum
- SC Heparin, if S.osm > 350 msm/L (Inj. Heparin 5000U SC 8 hourly)
- Identify ppt factors- infection, MI, CVA etc



* Start IVF : 0.9% saline

1-1.5L/hr (15-20 mL/kg/hr)

hydration

Subsequent fluid :
check S.Na
high/N - 0.45%

saline;
low - 0.9%
saline
4-14 mL/kg/hr

(1 L /hr x 3 hrs)
change to
5% dextrose
saline

Once RBS ~ 250 mg/dL
Run Θ 150 – 250 mL/hr

insulin

0.15 U/kg (or 20 U)
IV bolus followed by
cont IV infusion 5-7 U/hr

check RBS q1hrly;
RBS s'd
fall by 50-70 mg/dL/hr; if not

check hydration; if ok

increase by 2 U/hr till
RBS falls by 50 – 70 mg/dL
Once RBS reaches 250 mg/dL
Reduce insulin to 3 – 6 U/hr
Maintain RBS 150-200 mg/dL

potassium

if 3.3-5.5; add 20-30
mEq KCl/L of IVF
if < 3.3; add
40 mEq/L;
if k > 5.5 → Hold KCl;
recheck S.K after 2 hr



Alternatively use sliding scale of

IV Insulin infusion by syringe pump

40 U Regular Insulin (U-40 vial)
in 39 ml Normal Saline

Reduce infusion rate in elderly
or h/o CHF

RBS mg/dl	Insulin dose
< 80	0
81-120	0.5
121-200	1
201-250	2
251-300	3
301-350	5
>350	6

Monitor

- q 2-4 hrly: Na, K BUN, Creatinine, ABG
- q 1 hrly: RBS by Glucometer
- q 1 hrly: Urine Output, Pulse, BP
- Urine Ketones each time urine is passed
- Avoid rapid correction of RBS to reduce risk of Cerebral Edema



Precipitating Factors:

- Infection
- CVA
- Alcohol Abuse
- Pancreatitis
- Trauma
- Drugs
- New Onset type 1 DM
- Discontinuation or inadequate insulin in established type 1 DM
- Psychological problems complicated by eating disorders



Key Evaluation

- Look for precipitating factors
- Frequent patient monitoring
- Regular lab monitoring as per protocol

Examination:

- Vitals
- Hydration status
- Consciousness level
- Systemic exam including neurological
- Especially look for abdominal distention and bowel sounds

Do's

- Always look for Precipitating factors
- Monitor hydration status closely
- Monitor serum potassium (S.K) closely
- Regular adjustment of insulin infusion scale, if targets are not being met with

Don'ts:

- No SC Insulin if moderate to severe DKA
- Avoid rapid correction of blood sugar
- Avoid Hyperkalemia

Key medications:

- Insulin
- IV Insulin: Regular (H.Actrapid/ Huminsulin R)
- Preferably use U-40 vial with U-40 Syringe
- SC Insulin (U-40- H.Actrapid/ Huminsulin R; U-100 – Huminsulin R; NPH, U-40 – H. Monotard/ Huminsulin N; U-100 – Huminsulin N)
- Regular Insulin- given before meals
- NPH at bedtime
- U-100 insulin syringe for U-100 vial

Clinical Pearls

- Identify precipitating factors
- Frequent monitoring- hydration, blood sugar, serum K
- Achieve and maintain targets
- Avoid overzealous treatment- rapid correction of blood sugar/ over hydration/ hypokalemia

Severity of DKA

	Mild	Moderate	Severe
P.Glucose	>250	>250	>250
Arterial pH	7.25-7.30	7.00-7.24	<7.00
Serum HCO₃	5-18	10-5	<10
Anion Gap	>10	>12	>12
Sensorium	Alert	Alert/ Drowsy	Stupor/Coma

Other Lab findings

- Leucocytosis
- Low serum sodium
- Serum Potassium: elevated/normal/low
- Amylase/lipase elevated
- Serum Osmolality ≥ 320 mosmol/kg if stupor/coma

Differential diagnosis

- Starvation ketosis; plasma glucose low, serum $\text{HCO}_3^- > 18 \text{ mEq/L}$
- Alcoholic ketoacidosis: mildly elevated plasma glucose, H/O alcohol abuse
- Lactic acidosis: elevated blood lactate levels
- Uremic acidosis

Treatment Principles

- Correction of dehydration, hyperglycemia and electrolyte imbalance
- Identification of precipitating events
- Frequent patient monitoring

Fluids

- Adult patients
- Initial fluids: 0.9% normal saline
- Rate: 15-20 ml/kg in the first hour (~1 – 1.5 L in average adult)
- If hypovolemic shock: use plasma expander as well
- If Cardiogenic shock: Hemodynamic monitoring

Subsequent fluid:

- Check serum sodium
- Serum sodium high or normal: 0.45% saline at Rate of 4-14 ml/kg/hour
- Serum sodium low: 0.9% saline at the rate of 4-14 ml/kg/hour (1 L/hour x 3 hours)



Subsequent Fluid:

- Check Plasma Glucose
- If ~ 250 mg/dl
- Change to 5% dextrose with saline (DNS) at rate of 150-250 ml/hour



Pediatric patients

- Initial fluid : normal saline (for 10% hydration)
- 1st hour : NS 500 ml
- 2nd hour: NS 500 ml with 20 mEq KCL
- For 3rd to 12th hour: 200ml/hour x 10 hours
- Followed by 100 ml/hour x 24 hours
- Total fluids: 5.4 L in 36 hours

Insulin:

- Continuous IV insulin infusion
- Dose: 0.15 U/Kg IV bolus (or 20 U) of regular insulin followed by continuous IV infusion @ U/Kg/Hour (5-7 U/hour)
- If plasma glucose does not fall by 50-70 mg/dl from initial value in first hour, check hydration status
- If acceptable, increase insulin infusion rate by 2 U every hour until plasma glucose falls by 50-70 mg/dl
- Once plasma glucose level reaches 250 mg/dl reduce infusion rate to 0.05-0.1U/Kg/Hour (3-6 U/hour)

Insulin (Cont..)

- Maintain plasma glucose between 150-200 mg/dl until metabolic control is achieved
- Monitor every 2-4 hourly: serum electrolytes, glucose, blood urea nitrogen, creatinine, Osmolality, venous pH
- Once DKA resolves, i.e. plasma glucose < 200 mg/dl, $S.HCO_3^- > 18$ mEq/L, venous pH > 7.3, anion gap < 12 mEq/L and the patient is able to take fluids orally, switch over to subcutaneous insulin

Insulin use for Pediatric Patients

- Insulin 0.1 U/Kg wt stat followed by 0.1 U/Kg/hour continuous infusion till RBS ~ 250 mg/dl
- Then, reduce the dose to 0.05 U/Kg/hour

Potassium

- Maintain serum potassium between 4.0 and 5.0 mEq/L
- If S.K is between 3.3 – 5.5 mEq/L, add 20-30 mEq KCL to each liter of IVF
- If S.K is above 5.5 mEq/L, hold KCL but check S.K every 2 hours

Bicarbonate

- It's use is controversial
- Prospective randomized controlled trials have failed to show any benefit at pH between 6.9 and 7.1 and more than 7.0
- No prospective randomized studies have been reported on use of bicarbonate therapy at pH < 6.9
- Given that severe acidosis may lead to adverse vascular effects, it seems prudent to give bicarbonate when pH < 7.0

Bicarbonate (cont..)

- For pH < 6.9, 100 mmol bicarbonate is added to 400 ml of sterile water and infused at the @ 200 ml/hour
- Bicarbonate is not used if pH > 7.0
- In pediatric patients, if pH > 7.0, bicarbonate therapy is not used
- If pH < 7.0. repeat pH after initial hour of hydration.
- If still < 7.0, give NaHCO₃ 1-2 mEq/Kg added to 0.45% saline over 1 hour
- Check venous pH every 3 hours until pH > 7.0; repeat treatment every 2 hours if necessary
- Give @0 mmol KCL per 100 mM of HCO₃; recheck S.K later

Phosphate

Indication:

1. Cardiac dysfunction
2. Anemia
3. Respiratory depression
4. Serum Phosphate < 1 mg/dl

Dose: 20-30 mEq/L Potassium phosphate added to replacement fluids



Complications:

- Hypoglycemia
- Hypokalemia
- Hyperchloremic metabolic acidosis
- Cerebral edema
- Hypoxemia
- Non-Cardiogenic pulmonary edema



Cerebral Edema

Clinical features

- Lethargy
- Headache
- Deterioration in sensorium
- Seizures
- Bradycardia
- Respiratory arrest

Pathogenesis:

Too rapid fall in plasma
Osmolality with treatment of DKA

Prevention:

Gradual replacement of sodium
and water deficits: maximal reduction in
Osmolality 3 mosmol/kg/hour and addition
of dextrose to hydrating fluid once blood
Glucose reaches 250 mg/dl

Prevention:

- Periodic review sick day management with all patients
- Use supplemental short acting insulin during stress
- Control fever and treat infection promptly
- Initiate liquid diet containing carbohydrates and salt during sick days if the patient cannot take meals
- Never discontinue Insulin
- Seek professional help early
- Check urine ketone when blood glucose is > 300 mg/dl



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Thank You



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