
بسم الله الرحمن الرحيم

Nutrition and management of acute complications of diabetes:

hypoglycemia, **hyperglycemia** and **diabetic ketoacidosis**

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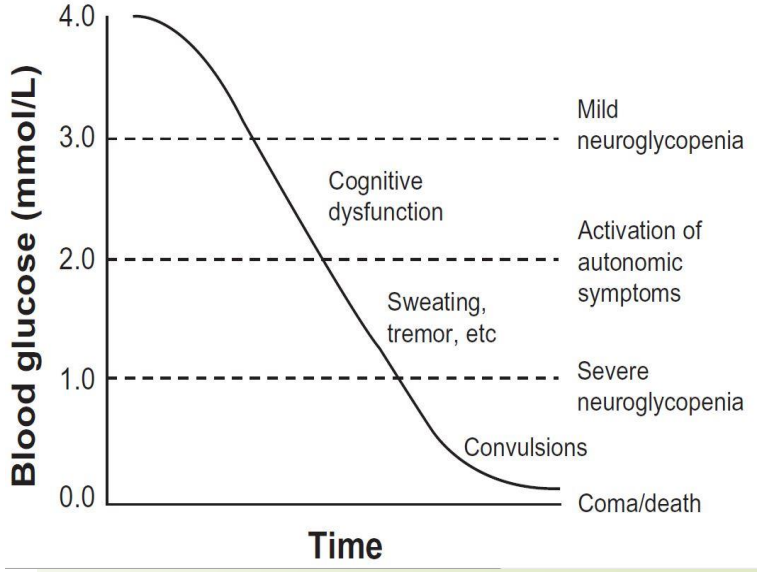
Hypoglycemia

Hypoglycemia definition

Glycemic thresholds for secretion of counter-regulatory hormones and **onset of symptoms** **in response to hypoglycemia**



Jeffrey Freeman et al. Postgrad Med. 2019 May;131(4):241-250.
Nitil Kedia et al. Diabetes Metab Syndr Obes . 2011:4:337-46.

Causes of Hypoglycemia

5 Insulin

- **Too much insulin** is a definite cause of hypoglycemia.
- **Accidentally injecting** the wrong insulin type, **too much insulin**, or **injecting directly** into the muscle (instead of just under the skin), can cause hypoglycemia.

Food

- Not enough **carbohydrates**.
- **Eating foods with less carbohydrate** than usual **without reducing** the **amount of insulin** taken.
- **Timing of insulin** based on whether your carbs are from liquids versus solids can affect blood glucose levels.
- **The composition of the meal** can also affect the absorption of carbohydrates.

Physical activity

- The **intensity**, **duration**, and **timing of exercise** can all affect the risk **for going low**.

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Prevention of Hypoglycemia

- Patient education
- Dietary intervention
- Recommendations on physical exercise
- Glucose monitoring: Self-monitoring of blood glucose (SMBG)
- Medication adjustment

Afif Nakhleh et al. World J Diabetes. 2021 Dec 15; 12(12): 2036–2049.
Krause's Food & The Nutrition Care Process. Medical Nutrition Therapy for Diabetes. 14th ed. St. Louis (MO): Elsevier; 2017. PP: 586-619.

Prevention of Hypoglycemia

- Don't skip or delay meals or snacks
- If taking insulin or oral diabetes medication, be consistent about the *amount eaten and the timing of meals and snacks.*
- Monitor blood sugar. Depending on treatment plan, check and record blood sugar level *several times a week or several times a day*.
- **Careful monitoring** is the only way to make sure that blood sugar level remains within the individual target range

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Management of Hypoglycemia

- **Treatment of hypoglycemia** is dependent on the **duration** and **severity of the hypoglycemia** episode.
- **Mild-to-moderate hypoglycemia** is **easily self-treated** with the **oral intake of rapid-acting carbohydrates** such as a glucose drink, tablets, or snacks.
- **Severe hypoglycemia** necessitates **external help**

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Management of Hypoglycemia

A) Adults who are **conscious**, **orientated**, and **able to swallow**:

1. If the patient is **receiving insulin** (pump or IV infusion), **stop it immediately**

2. Follow the **15/15 rule**: Give **15-20 g rapid-acting carbohydrate** of the patient's choice where possible:

   - 15-20 g chewable glucose tablets, 150-200 mL orange juice, **or** 3-4 heaped teaspoons of sugar dissolved in water

3. **Repeat capillary blood glucose** measurement **10-15 min later**. If it is still less than 70 mg/dL, **repeat the previous step up to 3 times**

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American Diabetes Association. https://diabetes.org/living-with-diabetes/treatment-care/hypoglycemia
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Management of Hypoglycemia

4. If the **capillary blood glucose** remains **<70 mg/dL after 30-45 min or three cycles of treatment**, consider **IV 200 mL of 10% glucose over 15 min** or administration of **1 mg of glucagon IM**

5. Once blood glucose is >70 mg/dL and the patient **has recovered**, it is recommended to give **a long-acting carbohydrate**:

- **A snack** should be consumed **if it will be an hour or more before** the **next meal**
- One slice of bread, a 200-300 mL glass of milk, or two biscuits
- **High-fat foods will delay peak of glucose levels** from **carbohydrate intake** and **should be avoided** (e.g., treatment of hypoglycemia with chocolate bars)

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Management of Hypoglycemia

B) Adults who **are conscious but confused**, **unable to cooperate** but **able to swallow**:

1. If the patient is receiving **insulin** (pump or IV infusion), **stop it immediately**

2. If the patient is uncooperative but is able to swallow, **give a 15g tube of glucose** (**e.g., Glucogel**), squeezed into the mouth between the teeth and gums, or (if this is ineffective) **glucagon 1mg IM**

3. **Repeat capillary blood glucose** levels **after 10-15 min**. If it **is still <70 mg/dL**, **repeat the previous step up to three times** (glucagon injection should only be given **once**)

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Management of Hypoglycemia

4. If the capillary blood glucose remains **<70 mg/dL after 30-45 min** (or three cycles of treatment), give **IV 200 mL of 10% glucose over 15 min**

5. <u>Once</u> blood glucose is **>70 mg/dL** and the patient **has recovered**, giving a **long-acting carbohydrate is recommended** (as detailed previously)

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Management of Hypoglycemia

C) **Adults** who are **unconscious** and/or **having seizures**:

1. An urgent medical assessment is required. The following things should be checked and treated accordingly:
   - Airway (administration of oxygen as appropriate), breathing, circulation (pulse), state of consciousness, blood glucose concentration, and body temperature
2. If the patient is receiving **insulin** (pump or IV infusion), **stop it immediately**
3. **Request immediate assistance** from **medical staff**
4. If **IV access is available**, give **100 mL of 20% glucose IV** or **200 mL of 10% glucose** **over 15 min**

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Management of Hypoglycemia

5. **If no immediate IV access is available**, give **1mg glucagon IM**. **Continue trying to obtain IV access** as IM glucagon is less likely to be successful if required for a second time. If there is a need for prolonged treatment, IV administration of glucose is the treatment of choice

6. **Capillary blood glucose test** should be **repeated after 10 min**. If it is **still <70 mg/dL repeat step 4** (**or** **step 5 if IV access remains unavailable**)

7. **Once** the **blood glucose** is **>70 mg/dL** and the patient **has recovered**, **give a long-acting carbohydrate** (as previously previously)

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Management of Hypoglycemia

Young children usually **need less than 15 grams of carbs** to **fix a low blood glucose level**:

- **Infants** may need 6 grams
- **Toddlers** may need 8 grams
- **Small children** may need 10 grams.
- This needs to be **individualized for the patient**

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Hyperosmolar Hyperglycemic State (HHS) and Diabetic ketoacidosis (DKA)

Hyperosmolar Hyperglycemic State (HHS) and Diabetic ketoacidosis (DKA)

- Are medical emergency **resulting from uncontrolled diabetes** that require prompt management in **a hospital setting**.
- **SMBG**, **testing for ketones**, and **medical intervention** can help **prevent HHS** and **DKA**.
- If left untreated, **HHS** and **DKA** can lead to coma and death.
- **Acute illnesses** such as flu, colds, vomiting, and diarrhea, **if not managed appropriately** in diabetic patients, can lead to the development of **HHS** and **DKA**.

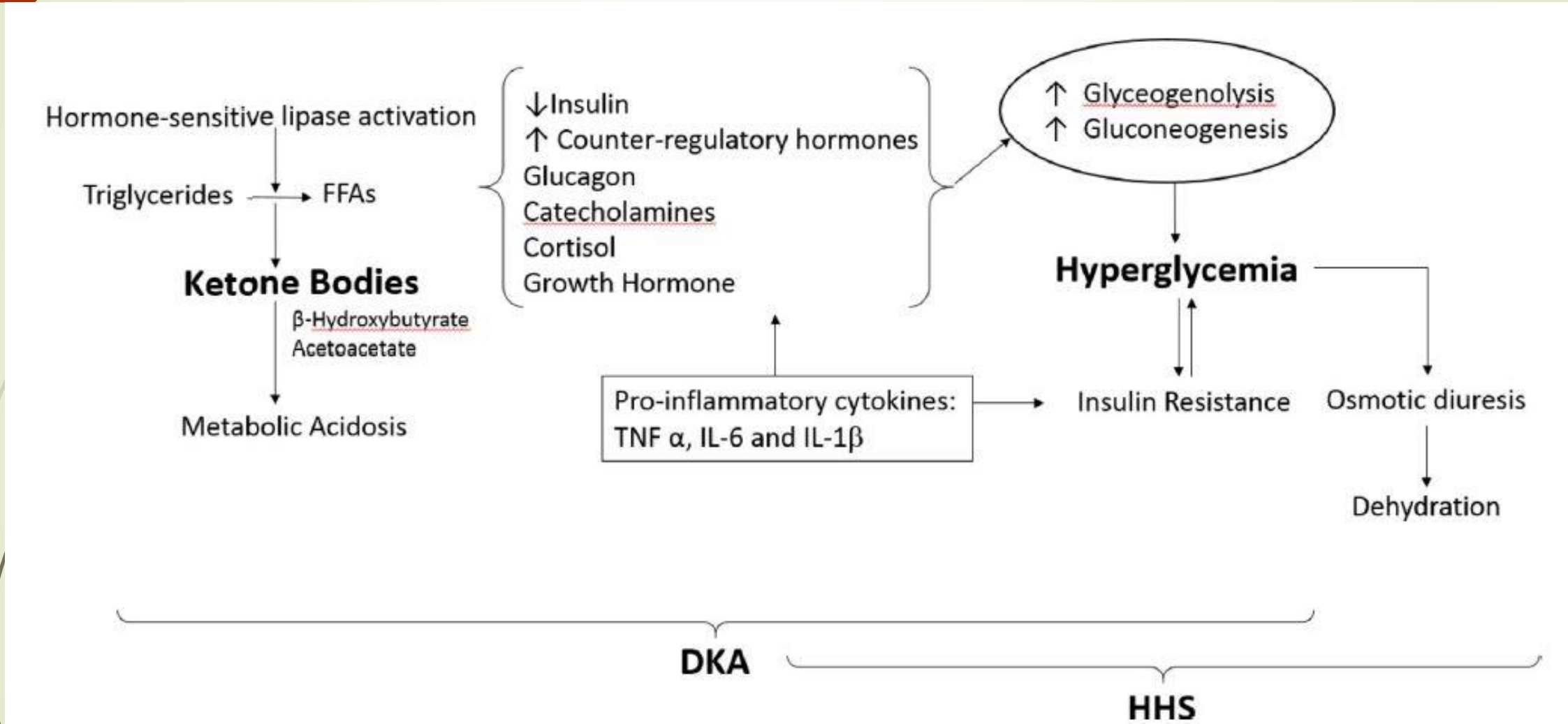
Parameter	Mild	Moderate	Severe
Serum bicarbonate (mmol/L)	15–18	10–<15	<10
Arterial pH	7.25–7.30	7.0–7.24	<7.0
Anion gap	>10	>12	>12
Mental status	Alert	Alert/drowsy	Stupor/coma

Diagnostic Criteria and Classification	DKA			HHS
	Mild	Moderate	Severe	
Plasma glucose (mg/dL)	>250	>250	>250	>600
Arterial pH	7.25–7.30	7.00 to <7.25	<7.00	>7.30
Serum bicarbonate (mEq/L)	15–18	10 to <15	<10	>15
Urine ketone[a]	1–3+	3–4+	3–4+	Trace to 1+
Serum ketone[a]	Positive	Positive	Positive	Small
Effective serum osmolality[b]	Variable	Variable	Variable	>320 mOsm/kg
Anion gap[c]	>10	>12	>12	<12
Mental status	Alert	Alert/drowsy	Stupor/coma	Stupor/coma

Variables	Normal range
Arterial PH	7.35-7.45
Serum Bicarbonate (mEq/l)	22-29
Anion Gap (mEq/l)	4-12
Serum osmolality	280-300

Mohsen S. Eledrisi et al. Saudi J Med Med Sci. 2020 Sep-Dec; 8(3): 165–173
Ketan K Dhatariya et al.Curr Diab Rep . 2017 May;17(5):33.

Pathogenesis of Hyperglycemic Emergencies: DKA & HHS



Maya Fayfman et al. Med Clin North Am. 2017 May; 101(3): 587–606

Prevention of hyperglycemia and Diabetic ketoacidosis During acute illnesses

- During **acute illnesses**, **usual doses of insulin** and **other glucose lowering medications** are required. The need for insulin continues, **or may even increase**, during periods of illness.
- **Fever**, **dehydration**, **infection**, or the **stress of illness** can trigger the release of counter-regulatory or "stress" hormones, causing **blood glucose levels to become elevated**.
  - ✓ **Blood glucose** levels and **urine or blood testing for ketones** should be monitored **at least four times daily** (before each meal and at bedtime).
  - ✓ **Blood glucose** readings **exceeding 250 mg/dl** and **the presence of ketones** are danger signals indicating that **additional insulin is needed**.
- **Ample amounts of liquid** need to be **consumed every hour**:
  - ✓ If **vomiting**, **diarrhea**, or **fever is present**, **small sips—1 or 2 tablespoons every 15 to 30 min** —can usually be consumed.
  - ✓ **If vomiting continues** and the **individual** is **unable to take fluids for longer than 4 h**, the health care team should be notified.

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Leonid Barski et al. Eur J Intern Med. 2023 Nov:117:38-44.
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Prevention of hyperglycemia and Diabetic ketoacidosis During acute illnesses

- During acute illness, **oral ingestion** of **about 50 to 200 g** of **carbohydrates per day** (45-50 g every 3-4 h) should be sufficient, **along with medication adjustments**, to **keep glucose** in the **goal range** and to **prevent starvation ketosis**.

- **If regular foods are not tolerated**, **liquid** or **soft carbohydrate-containing foods** (such as regular soft drinks, soup, juices, and ice cream) **should be eaten**. **Eating** about **10 to 15 g of carbohydrate** **every 1 to 2 h** (or 50 g of carbohydrate every 3 to 4 h) is usually **sufficient**.

- The **health care team** should be called **if illness continues for more than 1 day**.

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Management of hyperglycemia and Diabetic ketoacidosis

- The mainstays of **DKA** and **severe hyperglycemia (in HHS)** management include:
  - **Treating hyperglycemia** (supplemental insulin)
  - **Restoring the circulatory volume**
  - **Correcting electrolyte abnormalities** (fluid and electrolyte replacement)
  - **Medical monitoring**
  - **Diagnosing and treating the precipitating cause**
- **Moderate hyperglycemia** (blood sugar between 200 and 300 mg/dL) **is usually managed** with **medical nutritional therapy** and **appropriate medication uses** if diabetic patients have adequate cooperation.
- If **hyperglycemia is accompanied** by **symptomatic dehydration** and **acidosis**, it requires medical interventions in the **hospital setting**.

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Management of Hyperglycemic Emergencies: DKA & HHS

Insulin

Regular insulin IV bolus 0.1 unit/kg then IV infusion 0.1 units/kg/hour

or

Regular insulin IV infusion 0.14 units/kg/hour with no bolus

If **blood glucose does not fall** by at least 2.8-3.9 mmol/L (**50-70 mg/dL**) or 10 % in 1st hour

Increase IV infusion rate by 1 unit/hour

When glucose ≤200 mg/dL

Insulin infusion to 0.02-0.05 units/kg/hour

Add **dextrose 5%** to IV fluids

Keep glucose level at 150-200 mg/dL

Criteria for **resolution of DKA**

- **Glucose <200 mg/dL**

and

- 2 of the following: **serum HCO3 ≥ 15, venous pH > 7.3, anion gap≤ 12**

Switching from **IV to subcutaneous insulin** **when the patient can take orally** & **on resolution of DKA**:

- **Stop IV fluids**

- **Newly diagnosed DM**: 0.5 u/kg/day: [50% basal + 50% bolus over 3meals]

- **Established DM**: resume home insulin regimen if previously controlled or adjust insulin if previously uncontrolled

- **Stop IV insulin after 2 hours**

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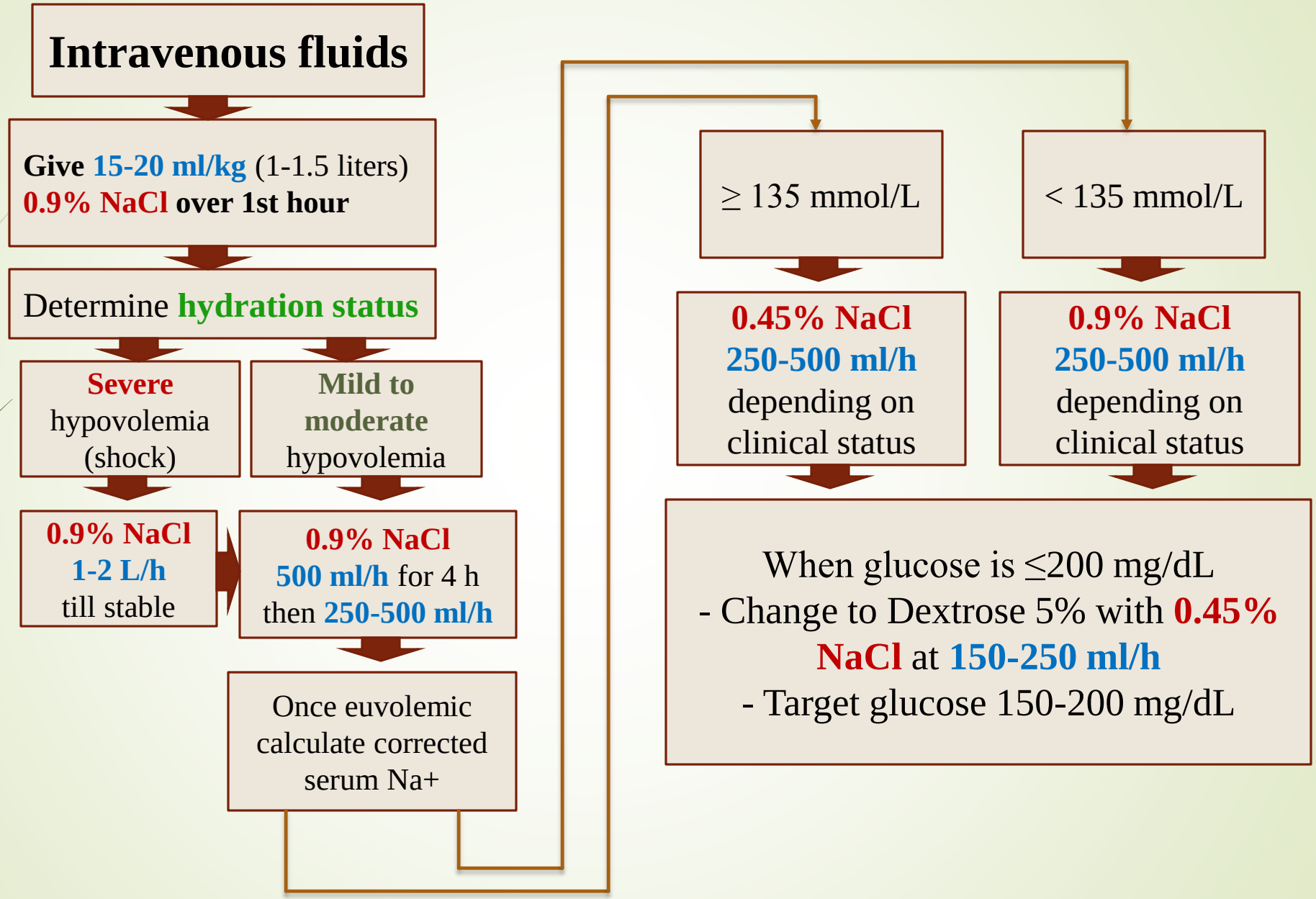
Management of Hyperglycemic Emergencies: DKA & HHS



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Management of Hyperglycemic Emergencies: DKA & HHS

Bicarbonate

- PH<6.9
  - **100 mmol** in **400 ml H2O** + **20 mEq KCL**, Infuse for 2 hours
    - Repeat **every 2 hours** untile PH ≥ 7
      Monitor serum K+ every 2 hours
- PH≥6.9
  - **No** Hco3-

Potassium

- Serum K+ < 3.3 mmol/L
  Do not start insulin till K+ > 3.3
  Give 20-40 mEq KCL/h
  - Serum K+ 3.3-5.2 mmol/L
    Give 30-40 mEq KCL in **each liter of IV fluid**

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با تشکر از توجه شما