

**Bismi Allahi, Allahumma shalli `alaa Muhammad
Wa l-`ashr innal-insaana lafie khusrin ...**

Early Detection and Management of Diabetic Ketoacidosis and Hypoglycemia

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God Guidance

You may dislike thing yet it may be good for you; or a thing may haply please you, but may be bad for you. Only Allah has knowledge and you do not know

[al-Baqarah (2): 216]

... and what comes to you of ill is from your own self [an-Nisa' (4): 79]

Acute Diabetes

- **Diabetic ketoacidosis (DKA)**
- Hyperosmolar hyperglycemic syndrome (HHS)
- **Recurrent hypoglycemia**
- Diabetes and acute myocardial infarction
- Diabetes and acute stroke
- Diabetes and critical limb ischemia
- Perioperative management of diabetes

Diabetic Ketoacidosis (DKA)

- **The most common life threatening hyperglycemic emergency**
- **Might be as the 1st manifestation and the leading cause of death in T1DM**
- **Annual incidence ~4.6 - 8 episodes per 1000 diabetic patients**
- **Early detection is important and critical**
- **Limited evidence comparing clinical outcomes between specialist vs non-specialist**

Etiology of DKA

- **Insulin error: missed injection, abnormal injection sites**
- **Intercurrent infection, diarrhea or vomitus, drug use, alcohol binge**

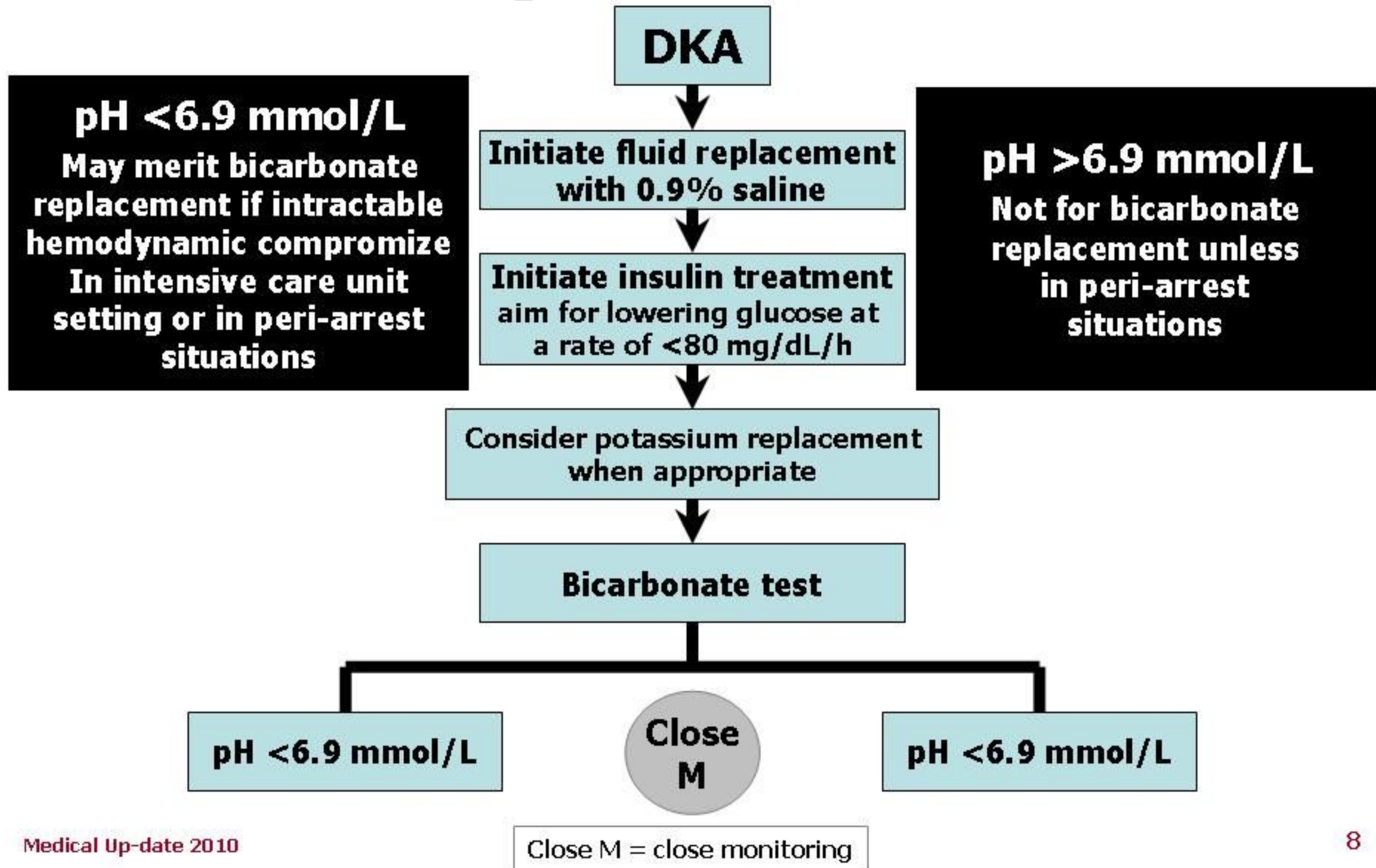
Features of DKA

- **Hyperglycemia: >14 mmol/L (250 mg/dL)**
- **Metabolic acidosis: Serum bicarbonate <15 mmol/L; Increased anion gap**
- **Heavy ketonuria (>++) and/or ketonemia (serum β -hydroxybutirate >3.9 mmol/L)
→ Sensitivity of ketonuria 97%**
- **Dx clues: dehydration, drowsiness, acidotic hyperventilation (Kussmaul), metabolic acidosis, smell of ketones on patient's breath**

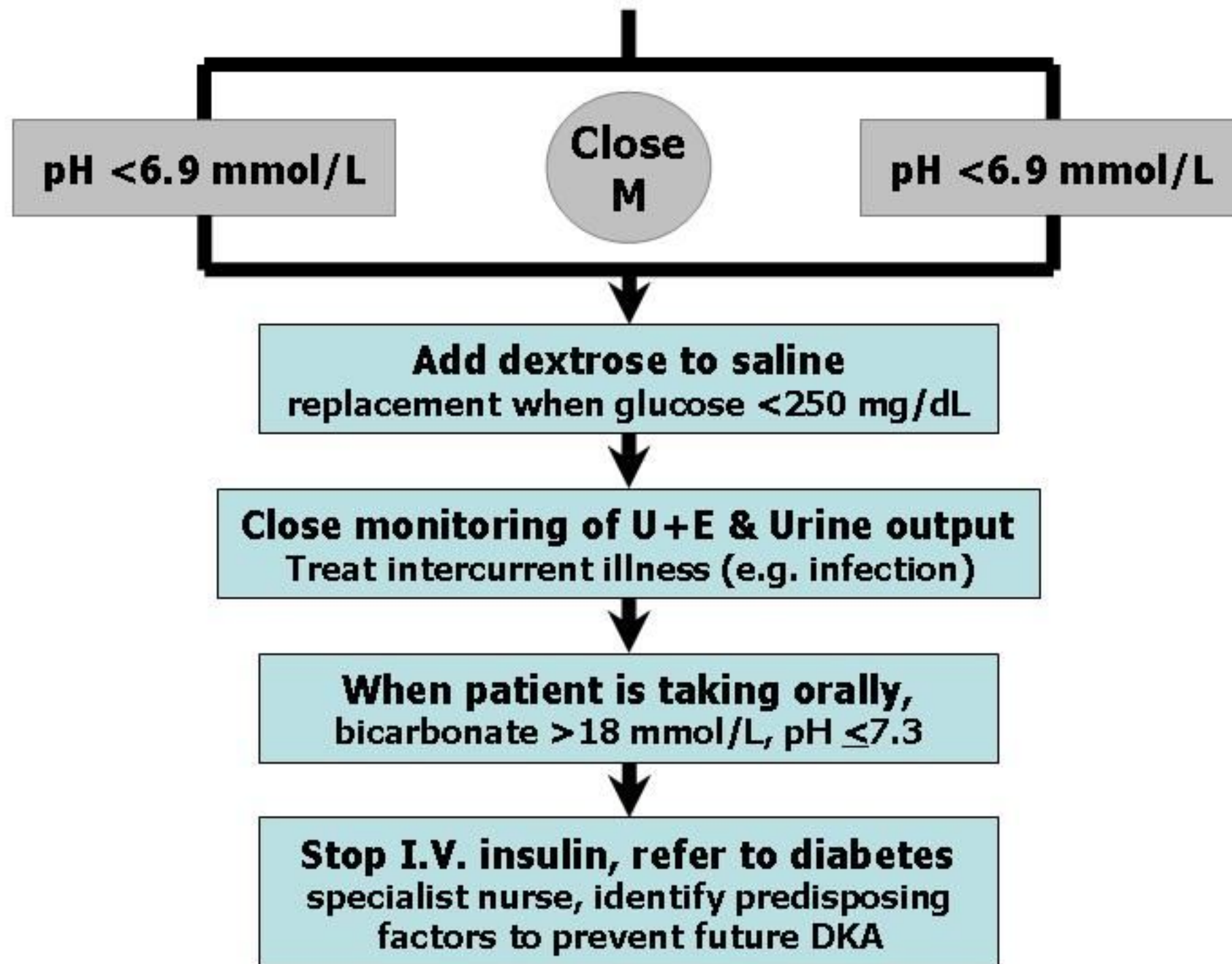
Management of DKA

- **Confirmation of diagnosis**
- **Early venous access; insertion of a central line for severely ill patients**
- **Fluid replacement**
- **Insulin treatment**
- **Potassium replacement**
- **Bicarbonate**
- **Overcome the triggers**
- **May be treated by non-specialist**

Management of DKA



DKA Management (cont'd)



Fluid Replacement

- **Normal-Saline (0.9% NaCl) 500 ml/h for the first 4 hours, followed by 250 ml/h for the next 4 hours**
- **Monitor urine output**
- **Insulin regimen**
- **Potassium substitution**
- **Bicarbonate substitution**

Insulin Regimen

Serum Glucose Levels (mg/dL)	Infusion line (Unit/hr)
200 – 249	4
250 – 299	6
300 – 399	8
>400	10

Subcutaneous Insulin Regimen in Clinical Emergencies

Serum Glucose Levels (mg/dL)	Insulin dose (Unit)
<140	No insulin
140 – 169	3
170 – 199	4
200 – 249	6
250 – 299	8
>300	10

Subcutaneous Insulin Maintenance

Serum Glucose Levels (mg/dL)	Insulin dose (Unit)
<140	Stop insulin infusion
140 – 169	2
170 – 199	3
200 – 249	4
250 – 299	6
300 – 399	8
>400	10

Potassium Substitution

Potassium levels	Add KCl
>5.5 mmol/L	No KCl
>4.0 - 5.5 mmol/L	20 mmol/L
>3.0 - 4.0 mmol/L	40 mmol/L
<3.0 mmol/L	10-20 mmol/hr → >3.0

The Heart should be monitored (ECG)

Hyperosmolar Hyperglycemic Syndrome (HHS)

HHS was previously termed hyperosmolar hyperglycemic nonketotic coma (HHNC)

The terminology was changed because coma is found in fewer than 20% of patients with HHS

Hyperosmolar ...

- Plasma glucose level of ≥ 600 mg/dL
- Effective se-osmolality of ≥ 320 mOsm/kg
~ **Se-osmolality = $[2 \times (\text{Na}^+) + \text{glucose}]$ mOsm/kg**
- Profound dehydration up to $\sim 9\text{L}$
- Serum pH > 7.30
- Bicarbonate levels > 15 mEq/L
- Small ketonuria and absent-to-low ketonemia
- Some alteration in consciousness

Comparison of blood chemistry abnormalities in DKA & HHS

	Normal range	DKA	HHS
Glucose (mmol/L)	4.2 – 6.4	>14	>34
Arterial pH	7.35 – 7.45	<7.3	>7.3
Bicarbonate (mmol/L)	22 – 28	<15	>15
Se-osmolality*)	275 – 295	<320	>320
Sodium (mmol/L)	136 – 145	134 (1.0)	147 (3.2)
Potassium (mmol/L)	3.5 – 5.0	4.5 (0.13)	3.9 (0.2)
Lactate (mmol/L)	0.56 – 2.2	2.4	3.9

*) mOsm/kg. Adapted from Chiasson *et al.*, *CMAJ*2003; 168:859-66.

Pathophysiology of HHS

- **Severe hyperglycemia, hyperosmolarity, and dehydration without significant ketoacidosis**
- **Occurs in T2DM who have some concomitant illness that leads to reduced fluid intake**
- **Infection is the most common cause, but many other conditions can cause altered mentation, dehydration, or both**
- **The concomitant illness may not be identifiable**

Pathophysiology of HHS

- Reduction of the effective circulating insulin + a elevation of counter-regulatory hormones, such as **glucagon**, **catecholamines**, **cortisol**, and **growth hormone**^{1,2}
- Decreased renal clearance and decreased peripheral utilization of glucose lead to hyperglycemia
- Hyperglycemia and hyperosmolarity result in an osmotic diuresis and an osmotic shift of fluid to the intravascular space → intracellular dehydration

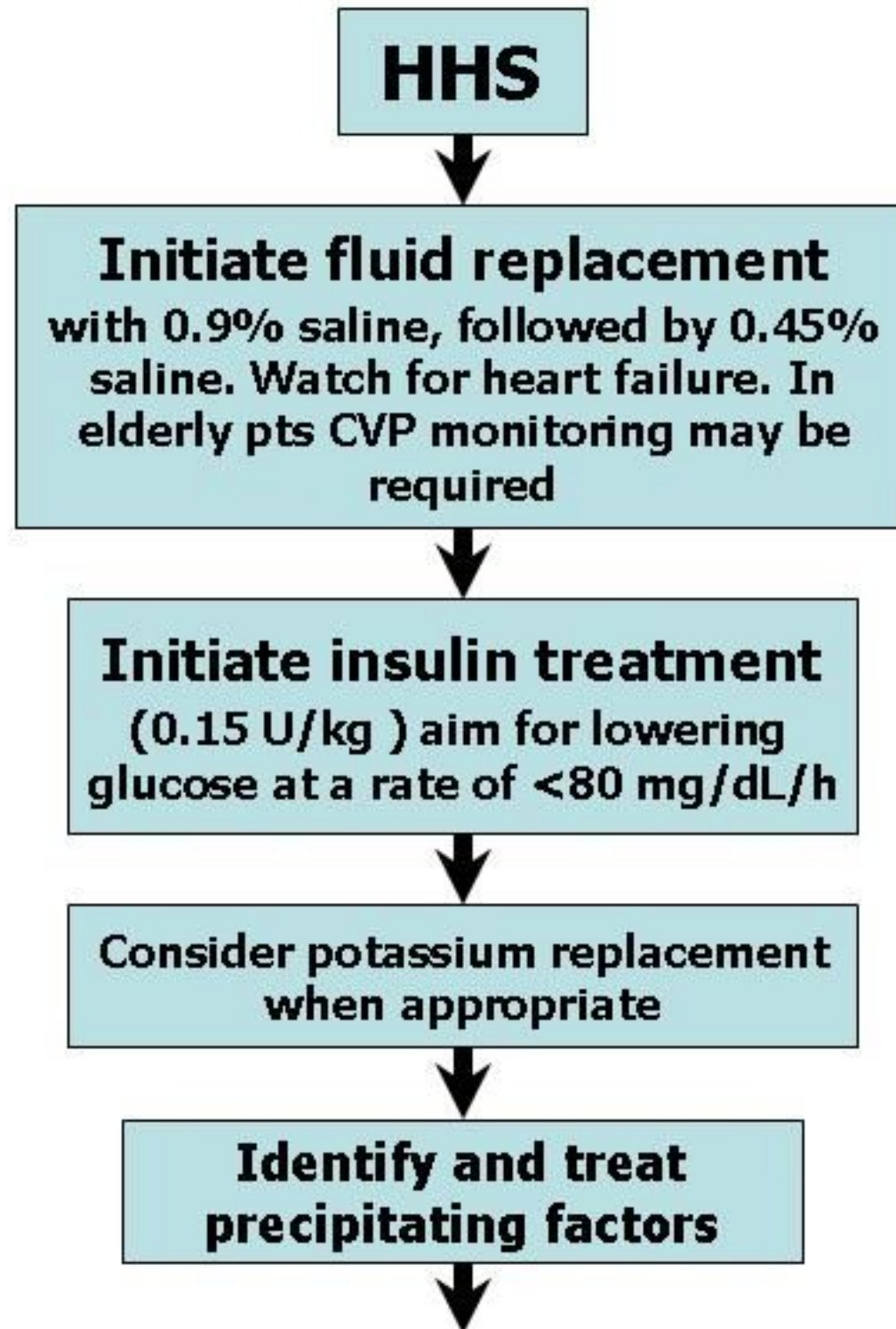
1. Kitabchi AE et al. *Diabetes Care*. Jan 2001;24(1):131-53;

2. Nugent BW. *Emerg Med Clin North Am*. Aug 2005;23(3):629-48,

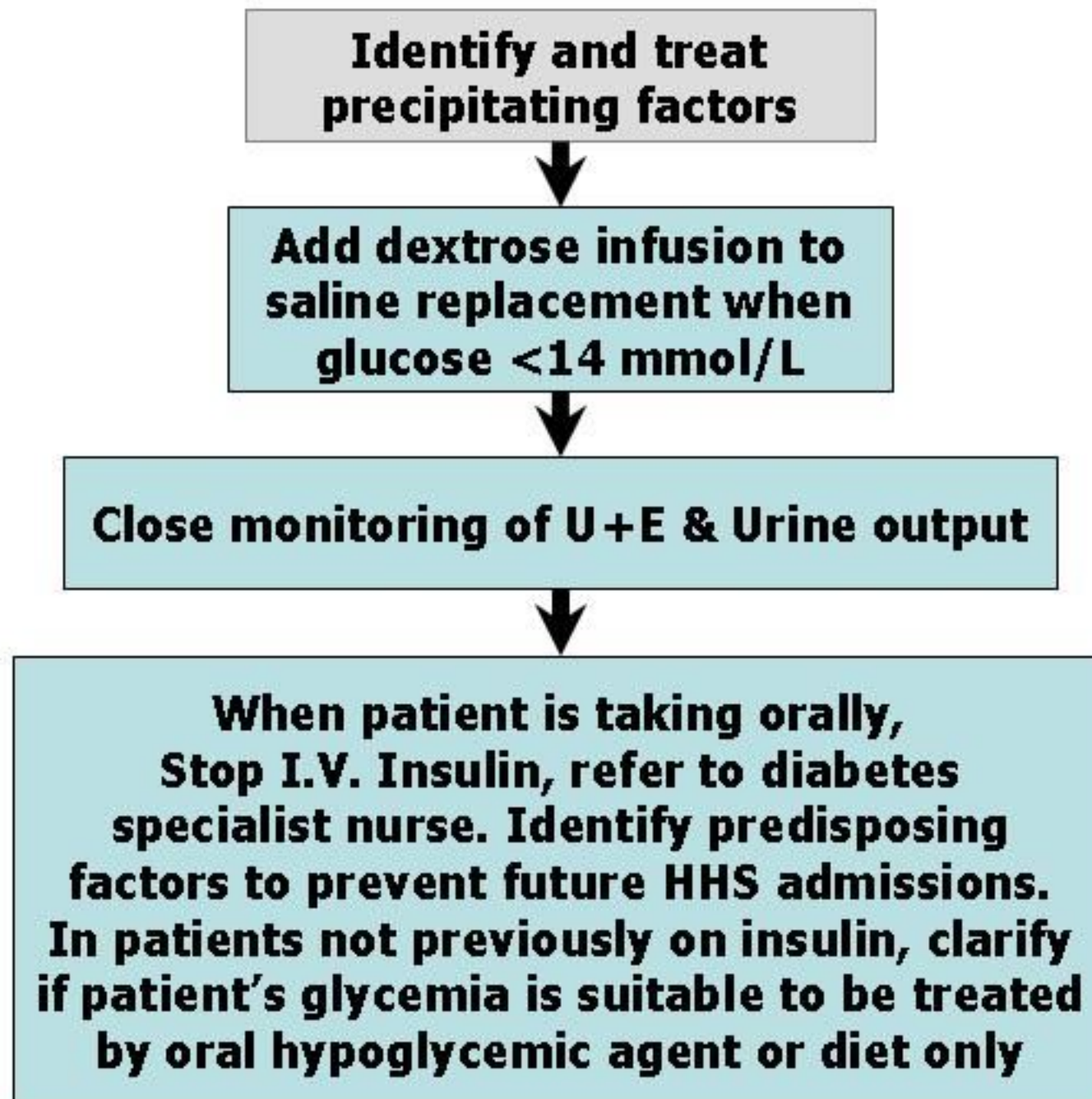
Prehospital Care

- **Standard care for dehydration and altered mental status is appropriate, including airway management, intravenous access, crystalloid, and any medications routinely given to coma patients**
- **Endotracheal intubation as needed**
- **Normal saline ~500 mL bolus**

Management of HHS



Management of HHS (cont'd)



U+E = urea and electrolyte; I.V. = intravenous

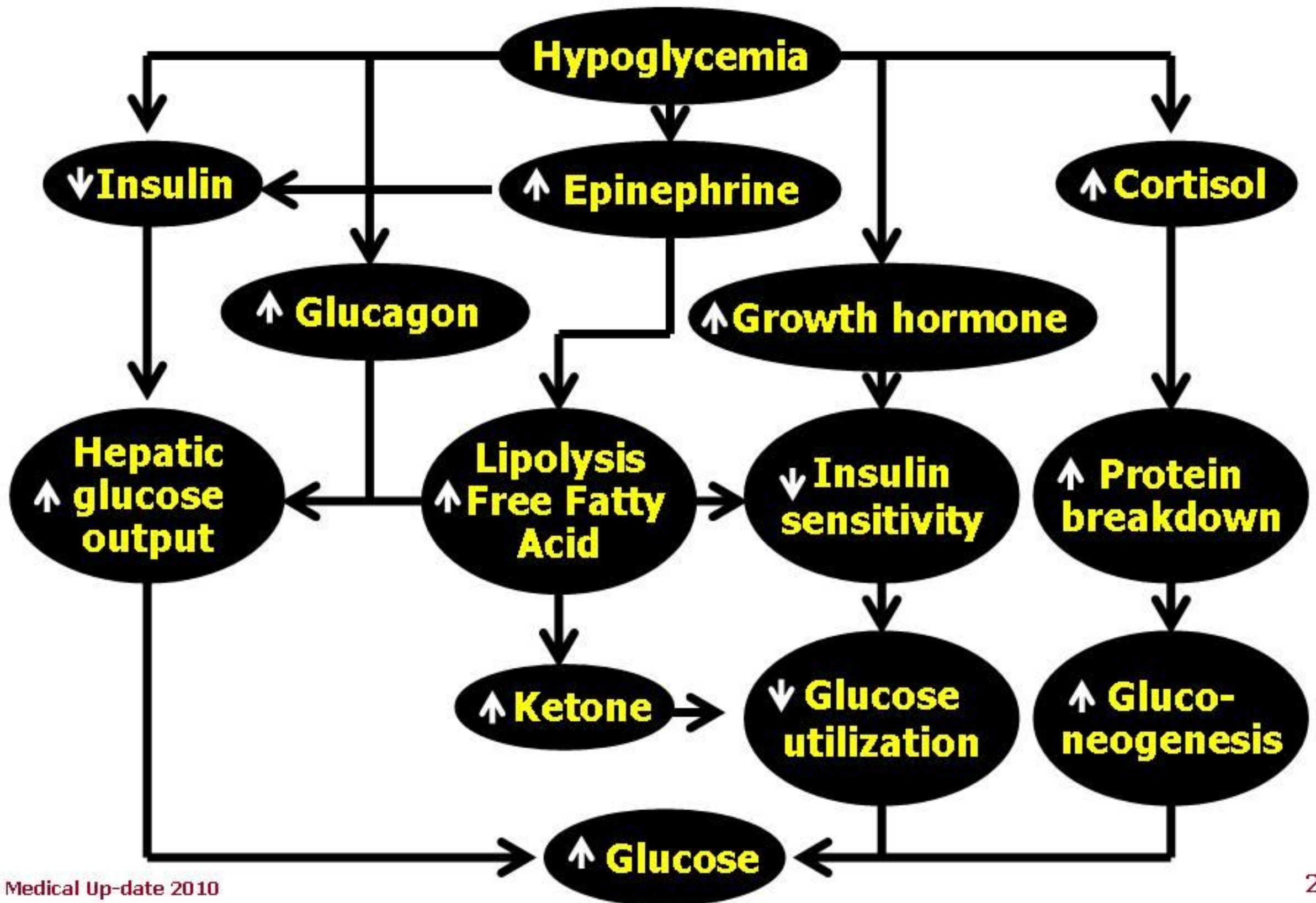
Consultations

- **Generally, no consultation is required to manage HHS in the Emergency Department**
- **Virtually all patients need admission to a monitored unit managed by medicine, pediatrics, or the ICU**
- **In occasional cases, endocrinology, neurology, or infectious disease consultation may be useful**
- **Psychiatry consultation may be useful during the hospitalization**

Recurrent Hypoglycemia

- **Most commonly as a result of treating patient with diabetes mellitus**
- **Whipple triad: 1) symptoms consistent with hypoglycemia; 2) a low plasma glucose levels; & 3) relief of symptoms after the plasma levels are increased**
- **May cause significant morbidity and can be lethal**

Normal hypoglycemic counterregulation



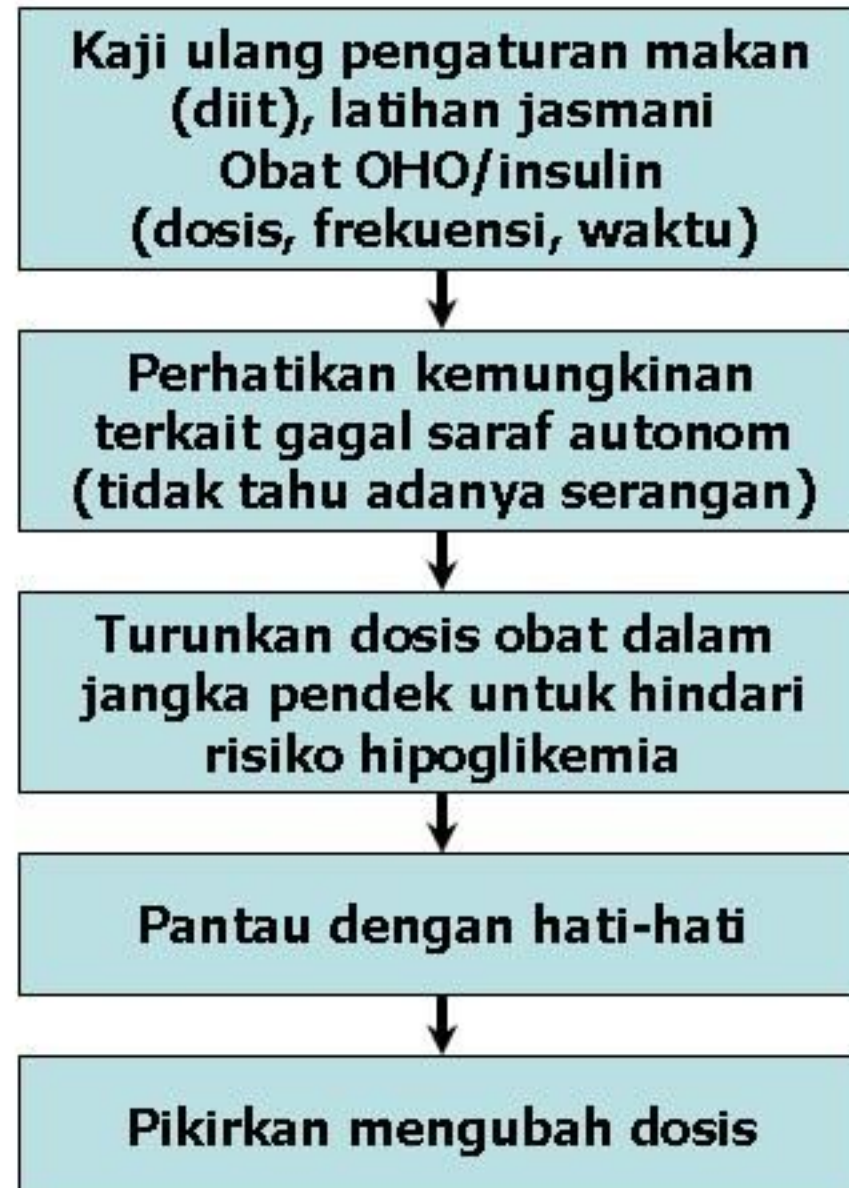
Etiology of Hypo

- **Excessive insulin dose**
- **Lack of carbohydrate intake**
- **Oral secretagogues**
- **Decreased hepatic glucose production (liver disease or alcohol abuse)**
- **Increased glucose catabolism (exercises or tumor disease)**
- **Increased insulin sensitivity (vigorous exercises, adrenal or pituitary failure)**
- **Decreased insulin clearance (renal failure)**

Manifestation of Hypo

Glucose (mg/dL)	Body Response
70 – 100	Inhibits insulin secretion
60 – 69	Increased glucagon, catecholamines secretion
50 – 59	Glycopenic symptoms
	Adrenergic: pallor, anxiety, palpitation, tremor
	Cholinergic: hunger, sweating, paresthesias
<50	Neuroglycopenic

Management of Hypo



Resume

- **Acute diabetes might be related to diabetes itself and treatment of diabetes, e.g. Diabetic Ketoacidosis (DKA), Hyperosmolar Hyperglycemic States (HHS), recurrent hypoglycemia**
- **Treatment for DKA & HHS: rehydration, insulin regimen, potassium replacement**
- **Polyuria, polydipsia, body weight loss are the early warning symptoms of DKA or HHS**

Resume

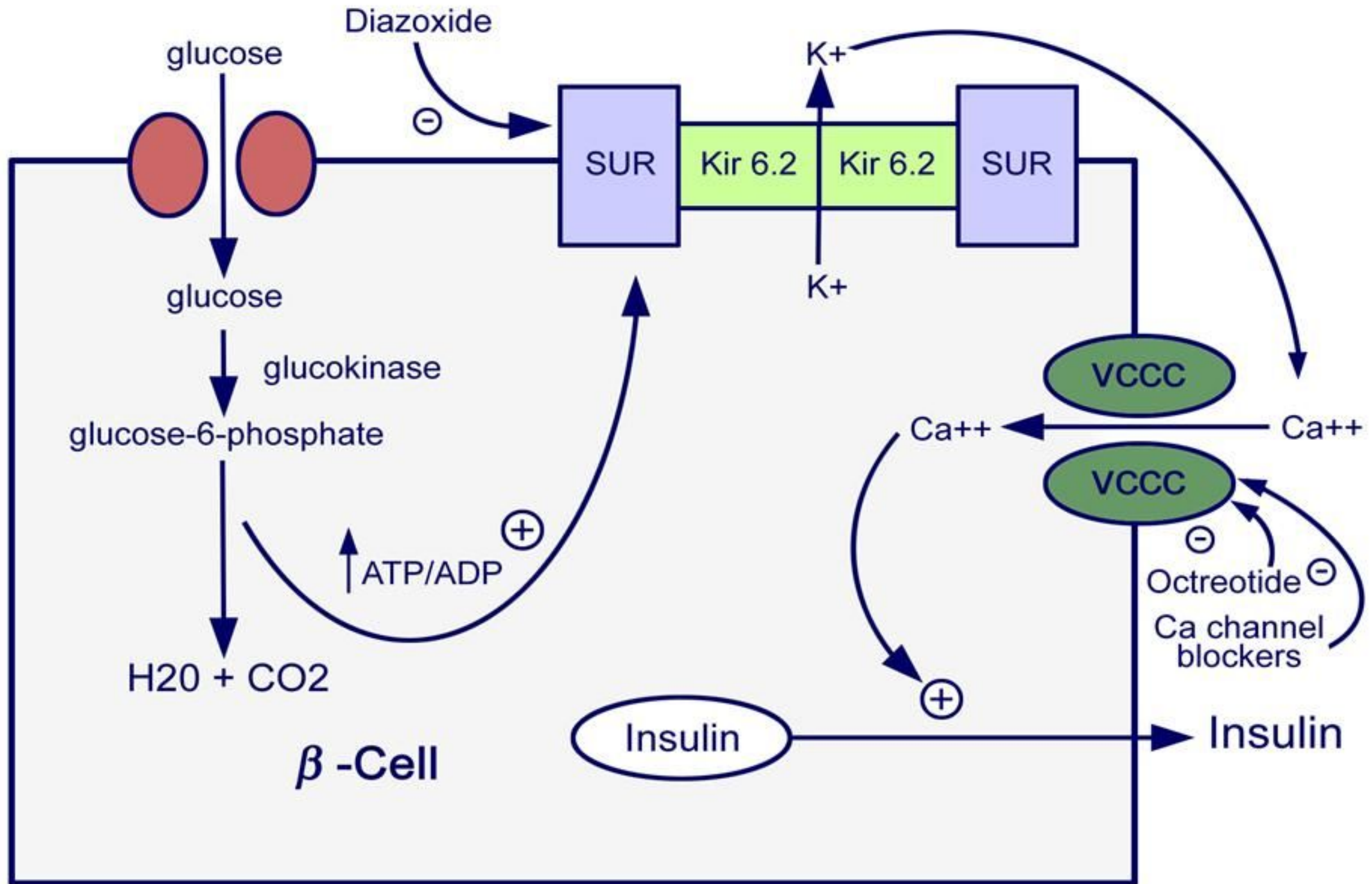
- **Hypoglycemia may cause adrenergic, cholinergic and neuroglycopenic symptoms**
- **Treatment: oral glucose or intravenous glucose injection**
- **Finding the causes may safe further events**

wa maa tadri nafsun maa
dzataksibu ghadan

Alhamdu li Allah

Kamsia
Matur Nuwun
Sakalangkong

Mechanisms of insulin secretion



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- **Editor** *Harrison's Principles of Internal Medicine* (Terjemahan, 1995), dll.