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# High Sugar / Hyperglycemia: Causes, Complications and Management



# Case Presentation

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A 45 year old obese man comes to your clinic with a chief complaint of “My blood sugar is 450”. He’s had diabetes for 5 years and is now taking glipizide, metformin and sitagliptin. His last diabetes check up was 4 months ago when his A1c = 8.2% and sitagliptin was added at that visit. He has polyuria, polydipsia and has a cold with a “deep cough”.

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What would you do to manage his symptomatic hyperglycemia ?

1

Identify causes of hyperglycemia

2

Recognize situations where emergency care may be necessary to treat hyperglycemia

3

Become familiar with newer classifications of ketosis-prone diabetes

Objectives

# Definitions of Hyperglycemia

- A fasting blood glucose above 130
- A post-prandial blood glucose above 180
- These numbers are above the high end of the target range for most people
- Hyperglycemia can be acute or chronic

# HYPERGLYCEMIA

(High Blood Glucose)

**Causes:** Too much food, too little insulin or diabetes pills, illness, or stress.

**Onset:** Often starts slowly. May lead to a medical emergency if not treated.

## SYMPTOMS:

 <p><b>NEED TO URINATE OFTEN</b></p>	 <p><b>DRY SKIN</b></p>	 <p><b>EXTREME THIRST</b></p>
 <p><b>BLURRY VISION</b></p>	 <p><b>DROWSY</b></p>	 <p><b>HUNGRY</b></p> <p><b>SLOW-HEALING WOUNDS</b></p>
<p><b>WHAT CAN YOU DO?</b></p>	 <p><b>CHECK BLOOD GLUCOSE</b></p>	<p><b>CALL YOUR HEALTHCARE PROVIDER</b></p> 

**Call your healthcare provider** if your blood glucose levels are higher than normal for 3 days and you don't know why.

# Causes of Severe Hyperglycemia

- Illness / infection
- Glucocorticoid medications
- Stimulant drugs (methamphetamine, cocaine)
- Glucose toxicity
- Prolonged severe hypoglycemia can lead to DKA and HHS
- ADA recommendation: if blood glucose is over 300 for more than 8 hours, call your doctor

# Preventing Hyperglycemia

- Taking your insulin (or glucose-lowering medication) as prescribed
- Avoiding consuming too many calories (i.e., sugary beverages)
- Consuming the right types and grams of carbohydrates
- Controlling stress
- Staying active (exercising)
- Going to your regularly scheduled doctor's appointments

# Sick Day Care Guidelines

- [Check your blood](#) sugar every 4 hours.
- [Test for ketones](#) if you have [type 1 diabetes](#) and your sugar level is above 240mg/dL. Call the doctor if you find ketones in your urine for advice about going to emergency room
- Check your temperature regularly.
- Drink liquids if you can't keep solid food down. Have one cup of liquid every hour while you're awake to prevent [dehydration](#). If you can't hold down liquids, you may need to go to the emergency room or hospital.
- Don't stop taking [insulin](#), even if you can't eat solid food. You may need to eat or drink something with sugar so that your blood sugar doesn't drop too low.
- You may need to stop taking [medicines](#) by [mouth](#) for [type 2 diabetes](#) while you're sick. Check with your doctor if you're not sure what to do.
- If you need an over-the-counter drug to control symptoms like [cough](#) and nasal congestion, ask your doctor or pharmacist for a list of sugar-free products.



# Managing Chronic Hyperglycemia

- **Medication Adjustment:** Your doctor may adjust your insulin (or glucose-lowering medication) dose or when you take it to help prevent hyperglycemia.
- **Meal Plan Help:** A healthy diet and proper meal planning can help you avoid hyperglycemia. This includes eating often, watching intake of sugar and carbohydrates, limiting use of alcohol, and eating a diet rich in vegetables, fruit and whole grains. If you are having difficulty planning meals, talk to your doctor or dietitian.
- **Exercise:** Regular exercise is important (even if you don't have diabetes). Maintaining a healthy level of activity can help you keep your blood glucose level in a normal range. \*\* don't exercise if ketones +

# Signs of Diabetic Ketoacidosis DKA

- High level of ketones in the urine
- Shortness of breath
- Fruit-smelling breath
- Dry mouth
- Chest pain / abdominal pain

## **DKA Predisposing and Precipitating Factors**

**Inadequate insulin treatment or noncompliance**

**New onset diabetes (20 to 25 percent)**

### **Acute illness**

Infection (30 to 40 percent)

Cerebral vascular accident

Myocardial infarction

Acute pancreatitis

### **Drugs**

Clozapine or olanzapine

Cocaine

Lithium

SGLT2 inhibitors

Terbutaline

# Hyperosmolar Hyperglycemic Nonketotic Syndrome (HHNS) aka HHS, HONK

- Extremely high blood glucose level (over 600 mg/dL)
- Dry mouth
- High fever (over 101°F)
- Sleepiness
- Vision loss

# Predisposing and Precipitating Factors for HHS

**Inadequate insulin treatment or noncompliance (21 to 41 percent)**

## **Acute illness**

Infection (32 to 60 percent)

Pneumonia

Urinary tract infection

Sepsis

Cerebral vascular accident

Myocardial infarction

Acute pancreatitis

Acute pulmonary embolus

Intestinal obstruction

Dialysis, peritoneal

Mesenteric thrombosis

Renal failure

Heat stroke

Hypothermia

Subdural hematoma

Severe burns

## **Endocrine**

Acromegaly

Thyrotoxicosis

Cushing's syndrome

**Previously undiagnosed diabetes**

# Drugs/therapy as Predisposing to HHS

Beta-Adrenergic blockers

Calcium-channel blockers

Chlorpromazine

Chlorthalidone

Cimetidine

Clozapine

Diazoxide

Ethacrynic acid

Immunosuppressive agents

L-asparaginase

Loxapine

Olanzapine

Phenytoin

Propranolol

Steroids

Thiazide diuretics

Total parenteral nutrition

DKA diabetic ketoacidosis			Severe	HHS hyperosmolar hyperglycemic state
	Mild	Moderate		
Plasma glucose (mg/dL)	>250	>250	>250	>600
Plasma glucose (mmol/L)	>13.9	>13.9	>13.9	>33.3
Arterial pH	7.25 to 7.30	7.00 to 7.24	<7.00	>7.30
Serum bicarbonate (mEq/L)	15 to 18	10 to <15	<10	>18
Urine ketones <sup>¶</sup>	Positive	Positive	Positive	Small
Serum ketones - Nitroprusside reaction	Positive	Positive	Positive	≤ Small
Serum ketones - Enzymatic assay of beta hydroxybutyrate (normal range <0.6 mmol/L) <sup>Δ</sup>	3 to 4 mmol/L	4 to 8 mmol/L	>8 mmol/L	<0.6 mmol/L
Effective serum osmolality (mOsm/kg) <sup>◇</sup>	Variable	Variable	Variable	>320
Anion gap <sup>§</sup>	>10	>12	>12	Variable
Alteration in sensoria or mental obtundation	Alert	Alert/drowsy	Stupor/coma	Stupor/coma

# Syndromes of Ketosis Prone Diabetes

- The A $\beta$  system was shown to be the most accurate in predicting long-term insulin dependence 12 months after the index DKA event, with 99 percent sensitivity and 96 percent specificity
- Presence or absence of autoantibodies and the presence or absence of beta cell functional reserve, as measured by a fasting C-peptide level
- ●A+ $\beta$ - autoantibodies present, beta cell function absent
- ●A+ $\beta$ + autoantibodies present, beta cell function present
- ●A- $\beta$ - autoantibodies absent, beta cell function absent
- ●A- $\beta$ + autoantibodies absent, beta cell function present



# A $\beta$ subgroups of ketosis-prone diabetes: Clinical characteristics and natural history

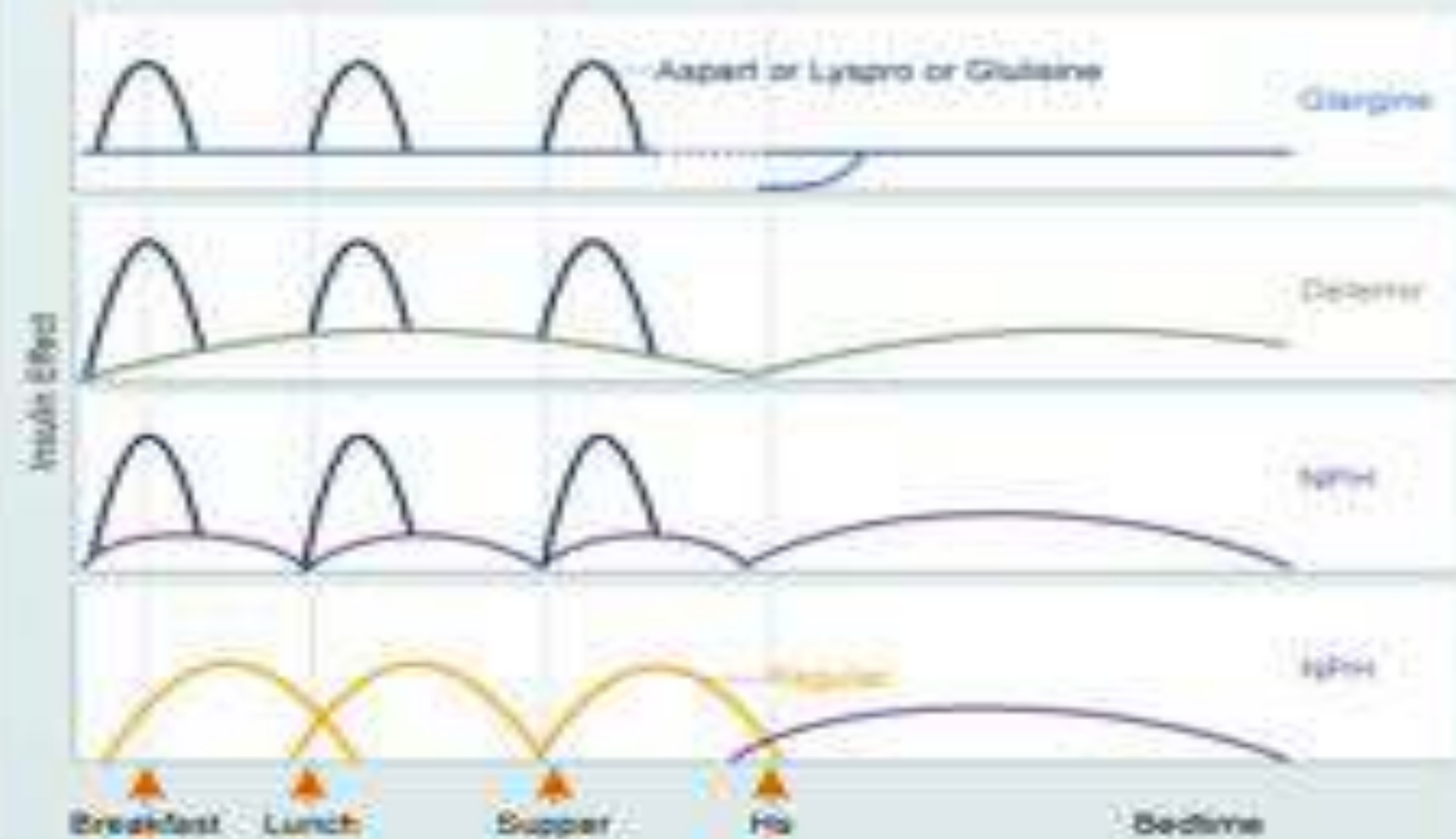
	A+ $\beta$ -	A- $\beta$ -	A+ $\beta$ +	A- $\beta$ +
Number	18 (17 percent)	23 (22 percent)	11 (11 percent)	51 (50 percent)
Age	34 $\pm$ 17	38 $\pm$ 15	43 $\pm$ 14	42 $\pm$ 13
Age at diagnosis	25 $\pm$ 17	26 $\pm$ 12	42 $\pm$ 12	39 $\pm$ 12
Years with diabetes	9.1 $\pm$ 10.4	9.8 $\pm$ 8.7	0.9 $\pm$ 3.0	3.0 $\pm$ 4.8
Family history of diabetes	9 (50 percent)	19 (83 percent)	9 (82 percent)	45 (88 percent)

	A+β-	A-β-	A+β+	A-β+
Anti-diabetic regimen at 12 months				
Insulin only	17 (94 percent)	23 (100 percent)	3 (27 percent)	17 (33 percent)
Insulin and oral hypoglycemics	1 (6 percent)	0	3 (27 percent)	8 (16 percent)
Oral hypoglycemics only	0	0	3 (27 percent)	21 (41 percent)
Diet and exercise only	0	0	2 (19 percent)	5 (10 percent)

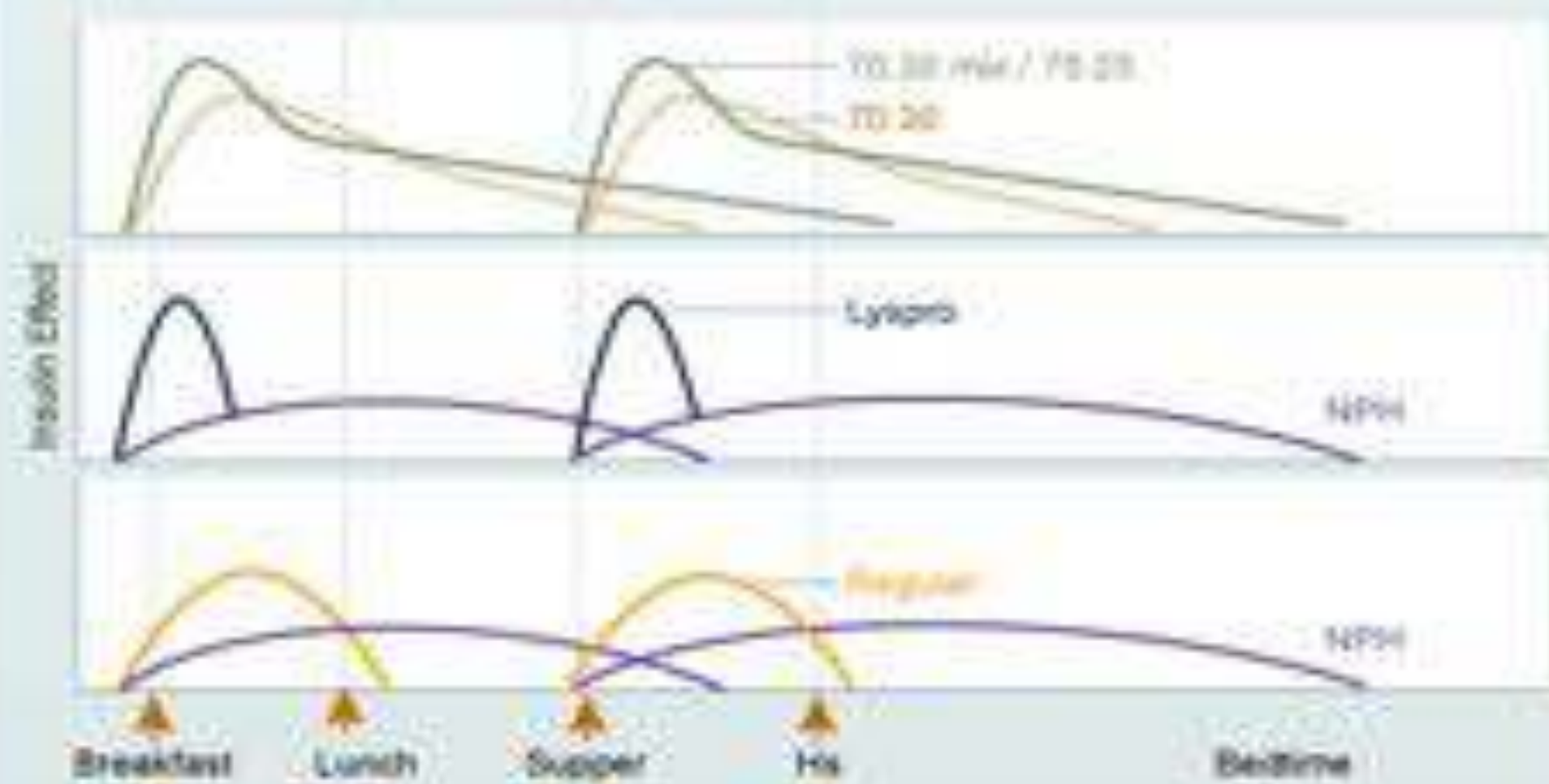
# Correction Insulin

- Correction insulin is meant to “correct” or lower high blood sugars before meals. It is often given **in addition to** the usual dose that you take to cover your meal. Some people also take it if blood sugars are high at bedtime.
- **Types of Correction Insulin**
- Short-acting or rapid-acting insulin can be used. Examples include:
  - Regular
  - Novolog® (aspart)
  - Humalog® (lispro)
  - Apidra® (glulisine)

## Setting Basal Insulin Regimens for Type 2 Diabetes Using Multiple Daily Injections



Sliding Scale Insulin Regimens for Type 2 Diabetes –  
Pre-mixed or Split Mixed Regimens



# Template for Correction Scale

- My doses as of this date \_\_\_\_\_ are:
- Before Meals
- If Blood Glucose is:      Add this much extra insulin:
- Less than 150 mg/dL      No extra insulin
- 151 - 200                      units
- 201 - 250                      units
- 251 - 300                      units
- 301 - 350                      units
- 351 - 400                      units

# Dose schedules for Correction Insulin

- Low schedule
  - BG 150-199: 1 unit [Bolus Insulin](#) (regular or rapid-acting)
  - BG 200-249: 2 units [Bolus Insulin](#)
  - BG 250-299: 3 units [Bolus Insulin](#)
  - BG 300-349: 4 units [Bolus Insulin](#)
  - BG Over 350: 5 units [Bolus Insulin](#)
- Medium schedule
  - BG 150-199: 1 unit [Bolus Insulin](#) (regular or rapid-acting)
  - BG 200-249: 3 units [Bolus Insulin](#)
  - BG 250-299: 5 units [Bolus Insulin](#)
  - BG 300-349: 7 units [Bolus Insulin](#)
  - BG Over 350: 8 units [Bolus Insulin](#)
- High schedule ([Insulin](#)-resistant)
  - BG 150-199: 2 unit [Bolus Insulin](#) (regular or rapid-acting)
  - BG 200-249: 4 units [Bolus Insulin](#)
  - BG 250-299: 7 units [Bolus Insulin](#)
  - BG 300-349: 10 units [Bolus Insulin](#)
  - BG Over 350: 12 units [Bolus Insulin](#)

# Correction Insulin Instructions for Patients

- **Key Points**

- Do **not** eat less food because of the high blood sugar. This can put you at risk for low blood sugars.
- Do not take correction insulin more often than every 4-6 hours unless you have been told to do so.
- If you need to use correction insulin daily, for three or more days in a row, call your health care team. Your usual doses may need to be changed.
- Exercise will likely lower your blood sugars. You may not need correction insulin at the meal before or after you exercise. Discuss this with your health care team.



# References

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- *Balasubramanyam A & Ram N. Syndromes of ketosis-prone diabetes mellitus. Up to Date Topic 1775 Version 10.0 literature current through Mar 2018*