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MED439 KING SAUD UNIVERSITY

Endocrine Emergencies

Objectives:

This lecture had no objectives and should be reviewed after studying endocrine system lectures.

Topics covered in this lecture:

1. Diabetic Ketoacidosis
2. Hyperosmolar non-ketotic hyperglycemia (HHS)
3. adrenal crisis
4. thyroid emergencies
5. calcium emergencies

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Editing File

Color Index

- Slides / Reference Book
- Doctor notes
- OnlineMeded / Amboss
- Important
- Extra

Diabetic ketoacidosis

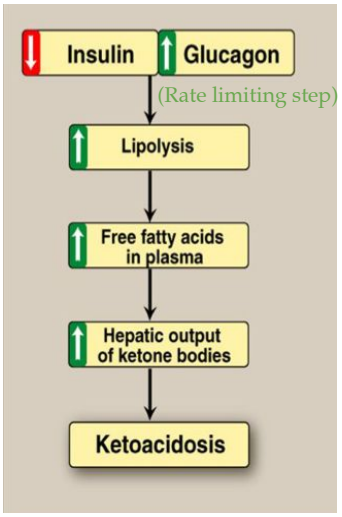
Definition

DKA is a life-threatening emergency of Type I diabetics. There is plenty of sugar in the blood, but without insulin none of it can get into the cells. It's as if the patient is starving. The brain activates ketones from fatty acids, causing both ketosis and acidosis. Simultaneously, the high levels of sugar in the blood spill into the urine. Glucose is a potent osmotic diuretic; the patient becomes dehydrated.

Pathogenesis

1. Ketogenesis:
Due to insulin deficiency & increased concentration of counter regulatory hormones esp. epinephrine
TG → FFA → LIVER → KETONE BODIES (acetoacetate (AcAc), 3-beta-hydroxybutyrate (3HB) and acetone)

2.Hyperglycemia:
A : gluconeogenesis
B: accelerated glycogenolysis
C : impaired glucose utilization



Precipitating Factors

- Infection (URTI, UTI and flu like illness)
- Stopping insulin (unavailability or psychological)
- First presentation of type 1 DM
- No obvious cause : psychological factors or taking insulin without eating
- Drugs : **SGLT2 inhibitors** (Dapagliflozin ,Empagliflozin, Canagliflozin)
- Malfunction of insulin pumps
- **Cocaine use**

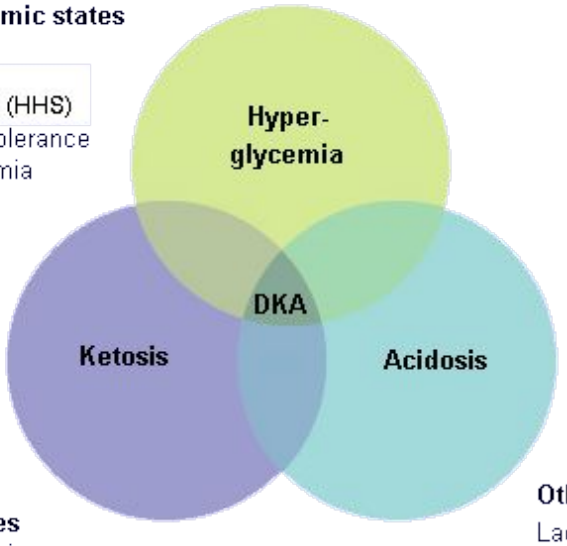
DKA Criteria :

- **Blood sugar above 14 mmol/l**
- **Arterial Ph below 7.3 (due to accumulation of ketone bodies)**
- **Bicarbonate concentration below 15 mEq/l**
- **Presence of ketonuria or ketonemia.**

Diabetic ketoacidosis

Possible Causes

Other hyperglycemic states
Diabetes mellitus
Hyperosmolar hyperglycemic state (HHS)
Impaired glucose tolerance
Stress hyperglycemia



Other ketotic states
Ketotic hypoglycemia
Alcoholic ketosis
Starvation ketosis (Similar to DKA but not very acidotic)
(Fat will be metabolized instead of food, causing accumulation ketones and FFA)

Other metabolic acidotic states
Lactic acidosis (Mainly due to sepsis)
Hyperchloremic acidosis
Salicylism
Uremic acidosis
Drug-induced acidosis (Metformin)

Clinical presentation

- Any type 1 diabetic patient with nausea , vomiting, shortness of breath ,fever , signs of infection is a candidate for DKA.
- Look for signs of dehydration : skin turgor, hypotension, tachycardia, Kussmaul breathing (Rapid and deep breathing to washout CO2)
- Neurological: CNS depression with high osmolality more than 320 mosm/kg
- Acetone smell.
- preceding history of polydipsia and polyurea, lethargy, anorexia, abdominal pain due to delayed gastric emptying and ileus (common in children)

Labs Results

The easiest way to make diagnoses (check urine and blood GLUCOCHECK)

- Serum glucose
- ABG for metabolic acidosis
- Urea and electrolytes
- CBC
- ECG
- CXR to exclude URTI
- Cultures (blood, urine and sputum)
- Urine dipstick for ketones

Diabetic ketoacidosis

Treatment

❑ GENERALLY

- **Admit patient to ICU.** For continuous MONITORING
- Monitor the following :
- blood (finger stick) or plasma glucose every 1-2 hours.
- **Plasma K every 2-4 hours (important).** It will decrease due to insulin and hyperglycemia[1]
- Other electrolytes every 4 hours.
- ABG as needed until PH is >7.1
- Plasma phosphate , Mg , Ca , on admission : if low repeat every 4 hrs.
- Urine for ketones every voiding.

❑ INSULIN

- 0.1 u/kg bulous for ex, 70kg pt will get 7 units of bolus insulin
- followed by iv infusion of regular insulin 0.1u/kg/hr.
- Plasma glucose should fall by 4 – 5.5 mmol/l/hrs (70-100 mg/hr).
- If no response (insulin resistance) by 4 hrs double the dose (of the infusion)

❑ FLUIDS

- Start with normal saline **(15-20 ml /kg)** first 2 hours :
- 1 liter in first hour
- 1 liter in second hour
- Then assess : if patient was initially hypotensive, give a third litre in the next 2 hours.
- **DON'T EXCEED MORE THAN 50 ML/KG IN THE FIRST 4 HOURS.**
- When blood glucose reaches 14 mmol (252 mg/dl), give 0.45 % saline infusion + 5 % glucose to run at 150 – 300 ml / hour. (to avoid sudden drop in glucose level leading to cerebral edema, which is mainly managed with **mannitol**)

❑ POTASSIUM

- Always deficient (UP TO 200 meq)
- Initial level could be high because of acidosis
- Replace as potassium chloride & 1/3 as KPO4
- Usually 20 – 30 meq /hr is needed . Replace if K+ if LESS THAN 5.3 Meq/l
- ECG monitoring

❑ BICARBONATE

- **only if PH IS ≤ 6.9 OR BICARBONATE IS < 5. (IMPORTANT)** if the PH is 7 we don't give
- WHY ?
- 1. WORSENING OF HYPOKALEMIA
- 2. PARADOXICAL CNS ACIDOSIS Give one ampoule of 7.5 % sod bicarb. (50 mmol) + 250 ML sterile water ((Add 15 meq of K CL for each ampoule (if K is ≤ 5.5 meq/l)))
- loss of drive for hyperventilation causing high PCO2 AND CEREBRAL ACIDEMIA
- Never give it to children

1. If potassium is over corrected, give calcium gluconate to protect the heart from severe hyperkalemia

Diabetic ketoacidosis

Criteria for resolution

- **Blood glucose < 200 mg /dl (11.1 mmol)**
- **Serum bicarbonate > 18 meq /l**
- **PH > 7.3**
- **Calculated anion gap < 12**
- **When patient is able to eat**

So once pt started to get better, we can overlap **subcutaneous insulin** with insulin infusion as follows:

- If patient is newly diagnosed, the initial total insulin dose should be 0.6 u/kg/day.
- Subcutaneous insulin takes time, that's why we overlap.

Complication of therapy

- Hypoglycemia
- Hypokalemia
- Cerebral edema : occurs in **pediatric patients.** May occur when blood sugar drops quickly to <14 mmol/l
- ARDS : rare

Prevention

1. **EDUCATION.**
2. **SICK DAYS MANAGEMENT :**
    - hydration
    - treatment of infection
    - monitoring for glucose & ketones
    - Use of short acting insulin
    - Never stop insulin

Case from the dr slides

- 18 years old diabetic patient was found to be in coma (mainly Type 1 DM)
- Her labs were:
    - ❑ Glucose :> 17 mmol/l
    - ❑ PH < 7.3
    - ❑ Bicarbonate : < 15 mEq / l
    - ❑ Ketonemia and ketonuria
    - ❑ High anion gap (Na – Cl + bicarb) > 14 m Eq / l

Hyperglycemic Hyperosmolar State (HHS)

- **Different from DKA by absence of ketosis and presence of higher plasma glucose.**
- **Glucose is usually > 33 mmol and osmolality > 320 mosM.**
- **Patient is typically a type 2 DM**
- **Serum PH is more that 7.3**
- **Serum Bicarbonate is higher than 18**
- **Usually pt is elderly and dehydrated.**
- HHS is the life-threatening emergency of Type II diabetics.
- the patient will still present with coma because of profound dehydration.
- The blood glucoses are often much more elevated in HHNKC than in DKA + the diuresis has gone on longer. This patient needs fluids and IV insulin.

Pathogenesis

- Hyperglycemia cuz elderly don't present early to the hospital
- Ketogenesis : not operating (some insulin is still available)
- Dehydration is more severe (because in elderly their thirst mechanism isn't that strong, and they might be unable to drink much of fluids)
- Hyperosmolar state once all the volume is depleted with dehydration, sugar start to accumulate resulting in high osmolality in the blood

Management

(Similar to DKA but less fluids due to the possible comorbidities)

- **Fluids :** 0.9% saline in first hour and 2nd hour .
- Then give 0.45% saline at about 500 ml / hr or less .
- Watch cardiac status carefully esp. in cardiac patients.
- Add 5% glucose when blood glucose reaches 14 - 16 mmol /l .

- **Insulin:** they have a bit low insulin, unlike DKA we don't give high doses
- 5 – 10 units regular insulin bolus.
- Then 0.1 u/kg /hr infusion
- When blood glucose reaches 14 – 16 mmol/l give 1 - 2 u /hr + saline / glucose infusion .

Diagnostic Criteria	
DKA	HHS
• Hyperglycemia : Blood glucose ≥14 mmol/L • Acidosis : pH < 7.3, HCO_3 <15 mmol/L • Ketonaemia or ketonuria	• Plasma glucose level of ≥ 33 mmol/L • Arterial pH > 7.3, serum bicarbonate > 15 mmol/L • Absence of severe ketonaemia or ketonuria • Serum total osmolality >330 mmol/L

Characteristic	*DKA*	*HHNKC / HHS*
Path:	**Type I,** Insulin Dependent Diabetes Mellitus (IDDM)	**Type II,** Non-Insulin Dependent Diabetes Mellitus (NIDDM)
Pt:	+ Diabetic Coma + Ketones + Acidosis	+ Diabetic Coma - Ketones - Acidosis
Dx:	**bG 300-500** U/A: + Ketones ABG: + Acidosis BMP: + Gap	**bG 800-1000** U/A: - Ketones ABG: - Acidosis BMP: - Gap
Tx:	Replete K IV Fluids – Bolus a lot IV insulin **Follow the GAP**	Replete K IV Fluids – Bolus a lot IV Insulin Follow the symptomatic improvement

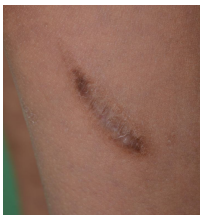
Adrenal emergency

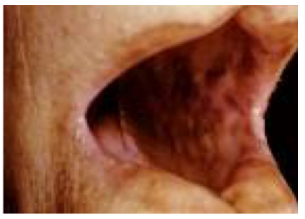
Adrenal insufficiency

The loss of adrenal function may be from a variety of etiologies, and may be sudden/acute with multiple presentations. The most common cause in the US is autoimmune adrenalitis; it's TB worldwide.

Primary (addison disease)

- In primary failure (loss of cortisol, maintenance of ACTH) the symptoms will be hypotension, fatigue, N/V of cortisol loss, as well as the **hyperpigmentation and hyperkalemia and hyponatremia.** Hyperpigmentation is a result of ACTH production trying to increase cortisol while hyperkalemia is from deficient aldosterone.
- proopiomelanocortin, a prohormone that is cleaved into the biologically active hormones ACTH, melanocyte stimulating hormone **(MSH)**, and others which causes the hyperpigmentation
- Hyperpigmentation might be generalized, or at friction sites (axila, joints, nails, gingiva and tongue, areola, perineum)





- Typical electrolytes results:
  - Hyponatremia
  - Hyperkalemia
  - Hypoglycemia
- CBC will show neutropenia, relative lymphocytosis and eosinophilia.
- Other Possible causes of hypoglycemia are **(EXPLAIN):**
  - Exogenous insulin or OHA
  - Pituitary disease (loss of ACTH causing sec hypoaldosteronism)
  - Liver disease (no gluconeogenesis)
  - Addison's disease.
  - Insulinoma (insulin producing adenoma)
  - Neoplasm (more consumption of the glucose)
- **Treatment:** IV SALINE + GLUCOSE + IV STEROIDS

Case from the dr slides

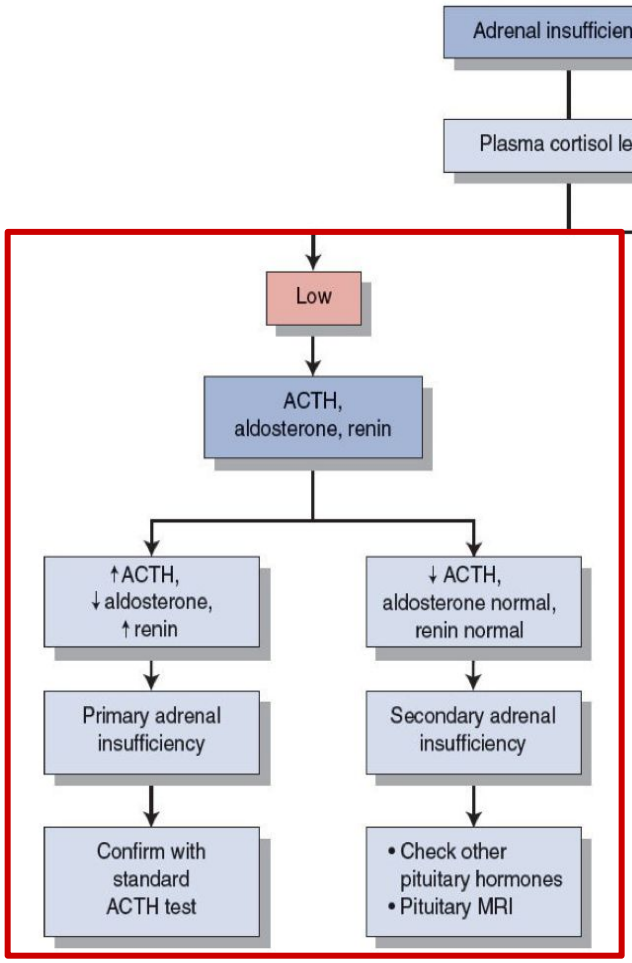
- 45 YEARS OLD Saudi lady presented with Fatigue, Tiredness and Increased skin pigmentation
- Her labs were (**Na 126, K 5.5**, Cl 89 and Bicarb 20)

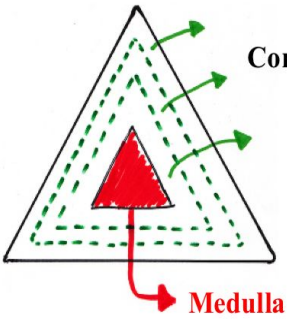
Secondary

- In secondary failure, no ACTH is produced so hyperpigmentation is absent. Because aldosterone production is intact there's also no hyperkalemia. (under renin-angiotensin system)

Adrenal emergency

Adrenal Crisis
An acute and severely symptomatic stage of adrenal insufficiency that can include severe hypotension and cardiovascular collapse, abdominal pain (can mimic an acute abdomen), acute renal failure, and death.
Any stress (e.g., trauma, infection, surgery) can precipitate an adrenal crisis.
Can be fatal if untreated.
Treat with IV hydrocortisone, IV fluids (several liters of normal saline with 5% dextrose), and a search for the underlying condition that precipitated the crisis.





Cortex - Glomerulosa "Salt" Aldosterone
Fasiculata "Sugar" Cortisol
Reticularis "Sex" Testosterone

Medulla → Catecholamines

Prevention

- They don't have the normal increase in cortisol in case of stress that's why they need to increase the dose.
- Extra steroids at times of stress
- Double dose for URTI
- Higher doses for more severe illnesses

Thyroid emergencies

Thyroid storm

Case from the dr slides

35 years old lady with hyperthyroidism (post surgery), developed the following :

- Fever : 41 c
- Agitation
- Tachycardia : 140 /min
- Upon taking further history, **the patient was NOT euthyroid before surgery**

- This is a rare, life-threatening complication of thyrotoxicosis characterized by an acute exacerbation of the manifestations of **hyperthyroidism**.
- There is usually a precipitating factor, such as infection, DKA, or stress (e.g., severe trauma, surgery, illness, childbirth).

❑ Clinical manifestations

- High fever and tachycardia, agitation and delirium, CHF and LOC.

❑ Treatment

- IODIDE : prevents release of thyroid hormone from thyroid gland (by negative feedback mechanism)
- ANTITHYROID DRUGS : prevent synthesis of hormone (from the thyroid or from the peripheral conversion)
- BETA BLOCKERS: prevent T4 to T3 conversion (Protect heart)
- STEROIDS: prevent T4 to T3 conversion
- ANTIPYRETICS
- SUPPORTIVE CARE : ICU admission

Myxedema coma

Case from the dr slides

- 81 years old lady was found in coma
- Her temperature: VERY LOW + PULSE : 45 /MIN

- A rare condition that presents with a depressed state of consciousness, profound hypothermia, and respiratory depression.
- May develop after years of severe untreated **hypothyroidism**.
- Precipitating factors are trauma, infection, cold exposure, and narcotics.

Thyroid emergencies

Myxedema coma, cont.

❑ Clinical manifestations

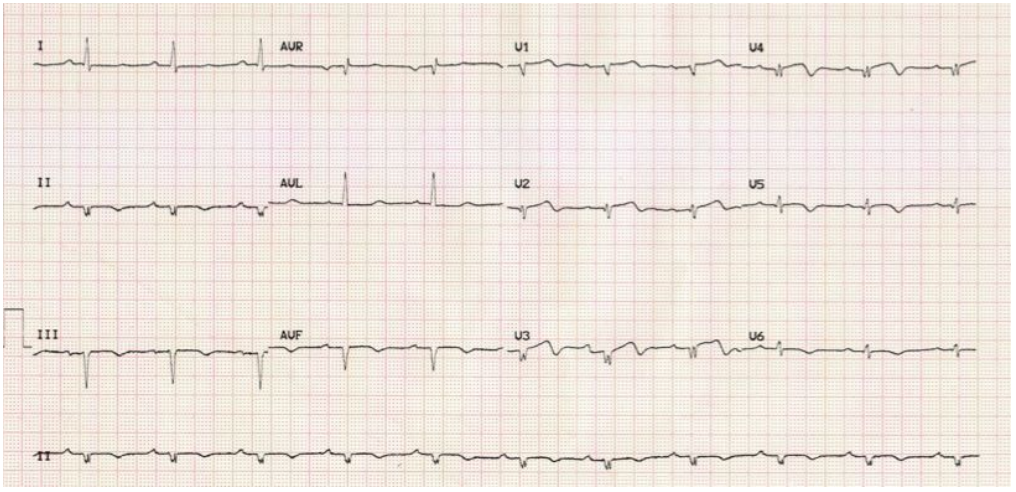
- Dry skin
- Loss of eyebrows
- Big tongue
- Look for a thyroidectomy scar
- HYPOVENTILATION IS A BIG PROBLEM (patient might need assisted ventilation)

Typical ABG: (hypoventilation)

- **PCO2 : High**
- **PO2: Low**

Labs And ECG

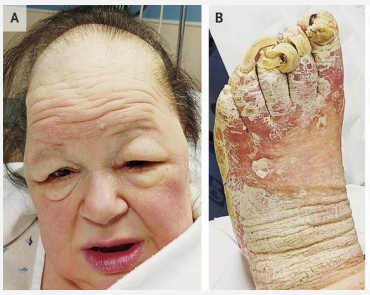
- Look for hyponatremia
- High cholesterol
- High CPK
- Low voltage and **bradycardia**

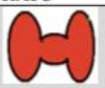


❑ Treatment

- **VENTILATION**
- **IV THYROXINE**
- **IV STEROIDS**
- **WARM THE PATIENT**

Thyroid emergencies

Outline	Myxedema Coma	Thyroid Storm
Definition	extreme or decompensated form of **HYPOthyroidism**	extreme or decompensated form of **HYPERthyroidism**
S&S	❖ Hypothermia ❖ Hypotension ❖ Altered Mental Status	Hyperthyroidism symptoms + alarming symptoms (fever, delirium, and hypotension)
Treatment	1. **IVF** 2. **Warming** Blankets 3. High dose of **T4** Or T3 (if symptoms are severe or T4 fail)	1. **IVF** 2. **Cooling** Blankets 3. Propranolol (to slow the heart down and get the BP back up) 4. High dose of **PTU** Or **Methimazole** (to reduce the production of new thyroid hormone) 5. **Steroids** (reduce the T4 to T3 conversion) 6. One single storm is an indication for curative surgical removal of thyroid gland.
Picture		

Disease	*Path*	*Patient*	*TSH*	*T4*	*RAIU*	*Diagnosis*	*Treatment*
Graves	Autoimmune stimulating antibodies	Hyperthyroid +ophthalmopathy +Pretibial Myxedema	↓	↑		**Anti-TSH-R Antibody**	Propranolol PTU/Methimazole Radioactive Ablation Surgery
Thyroiditis Painless Subacute Lymphocytic +TPO Painful Subacute Granuloma Viral Chronic Lymphocytic		Either painful or painless transient hyperthyroidism that may persist	↓	↑	N/A	Bx for Infiltrate **Anti-Peroxidase Antibody** (TPO)	NSAIDs Wait **Synthroid** if Hypothyroid
Toxic Goiter	Autonomous Nodules Secrete T4	Hyperthyroid with palpable nodules	↓	↑		Bx if suspicious for cancer	
Factitious	Exogenous T4, Oral	Hyperthyroid, often in a woman	↓	↑		Confrontation	Stop taking exogenous T4
Struma Ovarii	Ovarian tissue Dermoid Cyst produces T4	Hyperthyroid, always in a woman	↓	↑		"RAIU" of the Ovaries, **Sestamibi Scan**	Remove the Cyst
Thyroid Storm	Super mega ultra hypothyroidism	Hyperthyroid ⊕ CHF ⊕ AMS ⊕ Fever	↓↓	↑↑	Any , no one diagnostic	Diagnosis Ø Needed Just Treat, and treat fast	IVF, Cooling Blankets, Steroids, Propranolol, PTU, Iodide

Calcium emergencies

The dr didn't focus much on it

Hypocalcemia

Causes

- Hypoparathyroidism
- Renal insufficiency
- Vit D deficiency
- Hyperphosphatemia
- Hypoalbuminemia
- Hypomagnesemia

Clinical manifestations

- Asymptomatic
- Rickets and osteomalacia
- Increased neuromuscular irritability
  - Numbness/tingling
  - Convulsions especially in the young
  - Tetany (Hyperactive deep tendon reflexes Chvostek sign Trousseau sign)
- Cardiac manifestations:
  - Arrhythmias
  - Prolonged QT interval

Treatment

- If symptomatic, provide emergency treatment with IV calcium gluconate SLOWLY AND UNDER ECG MONITORING.
- For long-term management, use oral calcium supplements (calcium carbonate) and vitamin D.

Hypercalcemia

Causes

- Primary hyperparathyroidism
- Malignancy induced hypercalcemia
- Iatrogenic (high doses of calcium and vitamin D)

Case

A 60 years old man presented with confusion. Serum calcium found to be 3.7 mmol/l (N 2.1-2.5)

Treatment

- Saline hydration
- Calcitonin
- Bisphosphonate
- Steroids : only useful in sarcoidosis , multiple myeloma and lymphoma
- Dialysis : in renal failure or CHF

Lecture Quiz

1:D / 2:C / 3:B

Q1: A 45-year-old female presents with symptoms of fatigue, weight loss, increased thirst, and frequent urination. She has a history of type 2 diabetes but mentions that her symptoms have worsened recently. On examination, her blood pressure is low, and her skin appears hyperpigmented. Which condition should be suspected?

A. Hypercalcemia
B. Hypocalcemia
C. Hyperaldosteronism
D. Hypoaldosteronism

Q2: A 60-year-old male with a history of hypothyroidism presents with altered mental status, hypothermia, and bradycardia. He has a prolonged history of untreated thyroid disease. What is the most likely diagnosis?

A. Graves' disease
B. De Quervain's thyroiditis
C. Myxedema Coma
D. Hyperthyroidism

Q3: A 25-year-old female with a history of Graves' disease presents to the emergency department with a high-grade fever, profuse sweating, palpitations, and severe anxiety. Physical examination reveals a rapid heart rate and enlarged thyroid gland. Which of the following is the best next step in management?

A. Obtain T4 and TSH; begin intravenous thyroid hormone and glucocorticoid.
B. supportive therapy with IV fluids, cooling blankets, and antithyroid agents.
C. Begin intravenous antibiotics.
D. Begin rapid rewarming.