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Disorders of the Endocrine System

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Disclosures

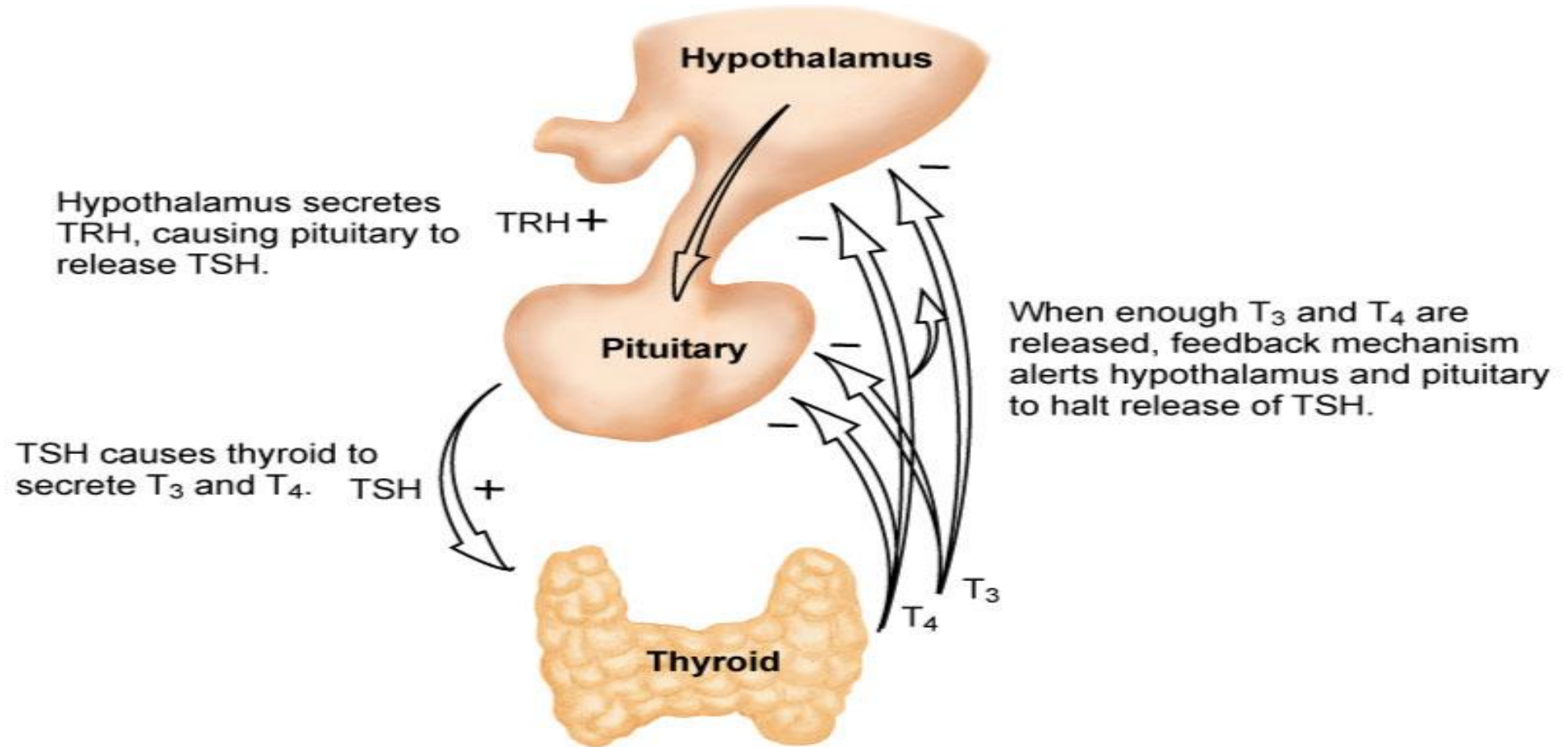
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Learning Objectives

- Describe the process of history and physical assessment of the endocrine system
- Summarize common diagnostic tests (laboratory and radiology) utilized when evaluating an endocrine concern
- Compare and contrast the pathophysiology, clinical presentation, management, and follow-up of the most common endocrine disorders seen in primary care
- Describe education needs related to the most common endocrine disorders.

Feedback Control in Hormone Production



Unn. Fig. 51-2. Feedback control in hormone production

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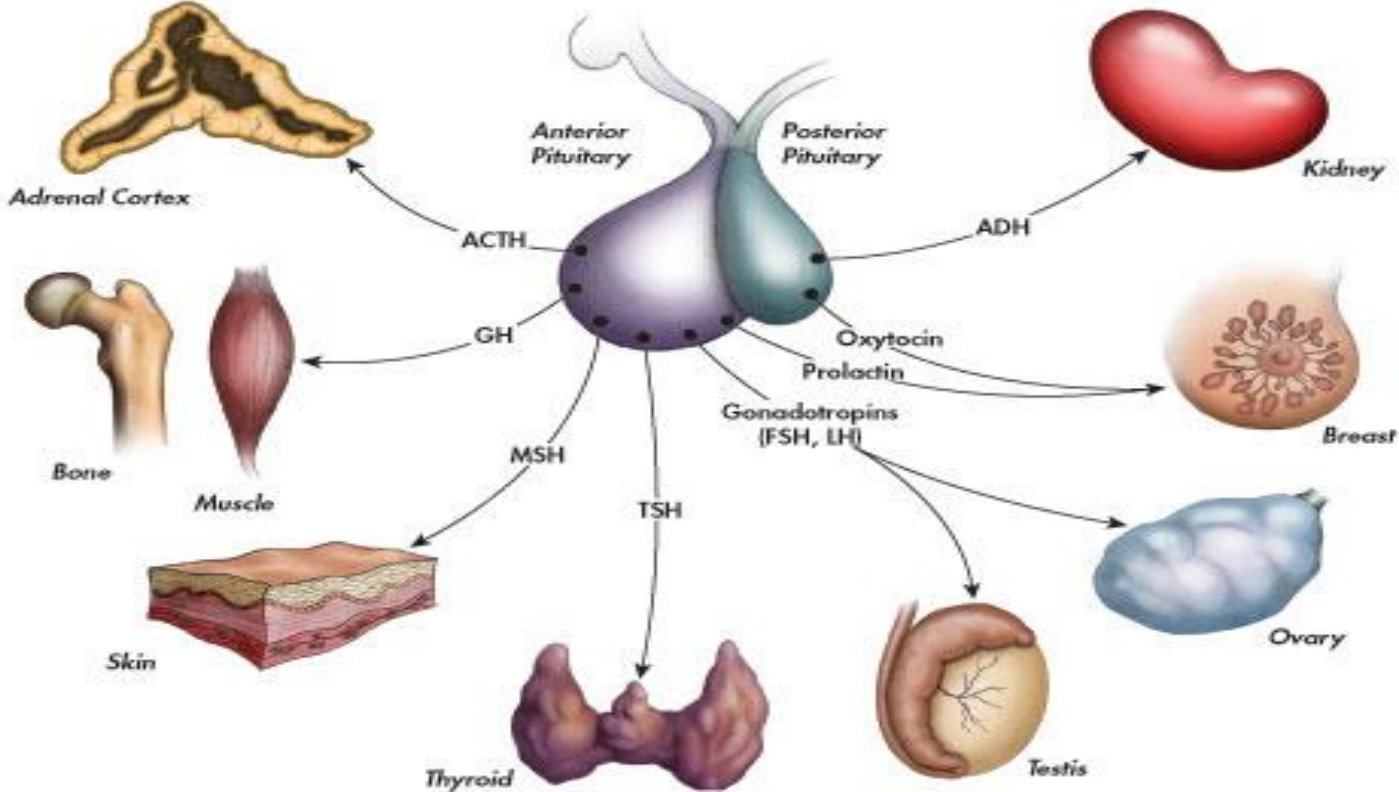
Assessment

- History
 - Growth patterns from birth/recent change
 - Medications
 - Signs/symptoms
 - Maternal exposures to iodine medication
 - Pubertal development
 - Diet/exercise history
 - Family history of endocrine/metabolic disorders
 - Unusual odors, vomiting, lethargy

Assessment

- Physical examination
 - **Stature/proportionate appearance/height age**
 - **Genitalia/sexual maturity rating**
 - Distribution/texture of hair
 - Skin for **striae/acanthosis nigricans**
 - Thyroid gland symmetry/size
 - Dysmorphic features
 - Organomegaly
 - General neurological examination

Pituitary Hormones and their Target Organs



Management

- Dietary considerations
 - Often require strict adherence to diets/restrictions
- Patient and family education
 - Understanding the nature of the disorder
 - Treatment plan
 - Possible complications
 - Plan for long-term follow-up, including transition to adult care

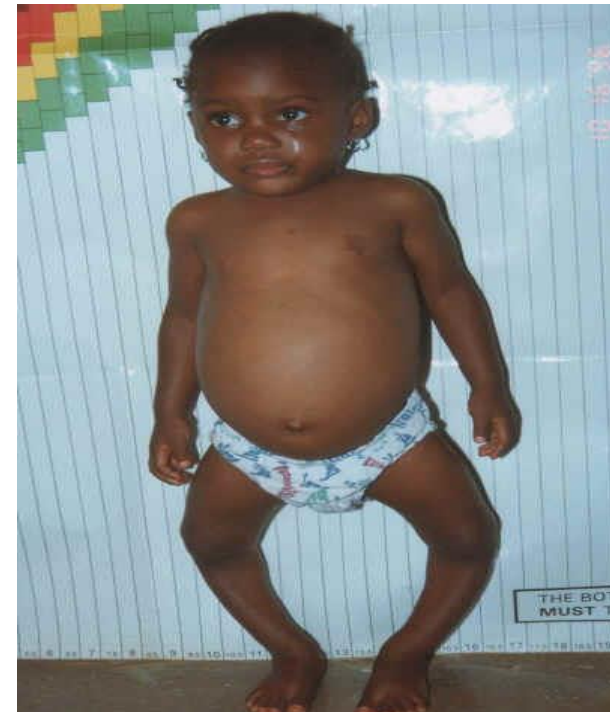
Growth Disturbances

Short stature or poor linear growth

- Any child over 2 years who is **more than 2 SD below the mean on standard growth charts or who has decreased growth velocity (falls off the growth curve)**
- 5% of the population is short
- Normal variants of short stature
 - **Familial short stature (most common)**
 - **Constitutional growth delay**

Causes of Disproportional Short Stature

- Skeletal dysplasia (dwarfism)
- Rickets



Physical Examination

- Determine if body is proportional
 - **Upper: top of head to pubic bone**
 - **Lower: from pubic bone to floor**
- Anthropometrics
- Head to toe assessment
 - Head shape, size, facial features
 - Thyroid: enlargement
 - Genitalia: penis size, Tanner staging

Laboratory Work-up for Short Stature

- Bone age (x-ray of left hand & wrist)
- CBC with differential
- Urinalysis
- ESR
- Stool O&P, occult blood, and fat
- Serum creatinine & electrolytes
- Serum calcium, phosphorus, & alkaline phosphatase
- Serum glucose, albumin, SGOT
- Sweat test (if CF is suspected)
- Somatocedin C level/growth hormone

Constitutional Growth Delay

- Key Characteristics:
 - **Not a disease – common variation**
 - **Delayed bone age with normal growth rate for bone age**
- S/S:
 - **History – normal length/weight at birth; slowed linear growth at 1-3 years; height at or just below 3rd percentile; delayed puberty; history of similar pattern in family**
- Evaluation:
 - **delayed bone age/normal growth velocity for bone age, normal neurological exam**
- Management
 - **reassurance and support**

Growth Hormone Deficiency

- Key Characteristics:
 - Inhibits somatic growth
 - Produced by pituitary gland
- S/S:
 - History – pregnancy, delivery, NB period, parents'/siblings' height/weight/growth; age when growth decelerates, chronic illness, hypothyroidism symptoms, CNS trauma
 - Physical examination – dysmorphic features, midline defects, increased cranial pressure, thyroid, puberty, measures of body proportions
- Evaluation:
 - **Definitive diagnosis based on radioimmunoassay of plasma GH levels**
 - **Hand x-rays to evaluate growth potential vs. ossification**

Growth Hormone Deficiency

- Management:
 - Referral to endocrinologist
 - **GH replacement successful in 80% of affected children**
 - **Growth rate of 3.5 to 4cm/year before treatment and increase to 8 to 9cm/year after treatment**
 - Response varies based on age, length of treatment, bone age, etc

Question 1

Short stature is considered how many standard deviations below the mean?

1. 1 SD
2. 2 SDs
3. 3 SDs
4. 4 SDs

Short stature is considered how many standard deviations below the mean?

Answer: 2 SDs

Question 2

Which one of the following is **NOT** characteristic of constitutional growth delay?

1. There is generally no history of a similar growth pattern in other family members
2. The child usually remains constitutionally small as an adult
3. Final adult stature tends to be normal
4. Weight and height at birth are generally in the lower percentiles

Which one of the following is NOT characteristic of constitutional growth delay?

Answer: The child usually remains constitutionally small as an adult

Precocious Puberty

- Key Characteristics:
 - **Early onset of puberty**
 - **Defined as sexual development before age 9 in boys or before age 8 in girls**
 - Occurs more frequently in girls
 - Potential causes:
 - Disorders of gonads, adrenal glands
 - Environmental
 - No causative factor in 80-90% of girls and 50% of boys

Precocious Puberty S/S:

Girls

- Breast development
- Pubic hair
- Axillary hair
- Enlargement of vagina, uterus, and ovaries
- Acne
- Growth spurt
- Adult body odor
- Onset of menstruation
- Moodiness

Boys

- Testicular enlargement
- Penile enlargement
- Pubic hair
- Facial hair
- Acne
- Adult body odor
- Deepening of voice
- moodiness

Management of Precocious Puberty

- Refer to pediatric endocrinologist
- **May be treated with leuprolide (Lupron)**
 - Slows pre-pubertal growth to normal rates
 - Treatment is discontinued at age for normal pubertal changes to resume
- Psychological support for child and family

Delayed Puberty

- Key Characteristics:
 - Considered **delayed** when a male 14 yrs or > or a female 13 years or > has no **clinical features of puberty**
 - Etiology: any chronic condition that delays bone age may cause delayed puberty
 - Chronic illness
 - Endocrine diseases

Delayed Puberty S/S

- Focus on clues that indicate a chronic illness, s/s of hypothyroidism, prior CNS injury or new CNS patterns
 - Pattern of growth
 - Growth velocity

Delayed Puberty

- Evaluation:
 - Screening for acute and chronic illness
 - **Bone age x-ray**
 - **Free T4 and TSH**
 - **Growth hormones**
 - **LH and FSH**

Management:

- **Refer to pediatric endocrinology**

Question 3

Precocious puberty is defined as the development of secondary sexual characteristics in boys before age _____ years and in girls before the age of _____ years.

1. 10; 10
2. 6; 8
3. 9; 8
4. 6; 5

Precocious puberty is defined as the development of secondary sexual characteristics in boys before age _____ years and in girls before the age of _____ years.

Answer: 9; 8

Thyroid



- Thyroid hormone important in:
 - Growth and development
 - Basal metabolic activity
 - Oxygen consumption
 - Brain development
 - Metabolism of lipids, carbohydrates, proteins

Hypothyroidism

- Hypothyroidism
 - Congenital
 - Acquired

Congenital Hypothyroidism

- Key Characteristics:
 - Condition is **present from birth**
 - Onset is several days to weeks after birth
 - Thyroid does not produce sufficient thyroid hormone to meet the body's metabolic demands
 - **If untreated, can lead to cognitive delay**
 - Etiology: **absent or underdeveloped thyroid gland**
 - Included on mandatory newborn screening

Congenital Hypothyroidism

- S/S:
- History often positive for:
 - Prolonged neonatal jaundice
 - Poor appetite and suck (large tongue)
 - Dyspnea with feeding
 - Constipation
 - Sluggishness
 - Hypothermia
 - Bradycardia
 - “The best baby ever...hardly ever cries”

Congenital Hypothyroidism

- S/S:
 - Birth wt and **head circumference may be increased**
 - Gen appearance: typically normal
 - Skin: **dry, thick, scaly, coarse** with jaundice
 - Hair: dry, coarse, brittle
 - MSK: **hypotonia, short extremities**

Congenital Hypothyroidism

- Evaluation:
 - All infants require **screening** for congenital hypothyroidism before discharge and **BEFORE** the 7th day of life
 - **TSH: would be elevated (indicates hypothyroidism)**
 - **FT4: low (more sensitive test)**
 - **T3: low**

Congenital Hypothyroidism Management

- **Oral Thyroid hormone replacement**
- Prompt treatment needed for brain growth in infants
- Compliance with medication regime is crucial

Acquired Hypothyroidism

- Key Characteristics:
 - Partial or complete thyroidectomy for CA
 - Following radiation from Hodgkins or other malignancy
 - **Hashimoto's thyroiditis**
 - Usually presents with a goiter
 - Result of an autoimmune process
 - Most common cause of hypothyroidism in children and adolescents

Acquired Hypothyroidism

- Key Characteristics:
 - **Dry skin**
 - Apathetic affect
 - **Sensitivity to cold**
 - Decreased appetite
 - **Lethargy**
 - **Constipation**
 - **Weight gain**
 - Difficulty with concentration
 - Poor school performance
 - Delayed puberty

Acquired Hypothyroidism

- S/S:
 - Weight (possibly overweight)
 - General appearance: sluggish
 - Skin: dry
 - Hair: coarse
 - Thyroid: usually enlarged and firm
 - Deceleration in growth

Acquired Hypothyroidism

- Evaluation:
 - TSH (increased)
 - T4 (normal or low)
 - T3 (normal or low)

Acquired Hypothyroidism Management

- Refer to Pediatric Endocrinologist
- DAILY treatment is life-long levothyroxine (Synthroid)
- Educate parents regarding the s/s of hypothyroidism(too low dose) vs. hyperthyroidism (too high dose)

Hyperthyroidism

- Key Characteristics:
 - A condition in which there is overproduction of the thyroid hormones or too much replacement
 - Most are the result of Grave's disease (autoimmune process)
- S/S:
 - History – increased appetite with weight loss, fatigue, muscle weakness, emotional lability, poor concentration, poor sleep
 - Physical examination – goiter, thyroid bruit, tachycardia, wide pulse pressure, underweight, exophthalmos, warm/moist skin, tremor, hyperreflexia

Hyperthyroidism

Graves Disease

- Most common cause of hyperthyroidism in childhood is Graves Disease
- Autoimmune condition in which excess thyroid hormones are produced by an enlarged thyroid gland
- Believed to be caused by serum thyroid-stimulating immunoglobulin
- Peak incidence 11 - 15 years of age

Hyperthyroidism

- Evaluation:
 - TSH (low)
 - Free T3 and T4 (high)
- Management:
 - Refer to pediatric endocrinologist
 - PTU to block thyroid hormone synthesis
 - Surgery (partial or complete)

Question

If you see an infant in clinic and he has a low T4 and elevated TSH for the second time the PNP should provide what information to the parents?

1. This is uncommon but it occurs more often in males than in female newborns
2. This condition needs to be treated with propylthiouracil These test results occur some times but this is nothing to worry about
3. It is important for your child to be referred to a Pediatric Endocrinologist and to begin treatment with levothyroxine to prevent cognitive delay

If you see an infant in clinic and he has a low T4 and elevated TSH for the second time the PNP should provide what information to the parents?

Answer: It is important for your child to be referred to a Pediatric Endocrinologist and to begin treatment with levothyroxine to prevent cognitive delay

Type 1 Diabetes (Insulin Dependent Diabetes)

- Key Characteristics:
 - As a result of an autoimmune process
 - there is destruction of the beta cells in the Islets of Langerhan in the pancreas
 - Markers of destruction
 - Islet Cell Antibodies (ICA)
 - Insulin Autoantibodies (IAA)

Type 1 Diabetes

- S/S:
 - Dehydration
 - Weight loss/muscle wasting
 - Tachycardia
 - If ketotic – slow, labored breathing, flushed cheeks/face, fruity-smelling breath
 - Vaginal yeast, thrush, other infection
 - *More than 50% of children diagnosed with Type 1 Diabetes are in DKA*

The image shows the cover of a New Yorker magazine. At the top, the word "New Yorker" is written in white on a red background. In the top right corner, there is a blue banner with the text "LIES ABOUT SOCIAL SECURITY BY ALLAN SLOAN" in white and yellow. The central image is a photograph of a young boy with short brown hair, wearing an orange long-sleeved shirt, holding a chocolate ice cream cone with white vanilla ice cream and eating it. The background is a plain, light-colored wall.

New Yorker

**LIES ABOUT
SOCIAL
SECURITY**
BY ALLAN
SLOAN

Fat for Life?

**Six Million Kids
Are Seriously Overweight.
What Families Can Do.**

By Geoffrey Cowley & Sharon Begley

Type 2 Diabetes

- Key Characteristics:
 - There is insulin resistance due to obesity or insulin receptor abnormalities
 - On the rise, especially in African-Americans, Hispanics, and Native Americans as a result of childhood obesity

Type 2 Diabetes

- Type 2 diabetes
 - Prevalence in youth increasing
 - Highest among American Indian youth; least common in non-Hispanic whites
 - Incidence may be underreported
 - Increased insulin resistance in tissues – hyperinsulinemia/hyperglycemia
 - Increased insulin demand – pancreas loses ability to secrete insulin effectively
 - Autoimmune destruction of beta cells does not occur
 - Growth hormone during puberty increases insulin resistance
 - Strong association with obesity, sedentary lifestyles, high-calorie, lipid-rich foods

Type 2 Diabetes

- S/S:
 - Onset (usually acute in T1DM)
 - Polydipsia, polyuria, polyphagia (and bedwetting)
 - Weight loss (T1DM)
 - Fatigue
 - Recent illness
 - Repeated infections
 - Vomiting and abdominal pain
 - Positive family history

Type 2 Diabetes

- S/S:
 - Vital signs
 - Neurologic
 - Height and weight
 - Skin (most children in ketoacidosis are 10% dehydrated)
 - Acanthosis nigricans
 - Eyes
 - Respirations (often kussmaul)
 - Deep and fast)



Diabetes Evaluation

- Symptoms of diabetes plus an elevated random plasma glucose of >200 mg/dl
 - A fasting blood glucose of >126 mg/dl on 2 occasions
 - Urine for ketones and glucose
- **1 of the 3 criteria above must be met for diagnosis of diabetes

Diabetes Evaluation

- Initial blood work: CBC with diff, venous blood gas, serum ketones, chemistry, urinalysis
- Chemistry (glucose, potassium, sodium, Ph, and serum CO₂)
- Hemoglobin A1C (every 3 months)
- Fasting serum lipid profile
- In a newly diagnosed diabetic, obtain islet cell antibodies, insulin antibodies, thyroid antibodies, thyroid function tests, and celiac markers

Question

To diagnose diabetes the NP knows a fasting serum glucose must be:

1. >126 mg/dl on 2 separate occasions
2. >200 mg/dl on 2 separate occasions
3. >126 mg/dl on 1 separate occasions
4. >200 mg/dl on 1 separate occasions

To diagnose diabetes the NP knows a fasting serum glucose must be:

Answer: >126 mg/dl on 2 separate occasions

Management of Type I Diabetes

- **Insulin and insulin administration and schedules are changing rapidly**
 - *Many children with type 1 diabetes are placed on:
 - **a fast acting insulin** (e.g., Novolog, Humalog, Apidra) with multiple daily injections to cover meals and snacks **and a long acting insulin** (e.g., Lantus/Levemir) for basal coverage
 - An A1C goal of <7.5% (58 mmol/mol) is recommended across all pediatric age-groups. (ADA)

Onset, Peak & Duration of Action for Four Main Insulin Categories

	<u>Onset (hours)</u>	<u>Peak (hours)</u>	<u>Duration (hours)</u>
Rapid	10-30min	30-90min	3-5hr
Regular	30-60min	1-3hr	6-8hr
NPH	1-2hr	4-12hr	18-24
Lantus	1-1.5hr	none	20-24

**As a result of peaks, snacks are generally needed mid-morning, mid-afternoon and at bedtime.

Management of Type 1

Insulin pumps have become very popular and are used with supplemental rapid acting insulin.

Patient sets a basal rate and then boluses at meals according to carbohydrate intake.



Other Management of Type 1 Diabetes

- **Nutrition:** The goal is to maintain normal growth and weight and to prevent obesity, hypertension, hyperlipidemia and extremes in blood glucose levels
- Adjustments of insulin dose/carb intake
- BG Monitoring: ~4 times per day
- Prevention of hypoglycemia
- Urine testing: if BG>300 twice in a row or during illness
- Regular exercise
- Child/Family Education
- Psychosocial Issues

Hypoglycemia

Signs/ Symptoms:

MILD

Tremors

Diaphoresis

Hunger

Palpitations

MODERATE

Pale, faint, weak

Headache

Rapid pulse

Irritability/sleepiness

/confusion

SEVERE

Unresponsive

Coma, convulsions

Urine: Negative

Hyperglycemia/ Ketoacidosis

Signs/ Symptoms:

Abdominal pain

Flushed, looks ill

Vomiting

Extreme thirst

Deep, rapid
respiration

Urine: +glucose

+ketones

Factors That Affect Glucose Control

- **Alcohol:** Decreases BG
- **Exercise:** Decreases BG
- **Sickness:** Increases BG
- **Stress:** Increases BG

Question

Blood glucose levels of younger children with diabetes are maintained at slightly higher levels than blood glucose levels of older children because:

1. Children have a greater need for available glucose in the blood system
2. Younger children tend to be more active
3. Younger children become more irritable than do older children
4. Lowering the risk of hypoglycemia in younger children is particularly important in order to avoid the potential for hypoglycemia with consequent neurological system damage

Blood glucose levels of younger children with diabetes are maintained at slightly higher levels than blood glucose levels of older children because:

Answer: Lowering the risk of hypoglycemia in younger children is particularly important in order to avoid the potential for hypoglycemia with consequent neurological system damage

Question

Abdominal pain and vomiting are particularly critical to monitor in children with diabetes because these findings may represent the onset of:

1. Ketoacidosis
2. Gastrointestinal infection
3. Hyperglycemia
4. Autoimmune response to the pancreas

Abdominal pain and vomiting are particularly critical to monitor in children with diabetes because these findings may represent the onset of:

Answer: Ketoacidosis

Type 2 Diabetes Management

- BG monitoring
- Diet plan
- Weight reduction
- Exercise
- Oral hypoglycemic agents as necessary
- Referral to Endocrine

Type 2 Diabetes Management

- Lifestyle changes: nutrition/exercise
 - Must be comprehensive/family based
 - Referral to registered dietician
 - Successful management may be weight maintenance, not weight loss
 - Physical activity

Question

Kevin is a 15-year-old who comes to your clinic concerned about the darkened thickened skin across the back of his neck. You know this is Acanthosis Nigricans. Kevin is also 67 inches and weighs 238 lbs. Given this historical information what laboratory testing would be most appropriate for Kevin?

1. Thyroid panel
2. Hgb A1c
3. Lipid panel
4. All of the above

Kevin is a 15-year-old who comes to your clinic concerned about the darkened thickened skin across the back of his neck. You know this is Acanthosis Nigricans. Kevin is also 67 inches and weighs 238 lbs. Given this historical information what laboratory testing would be most appropriate for Kevin?

All of the above

Overweight and Obesity

- Approximately 17% of children and adolescents aged 2—19 years are obese (CDC)
- Childhood obesity among preschoolers is more prevalent among those from lower-income families (CDC)

Etiology of Overweight/Obesity

- Genetics
- Syndromes
- Endocrine disorders (e.g., hypothyroidism)
- Medications (e.g., Risperdol; Zyprexa, Depakote)
- Psychosocial/mental health (e.g., depression, anxiety disorders)
- Environmental
- Lifestyle behaviors and habits

Management

- Balanced diet (avoid concentrated sugar)
- Exercise (goal is 60 minutes daily; start low and work up)
- Behavior modification
- D&E only for first 6 months
- Treat the child in the context of the family (evidence from studies indicates the best treatment is when both child and parents receive interventions)
- Monitor for comorbidities

Complications

- Hypertension
- Osteoarthritis
- Ovarian dysfunction
- Hyperandrogenism
- Insulin resistance/
 - impaired glucose tolerance
- Increase GER
- Gallbladder disease
- Sleep apnea
- Fatty liver
- Low self-esteem and depression
- Increased asthma symptoms
- Metabolic syndrome