Endocrine Dysfunction in Children

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Instructional Module 5

Endocrine System Overview

- Controls & Regulates Metabolism
  - Energy production
  - Growth
  - Fluid & electrolyte balance
  - Response to stress
  - Sexual development

Hormones

- Chemical substances our bodies produce which control/regulate activities of other cells/organs
  - most released by endocrine glands into bloodstream
  - production regulated by feedback mechanism
- Master gland of endocrine system - Anterior Pituitary
  - controlled by hypothalamus
- Some hormones regulated by other mechanisms (insulin)

Disorders of Pituitary Function

- Hypopituitarism
  - Diminished secretion of one or more pituitary hormones
    - Gonadotropin deficiency
    - Growth hormone (GH) deficiency
    - Thyroid-stimulating hormone (TSH) deficiency
    - Adrenocorticotropic hormone (ACTH) deficiency
  - Consequences depend on degree of dysfunction
  - Clinical manifestations depend on
    - Hormones involved
    - Age

Disorders of Pituitary Function

- Causes of Hypopituitarism
  - Tumors
  - Incomplete/underdevelopment of pituitary gland or hypothalamus
  - Congenital
  - Surgery
  - Radiation
  - Trauma
  - Autoimmune
  - Idiopathic

Growth Hormone Deficiency

- Clinical Manifestations
  - Normal growth during 1st year
  - Slowed growth curve after 1st year - below 3rd percentile
  - Height may be stunted more than weight
  - Skeletal proportions normal for age
  - Primary teeth appear at normal age; permanent teeth delayed
  - Teeth overcrowded and malpositioned
  - Delayed sexual development

Growth Hormone Deficiency

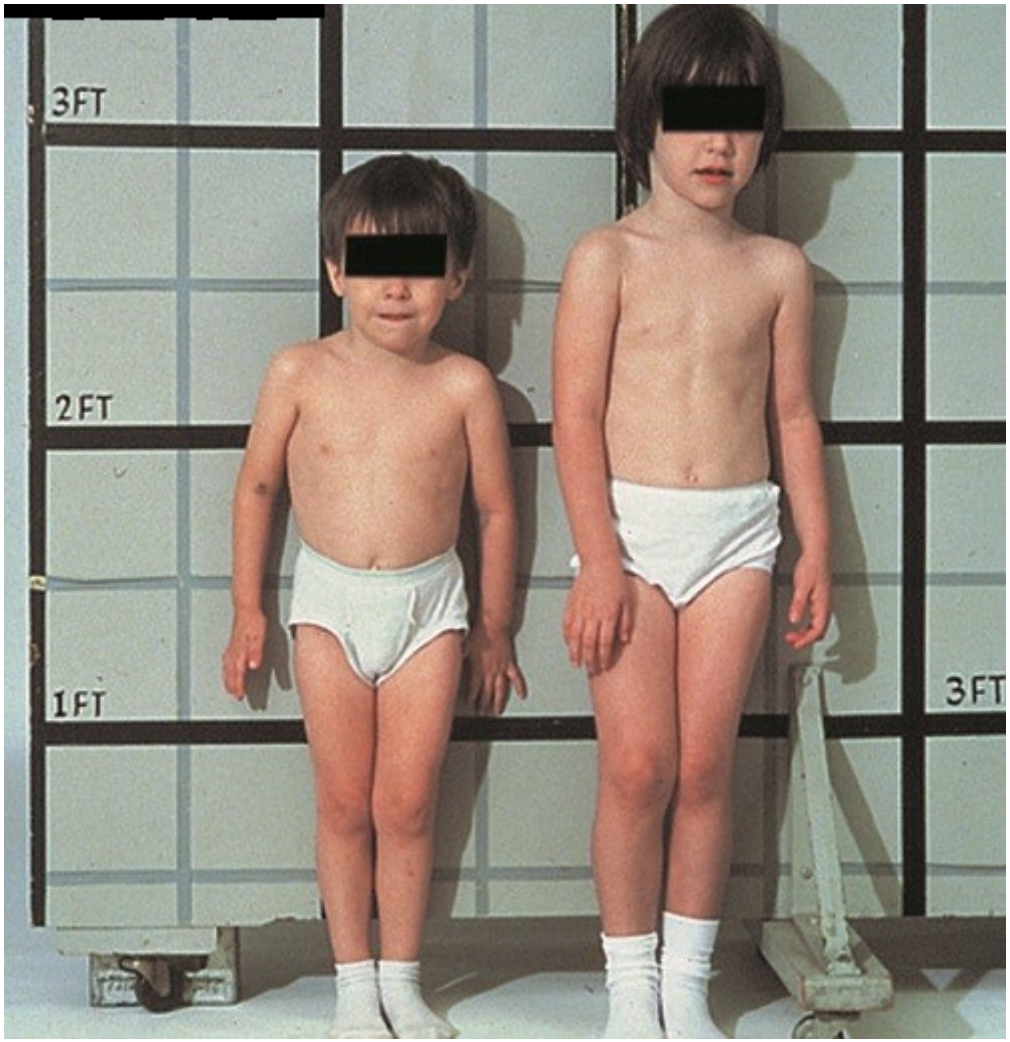
- Diagnosis
  - Family history
  - Physical exam
  - X-rays/MRI
  - Endocrine studies
  - Genetic testing

CCH Pediatric Growth Hormone Stimulation Test Time Sheet

Start Time	Blood Pressure/Glucose	**Notify NP of admission** **Start Large Bore IV & draw labs** Put Admission Labs In Meditech: -POC Glucose, BMP, CBC -Cortisol Random -Growth Hormone GH RL, IGFB3 -IGF I LC MS RL, Sed. Rate **Start Ordered MIVFs**	Time **Completed**
0 minutes	Blood Pressure	**Meds:** -Cosyntropin and Clonidine Make copy of Orders/Time sheet **and tube to Lab**	**Time Completed**
30 minutes	**Blood Pressure**	Labs: -HGHL & Cortisol Random	**Time Completed**
60 minutes	**Blood Pressure**	Labs: -HGHL - Cortisol Random	**Time Completed**
90 minutes	Blood Pressure/Glucose	Labs: -HGHL -Glucose Random -POC Glucose **Meds:** Arginine over 30 min (Stop MIVF during Infusion)	**Time Completed**
105 minutes	Blood Pressure/Glucose	Labs: -HGHL -Glucose Random -POC Glucose	**Time Completed**
120minutes	Blood Pressure/Glucose	**Labs:** -HGHL -Glucose Random -POC Glucose	**Time Completed**
150 minutes	Blood Pressure/Glucose	Labs: -HGHL -Cortisol Random -Glucose Random -POC Glucose	**Time Completed**

Date/Time:

Place Patient Label Here



Retrieved from
https://journals.lww.com/neurotodayonline/blog/breakingnews/Pages/post.aspx?PostID=350

Growth Hormone Deficiency

- Therapeutic Management
  - Correct underlying disease process
  - Growth Hormone replacement
    - Biosynthetic growth hormone
    - Very expensive
- Child and Family Support
  - Human Growth Foundation
    - Research, education, support groups, bully prevention

Disorders of Pituitary Function

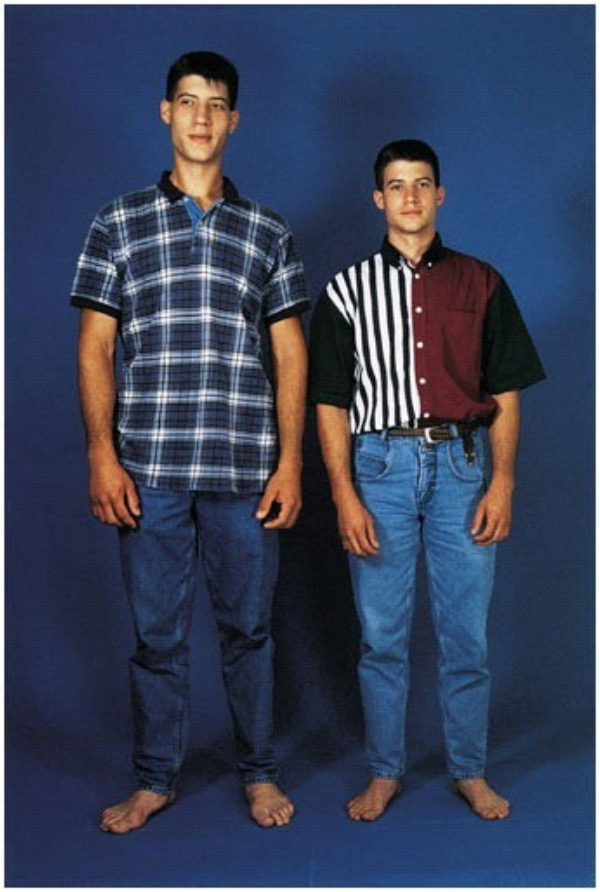
- Hyperpituitarism
  - Overproduction of anterior pituitary hormone
    - Caused by
      - Hyperplasia of pituitary cells
      - Primary hypothalamic defect
    - Clinical Manifestations
      - Gigantism
      - Hyperthyroidism
      - Hypercortisolism
      - Precocious puberty

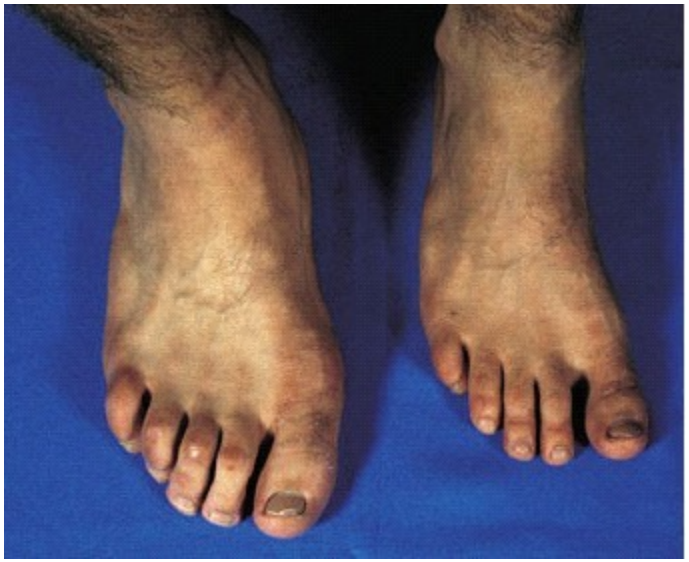
Growth Hormone Excess

- Clinical Manifestations **Before** growth plate closure
  - Proportional overgrowth of long bones
  - Rapid & increased muscle development
  - Weight increase in proportion with height
  - Proportional head enlargement
    - Delayed fontanel closure in young children

Growth Hormone Excess

- Clinical Manifestations **After** growth plate closure
  - Growth in transverse direction
    - Acromegaly
      - Overgrowth of head, lips, nose, tongue, jaw, and paranasal and mastoid sinuses
      - Separation and malocclusion of teeth
      - Disproportion of face to cerebral division of the skull
      - Increased facial hair
      - Thickened, deeply creased skin
      - Increased tendency toward hyperglycemia & DM





A 22-year-old man with gigantism due to excess growth hormone is shown to the left of his identical twin. The increased height and enlarged foot of the affected twin are apparent. Their clinical features began to diverge at the age of approximately 13 years. (Harrison 2005)

Retrieved from group14.pbworks.com/w/page/16025094/pituitary%20gigantism

Growth Hormone Excess

- Diagnosis
  - History of excessive growth
  - Increased levels of GH
  - Normal bone age
  - Enlargement of bones
  - Endocrine studies

- Therapeutic Management
  - Removal of tumor/lesion if present
  - External radiation or radioactive implants
  - Pharmacologic agents

Precocious Puberty

- Early onset of sexual development
  - Before age 9 in boys
  - Before age 7 in Caucasian girls
  - Before age 6 in African-American girls

- Three types
  - Central
  - Peripheral
  - Incomplete

Precocious Puberty

- Therapeutic Management
  - Treat specific cause if known
    - MRI
  - Synthetic hormones
    - Lupron Depot injections
    - histrelin implant

- Goal of Therapy
  - Slow/stop pubertal progression
  - Allow for normal adult height

Precocious Puberty

- Nursing Considerations
  - Education regarding injections & side effects
  - Emotional support
  - Provide privacy during physical examination
  - Family education
    - Expression of concerns by the child
    - Dress according to chronological age
    - Reassurance regarding physiologic changes
    - Child's social, cognitive, & emotional development match chronological age although physical development is advanced

Posterior Pituitary Disorders

- Diabetes Insipidus (DI)
- Syndrome of Inappropriate Antidiuretic Hormone (SIADH)

Diabetes Insipidus (DI) (Neurogenic DI)

- **Hypo**function of the Posterior Pituitary
  - **Under**secretion of Antidiuretic Hormone (ADH)
    - ADH (vasopressin)
  - Produces uncontrolled diuresis

Diabetes Insipidus (DI) (Neurogenic DI)

- Causes
  - Primary
    - Familial
    - Idiopathic
  - Secondary
    - Trauma
    - Tumors
    - Autoimmune disease
    - CNS infections
    - Cranial malformations
    - Vascular anomalies

Diabetes Insipidus (DI) (Neurogenic DI)

- Clinical Manifestations
  - Cardinal signs: **Polyuria & Polydipsia**
  - Older child
    - Excessive urination accompanied by insatiable thirst
    - 1st sign often enuresis
  - Infants
    - Irritability relieved by WATER not milk
    - Prone to dehydration/electrolyte imbalance
    - May see vomiting, constipation, fever, irritability, sleep issues, failure to thrive & growth problems

Diabetes Insipidus (DI) (Neurogenic DI)

- Diagnosis
  - Water deprivation test
    - Restrict oral fluids
    - Observe for changes in urine volume & concentration
    - Strict monitoring of fluid intake, urine output, urine concentration & weights
  - If positive, follow with test dose of vasopressin
    - Polyuria & polydipsia should be alleviated

Diabetes Insipidus (DI) (Neurogenic DI)

- Therapeutic Management
  - Hormone replacement (vasopressin)
    - Drug of choice: desmopressin (DDAVP)
    - Lifelong treatment

- Family education
  - DI is different than DM
  - Treatment is lifelong
  - Correct preparation and administration of DDAVP
  - Child should wear medical alert ID
  - Carry DDAVP nasal spray with them

Syndrome of Inappropriate Antidiuretic Hormone (SIADH)

- Hyperfunction of posterior pituitary
  - Oversecretion of antidiuretic hormone (ADH)
  - Excess ADH causes free water to be reabsorbed from kidneys
  - Causes
    - Infections
    - Tumors
    - CNS disease
    - Trauma

Syndrome of Inappropriate Antidiuretic Hormone (SIADH)

- Clinical Manifestations – r/t fluid retention and hyponatremia
  - ↓ serum osmolality with inappropriately ↑ urine osmolality
  - Serum Sodium levels 120 mEq/L
    - Anorexia
    - Nausea
    - Vomiting
    - Stomach cramps
    - Irritability
    - Personality changes

Syndrome of Inappropriate Antidiuretic Hormone (SIADH)

- Clinical Manifestations (cont.)
  - Progressive decrease in sodium
    - Stupor
    - Seizures
- Therapeutic Management
  - Fluid restriction
    - ¼ - ½ of maintenance
  - Possibly sodium replacement
  - Correction of underlying disorder (infection, tumor resection, etc.)

Syndrome of Inappropriate Antidiuretic Hormone (SIADH)

- Nursing Care
  - Early recognition of S/S
  - I & O
  - Daily weight
  - Watch for S/S of fluid overload
  - Seizure precautions
  - Educate patient and family regarding fluid restriction

Diabetes Insipidus vs. SIADH

Diabetes Insipidus (DI) ↓	Syndrome of Inappropriate Antidiuretic Hormone (SIADH) ↑
↑ Levels of ADH	↓ Levels of ADH
↑ Urine Output	↓ Urine Output
Serum Sodium	Serum Sodium
Dehydrated	Over hydrated
Lose too much fluid	Retain too much fluid

Disorders of Thyroid Function

- Juvenile Hypothyroidism
  - Common endocrine problem of childhood
  - Congenital
    - Congenital hypoplastic thyroid gland
  - Acquired
    - Partial/complete thyroidectomy
    - Following radiation treatment
    - Infectious processes
    - Dietary iodine deficiency

Juvenile Hypothyroidism

- Clinical Manifestations
  - Thyromegaly
  - Decelerated growth
  - Myxedematous skin changes
  - Constipation
  - Sleepiness
  - Lethargy
  - Mental decline
  - Delayed puberty
  - Excessive weight gain

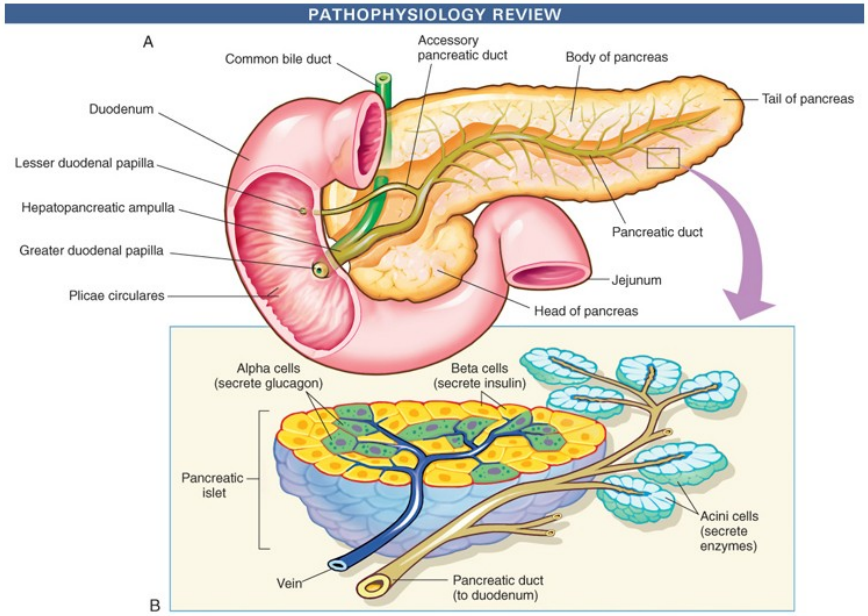
Juvenile Hypothyroidism

- Therapeutic Management
  - Oral thyroid hormone replacement
  - Prompt treatment in infants to facilitate brain growth
  - Lifelong treatment

- Education for Family
  - Daily compliance with medication
  - Need for periodic monitoring of serum thyroid levels

Disorders of Pancreatic Hormone Function

- Review
  - Islets of Langerhans
    - Alpha cells
    - Beta cells
    - Delta cells

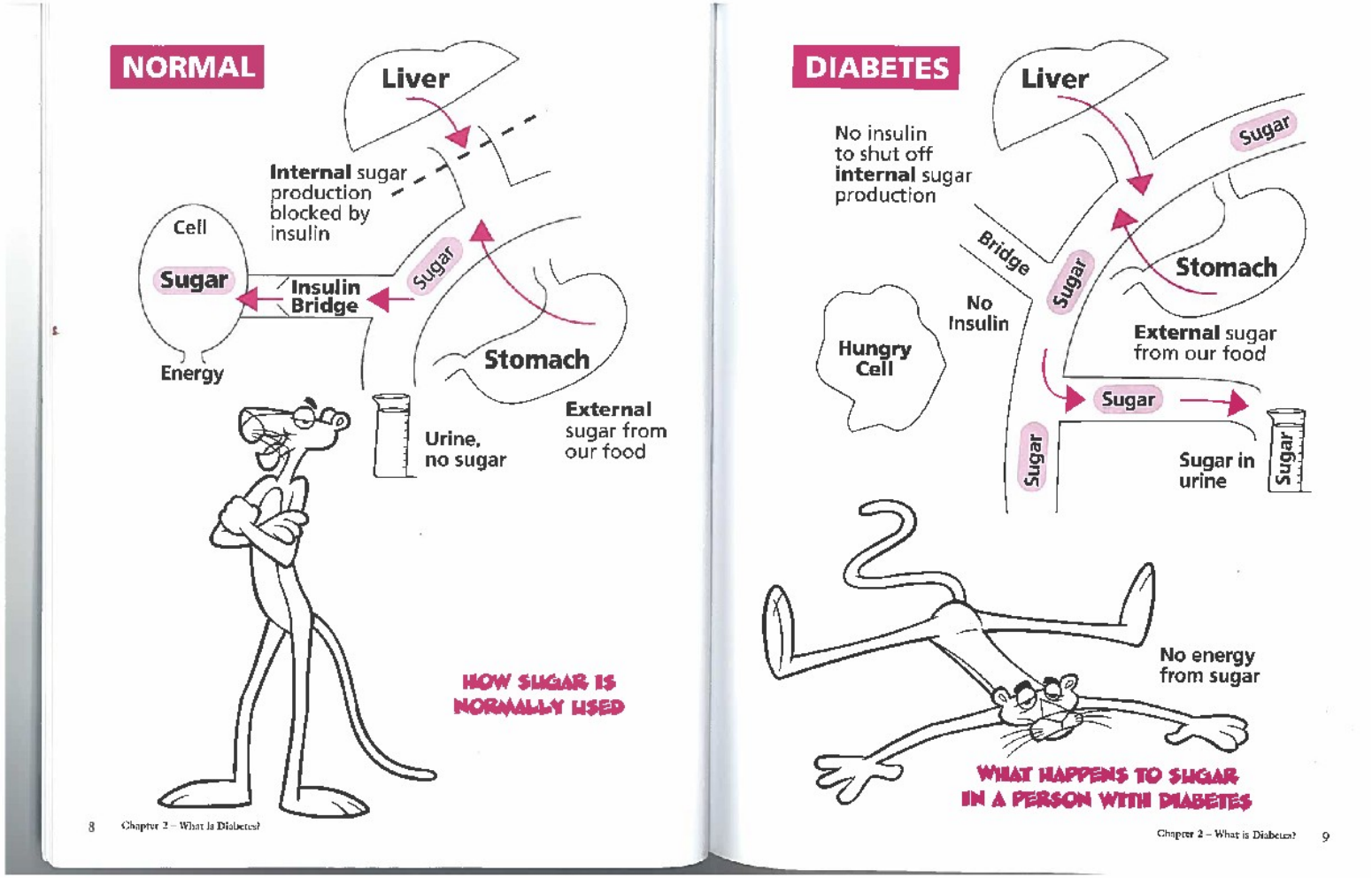


From Patton KT, Thibodeau GA: *Anatomy and physiology*, ed 7, St. Louis, 2010, Mosby.

Diabetes Mellitus

- Chronic disorder of metabolism
- Characterized by **hyper**glycemia and insulin resistance
  - Impairs body's ability to use food for energy
- Most common metabolic disease
- No cure

Diabetes Mellitus



Chase, H. P., & Maahs, D. M. (2014). *A first book for understanding diabetes*. (13th ed.). Denver, CO: Children's Diabetes Foundation at Denver, Colorado.

Diabetes Mellitus

Type 1

- Destruction of pancreatic beta cells
- Absolute insulin deficiency
- Two forms
  - Immune-mediated DM
    - Autoimmune destruction of beta cells
  - Idiopathic
    - No known cause
- Not simple inheritance
  - Genetic predisposition **plus** trigger event

Type 2

- Relative insulin deficiency
  - Insulin resistance
  - Body fails to use insulin properly
- Typically more common in adults > 45 years of age, overweight & sedentary, with family history of DM
- Increasing prevalence in children/adolescents

Diabetes Mellitus

Type 1

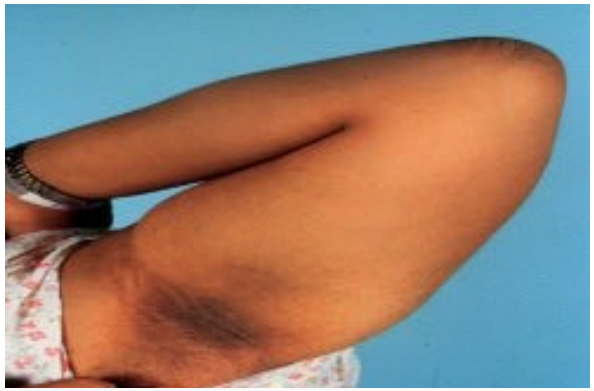
- Signs and symptoms
  - **Polyuria**
  - **Polydipsia**
  - **Polyphagia**
  - Hyperglycemia
  - Rapid weight loss
  - Dry skin
  - Irritability
  - Drowsiness/fatigue
  - Abdominal discomfort
  - Ketoacidosis

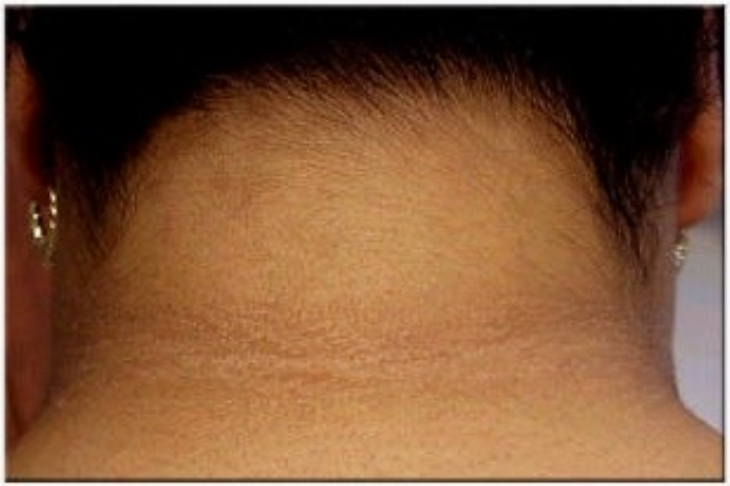
Type 2

- Signs and symptoms
  - Polyuria
  - Polydipsia
  - Fatigue
  - Blurred vision
  - Slow-healing sores
  - Frequent infections
  - Areas of darkened skin (acanthosis nigricans)
  - Polycystic ovary syndrome

Diabetes Mellitus

- Acanthosis nigricans





http://www.primehealthchannel.com/acanthosis-nigricans-pictures-symptoms-causes-and-treatment.html

Diabetes Mellitus

Type 1

- Treatment – Team Approach!
  - Insulin
  - Monitor glucose levels
  - Lifestyle changes
    - Nutrition
    - Exercise

Type 2

- Treatment
  - Lifestyle changes
    - Nutrition
    - Exercise
  - Oral medication
  - Possibly insulin
  - Monitor glucose levels

Diabetes Mellitus

- Diagnosis
  - 8-hour fasting blood glucose level ≥126 mg/dl
  - Random blood glucose ≥ 200 mg/dl with classic s/s of diabetes
  - Oral glucose tolerance test ≥ 200 mg/dl in the 2-hour sample
  - Hemoglobin A1C ≥ 6.5%

Types of Insulin

- Based on
  - Onset
  - Peak
  - Duration
- 4 types
  - Rapid
  - Short
  - Intermediate
  - Long
- Mixed
  - Combination of intermediate & rapid-acting

Types of Insulin

- **Rapid**
  - Give within 15 minutes of a meal
- **Short**
  - Give 30 minutes before a meal
- **Intermediate**
  - Cloudy
- **Long acting**
  - *Cannot* be mixed in a syringe with any other insulin

⇨ All types = 100 units/ml

Insulin Dosing

- Conventional management = twice daily dosing
  - Rapid/short acting mixed with intermediate acting
  - Given prior to breakfast and supper
- Intensive therapy - multiple injections
  - Long acting once or twice daily plus rapid acting prior to each meal
  - Better control, fewer long-term complications

Insulin Administration

- Subcutaneous administration
- Rotate sites
- Insulin absorption

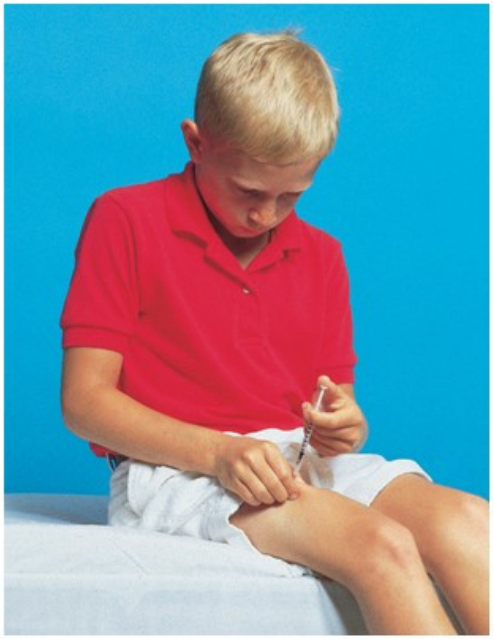
Pinching the skin to give an insulin injection. A small pinch with the finger and thumb is enough.

Insulin injection sites:

- Outer arm
- Abdomen
- Hip area
- Thigh

Insulin Administration

- **Complications**
  - Lipoatrophy
  - Lipohypertrophy



Insulin Administration

- **Insulin pen**
  - Needle is screwed onto tip immediately prior to injection

Insulin Administration

- **Insulin pump**
  - Computerized device
  - As close to normal insulin delivery as possible
  - Site changed/rotated every 48-72 hours
  - Drawbacks

Insulin Administration

- Absorption can be altered
  - Exercise
  - Illness
- Self monitoring is a must!

Monitoring

- Self- blood glucose monitoring
  - At home & in hospital
  - Goal - blood glucose 80-120 mg/dl

- Glycosylated hemoglobin (Hgb A1C)
  - Typically levels of 6.5%-8% are acceptable

Monitoring

- Finger sticks / Atraumatic care
  - Warm the finger
  - Use the ring finger and thumb
  - Puncture to the side of the finger pad
  - Press lancet device lightly against skin
  - Use lancet device with adjustable-depth tips
  - Use glucose monitors that require small samples

Complications

Hyperglycemia

- Caused by
  - Too little insulin
  - Illness/infection
  - Injury
  - Stress- physical/emotional
  - Growth
  - Medications
  - Menses

Complications

- **Hyperglycemia**
  - Symptoms
    - Thirst
    - Polyuria (early)
    - Nausea
    - Blurred vision
    - Fatigue
    - Diabetic ketoacidosis
  - Treatment
    - Drink fluids
    - Administer additional insulin
    - Monitor glucose more closely

Complications

- **Hypoglycemia**
  - Caused by
    - Too much insulin
    - Diet
    - Exercise
    - Growth spurts
    - Puberty
    - Illness (esp. with vomiting)

Complications

- **Hypoglycemia**
  - Symptoms (Mild to Moderate)
    - Shaky/sweaty
    - Hungry
    - Pale
    - Headache
    - Confusion
    - Disorientation
    - Lethargy
    - Change in behavior
  - Symptoms (Severe)
    - Inability to swallow
    - Seizure/convulsion
    - Unconsciousness

Complications

- **Hypoglycemia**
  - Treatment
    - Often difficult to differentiate **HYPO** from **HYPERglycemia**
    - Check blood sugar if possible
    - When in doubt, give simple carbohydrate
    - Follow with complex carbohydrate, then protein
    - **If unconscious, seizes, or cannot swallow**
      - Glucagon
        - Mixed and given IM/SQ
        - Releases stored glycogen from liver
        - Should increase blood glucose in 15 minutes
        - Can cause nausea/vomiting
        - Protect from aspiration

Long-term Complications

- **Vascular changes**
  - Involve large and small vessels
  - Heart disease
  - Retinopathy
  - Neuropathy
  - Arterial obstruction
    - Gangrene

Education

- **Always carry**
  - Glucose tablets
  - Insta-glucose
  - Sugar cubes
  - Candy

- **Exercise**
  - With good control
    - Decreases insulin requirements
  - With poor control
    - May stimulate ketoacidosis

Education

- **Nutrition**
  - Sufficient calories to balance daily expenditure for energy and growth
  - Constant carbohydrate diet-exchange system
  - Consistent intake/timing of food
  - Timing of food coincides with time/action of insulin
  - Total # of calories/proportions of basic nutrients needs to be consistent day to day

Education

- Type 1 Diabetes
  - Allow toddler and preschooler to make food choices - monitor Carbohydrates
  - Monitor temper tantrums as possible signs of hypoglycemia
  - Snacks should be available during increased activity such as sports activities

Education

- Eyeballing portion size
  - 1 ounce of cheese is as big as 4 dice
  - ½ cup of rice is as big as half a baseball
  - A 4-ounce bagel is the size of a hockey puck
  - 3 ounces of meat is as big as a deck of cards
  - 2 tablespoons of peanut butter is about a Ping-Pong ball
  - 1 cup of pasta equals a tennis ball

Education

- **Illness management**
  - Monitor glucose every 3 hours
  - Monitor urine ketones every 3 hours or when glucose is > 240 mg/dl
    - Urine ketones are not used for daily management

Diabetic Ketoacidosis

- Most complete state of insulin deficiency
- Life-threatening situation

- Lack of insulin → glucose unavailable for cellular metabolism → body burns fat for energy → fat breaks down into fatty acids → glycerol in fat cells converted to ketones in liver → excess eliminated in urine (ketonuria) or lungs (acetone breath)
- Ketones in blood (ketonemia) are strong acids lowering pH producing ketoacidosis

Diabetic Ketoacidosis

- With cellular death
  - Potassium released from cells (intracellular) into bloodstream (extracellular fluid) and excreted by kidneys
  - Total body potassium decreased even though serum potassium may be elevated (decreased circulating fluid volume)
  - Alteration in serum and tissue potassium can lead to cardiac arrest
  - If not reversed by insulin therapy/fluid & electrolyte correction, progressive deterioration occurs (dehydration, electrolyte imbalance, acidosis, coma, death)

Diabetic Ketoacidosis

- Management
  - Rapid assessment
  - Adequate insulin
  - Fluids
  - Electrolyte replacement (especially potassium)
  - PICU
    - IV X2
    - Cardiac monitor
    - Labs
    - Possible O2
    - Possible NG (unconscious pt)
    - Possible antibiotics
- Happens most frequently with infection

References

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