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# Chapter 31

## The Child with a Metabolic Condition



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# Objectives

- “ Relate why growth parameters are of importance to patients with a family history of endocrine disease.
- “ List the symptoms of hypothyroidism in infants.
- “ Discuss the dietary adjustment required for a child with diabetes insipidus.
- “ Compare the signs and symptoms of hyperglycemia and hypoglycemia.

## Objectives (cont.)

- “ Differentiate between type 1 and type 2 diabetes.
- “ List three precipitating events that might cause diabetic ketoacidosis.
- “ List a predictable stress that the disease of diabetes has on children and families during the following periods of life: infancy, toddlers, preschool age, elementary school-age, puberty, and adolescence.



## Objectives (cont.)

- “ Outline the educational needs of the diabetic child and parents in the following areas: nutrition and meal planning, exercise, blood tests, administration of insulin, and skin care.
- “ List three possible causes of insulin shock.
- “ Explain the Somogyi phenomenon.
- “ Discuss the preparation and administration of insulin to a child, highlighting any differences between pediatric and adult administration.



# Endocrine System

“ Two major control systems that monitor the functions of the body are the

- Nervous system
- Endocrine system

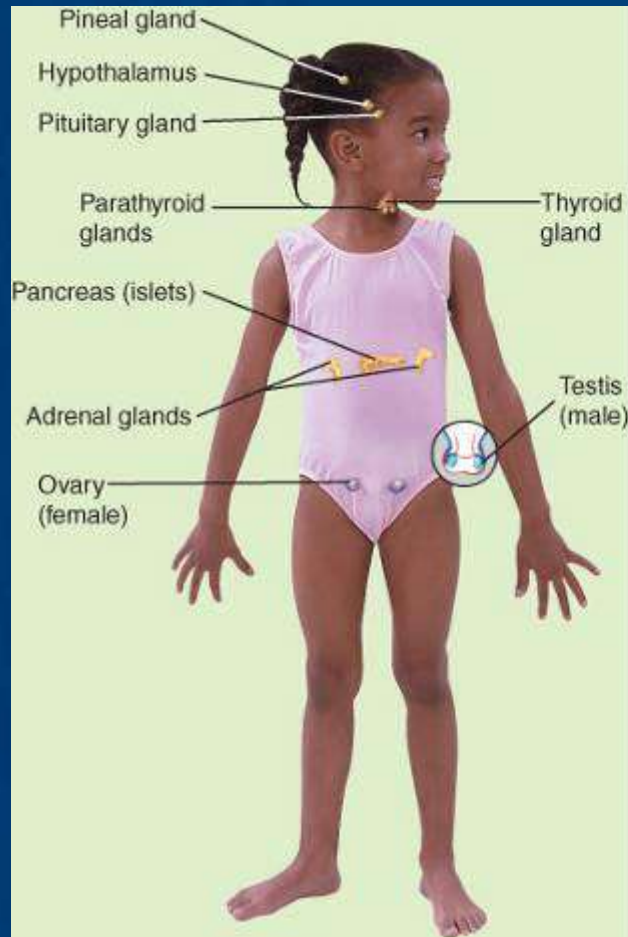
“ These systems are interdependent

“ Endocrine (ductless) glands regulate the body's metabolic processes

“ Primary responsibilities

- Growth
- Maturation
- Reproduction
- Response of the body to stress

# Endocrine System (cont.)



## ENDOCRINE SYSTEM

- The endocrine system of the newborn is supplemented by maternal hormones that cross the placental barrier. In males and females, this may result in swelling of the breasts and genital changes.
- Hormone disturbances during childhood may cause disrupted growth patterns, resulting in short stature or gigantism.
- Congenital hypothyroidism may occur as a result of an absent, nonfunctioning thyroid gland.
- In childhood the pancreas may be deficient in insulin, causing type I (insulin-dependent) diabetes.





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# Endocrine System (cont.)

## “ Hormones

- Chemical substances produced by the glands
- Secreted directly into the blood
- An organ specifically influenced by a certain hormone is called a *target organ*
- Too much or too little can result in disease



## Endocrine System (cont.)

- “ The absence or deficiency of an enzyme that has a role in metabolism causes a defect in the metabolic process
- “ Most inborn errors of metabolism can be detected by clinical signs or screening tests that can be performed in utero
  - Lethargy, poor feeding, failure to thrive, vomiting, and an enlarged liver may be early signs of an inborn error of metabolism in the newborn





## Endocrine System (cont.)

- “ If clinical signs are not manifested in the neonatal period, an infection or body stress can precipitate symptoms of a latent defect in the older child
- “ Unexplained mental retardation, developmental delay, convulsions, an odor to the body or urine, or episodes of vomiting may be subtle signs of a metabolic dysfunction



## Endocrine System (cont.)

- “ Studies that can help in the diagnosis
  - Radiographic
  - Serum blood screening tests
    - “ Phenylketonuria (PKU)
    - “ Chromosomal studies
  - Tissue biopsy
  - Thyroid function
  - Ultrasound
  - 24-hour urine specimen



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# Inborn Errors of Metabolism



# Tay Sachs Disease

- “ Deficiency of *hexosaminidase* , an enzyme necessary for the metabolism of fats
  - Lipid deposits accumulate on nerve cells causing physical and mental deterioration
  - Primarily found in the Ashkenazic Jewish population
  - Autosomal recessive trait



## Tay Sachs Disease (cont.)

- “ Infant appears normal until about 5-6 months of age when physical development begins to slow (head lag or an inability to sit)
- “ As it progresses, blindness and mental retardation develop
- “ Most children with Tay-Sachs die before 5 years of age due to secondary infection or malnutrition
- “ There is no treatment
- “ Nursing care is mainly palliative
- “ Carriers can be identified by screening tests in the first trimester



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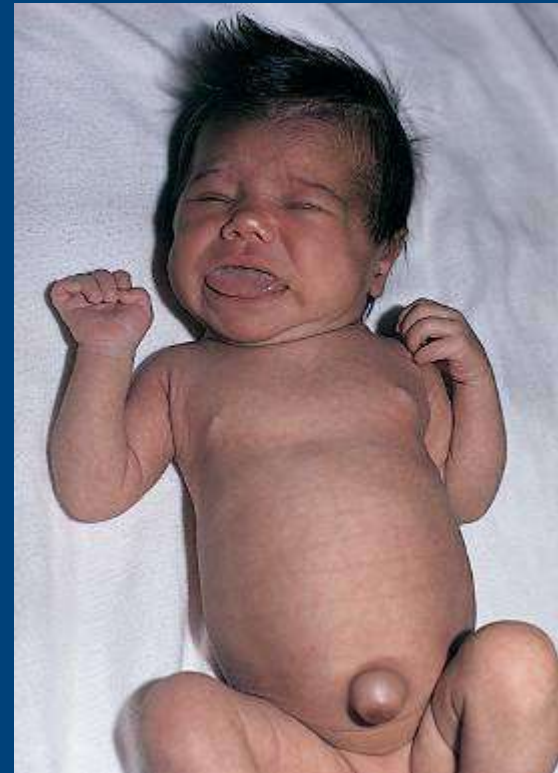


# Endocrine Disorders



# Hypothyroidism

- “ Deficiency in hormone secretions of the thyroid gland
- “ May be congenital or acquired
  - In congenital, the gland is absent or not functioning
- “ More common endocrine disorders in children
- “ Controls metabolism in the body
- “ Symptoms may not be apparent for many months





# Manifestations of Hypothyroidism

- " Infant is very sluggish and sleeps a lot
- " Tongue becomes enlarged, causing noisy respiration
- " Skin is dry, no perspiration
- " Hands and feet are cold
- " Infant feels floppy when handled
- " Chronic constipation
- " Hair eventually becomes dry and brittle
- " If left untreated, irreversible mental retardation and physical disabilities result



# Juvenile Hypothyroidism

- “ Juvenile hypothyroidism acquired by the older child
  - Most often caused by lymphocytic thyroiditis
  - Often appears during rapid growth period
- “ Symptoms and diagnosis similar to congenital hypothyroidism
- “ Because brain growth is nearly complete by 2 to 3 years of age, mental retardation and neurological complications are not seen in the older child



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# Screening for Hypothyroidism

“ A screening test for hypothyroidism is mandatory in the U.S. and is performed at birth



# Treatment for Hypothyroidism

- “ Administration of synthetic thyroid hormone
- “ Serum hormone levels monitored regularly
- “ Therapy reverses symptoms and, in the infant, prevents further mental retardation but does not reverse existing retardation
- “ Children may experience temporary, reversible hair loss, insomnia, aggressiveness, and their schoolwork may decline during the first few months of therapy
- “ Hormone replacement for hypothyroidism is lifelong



## Treatment for Hypothyroidism (cont.)

### “ Signs of too much thyroid replacement

- Rapid pulse rate
- Dyspnea
- Irritability
- Weight loss
- Sweating

### “ Signs of too little thyroid replacement

- Fatigue
- Sleepiness
- Constipation

### “ Parents should be instructed about both





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# Diabetes Insipidus



# Diabetes Insipidus: Pituitary Gland (Anterior)

Problem	Hormone	Manifestation	Therapy
Decreased: hypopituitarism	Growth hormone (GH)	Short stature, dwarfism	Synthetic GH replacement
Increased: hyperpituitarism		Before epiphyseal closure, gigantism  After epiphyseal closure, acromegaly  Sexual precocity (puberty before 8 to 9 years of age)	Surgery, irradiation  Radioactive implants  Monthly hormone injections to control secretions until puberty



# Diabetes Insipidus: Pituitary Gland (Posterior)

Problem	Hormone	Manifestation	Therapy
Decreased: hypopituitarism	Decreased antidiuretic hormone	Diabetes insipidus: uncontrolled diuresis	Vasopressin by injection or nasal spray  Provide adequate fluids
Increased: hyperpituitarism (syndrome of inappropriate antidiuretic hormone secretions [SIADH])	Increased antidiuretic hormone	SIADH	Fluid restriction and hormone antagonists



# Parathyroid Gland Disorders

Problem	Hormone	Manifestation	Therapy
Decreased: hypoparathyroidism	Decreased parathormone	Decreased blood calcium and increased phosphorus levels, causing tetany and laryngospasm	Calcium gluconate, vitamin D supplements
Increased: hyperparathyroidism	Increased parathormone	Elevated blood calcium and lowered phosphorus levels, causing spontaneous fractures and CNS problems	Restore calcium balance, excise tumor



# Adrenal Gland Disorders

Problem	Hormone	Manifestation	Therapy
Decreased: adrenal cortical insufficiency (Addison's disease)	Decreased steroids, sex steroids, epinephrine	Craving for salt, seizures, neurological and circulatory changes, decreased sexual development	Replace cortisol and body fluids, genetic sexual assessment
Increased: hyperadrenalism (Cushing's disease)	Increased cortisol	Cushing's syndrome, hyperglycemia, electrolyte problems, pheochromocytoma	Depends on cause, tumor removal



# Diabetes Mellitus (DM)

- “ Chronic metabolic syndrome. the body is unable to use carbohydrates properly
  - . Leads to impairment of glucose transport
- “ Body unable to store and use fats properly
- “ Decrease in protein synthesis
- “ When blood glucose level becomes dangerously high
  - . Glucose spills into the urine
  - . Diuresis occurs





## Diabetes Mellitus (DM) (cont.)

- “ Incomplete fat metabolism produces ketone bodies that accumulate in the blood
  - Known as ketonemia
  - “ Serious complication
- “ DM impacts physical and psychological growth and development of children
- “ Treatment designed to
  - Optimize growth and development
  - Minimize complications



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## Diabetes Mellitus (DM) (cont.)

- “ Long-term complications related to hyperglycemia
  - Blindness
  - Circulatory problems
  - Kidney disease
  - Neuropathy



# Classifications of DM

Type 1	Autoimmune. Destruction of beta cells in pancreas results in lack of insulin production. Formerly known as insulin-dependent (IDDM) or juvenile-onset DM.
Type 2	Involves insulin resistance. Associated with sedentary lifestyle, obesity, and elevated blood lipids. Formerly known as noninsulin-dependent (NIDDM) or adult-onset DM.
GDM	Transient form of DM that is triggered by pregnancy. Resolves after delivery but may recur several years later.
Other genetic defects	Defects in chromosomes 6, 7, 12, and 20 and other genetic disorders are associated with DM syndrome



# Type 1 Diabetes Mellitus (DM)

- “ Can occur at any time in childhood, new cases highest among
  - 5- and 7-year-olds: Stress of school and increased exposure to infectious diseases may be a triggering factor
  - 11- to 13-year-olds: During puberty, rapid growth, increased emotional stress, and insulin antagonism of sex hormones may be implicated
- “ More difficult to manage in childhood because of growing, energy expenditure, varying nutritional needs
- “ Initial diagnosis may be determined when the child develops ketoacidosis



# Manifestations of Type 1 DM

- “ Classic triad of symptoms
  - Polydipsia
  - Polyuria
  - Polyphagia
- “ Symptoms appear more rapidly in children
- “ Insidious onset with lethargy, weakness, and weight loss also common
- “ Skin becomes dry
- “ Vaginal yeast infections may be seen in the adolescent girl



# Laboratory Findings in Type 1 DM

- “ Glucose in urine (glycosuria)
- “ Hyperglycemia
  - Occurs because glucose cannot enter the cells without the help of insulin; glucose stays in bloodstream
- “ Cells use protein and fat for energy
  - Protein stores in body are depleted
  - Lack of glucose in cells triggers polyphagia
- “ Increase in glucose intake further increases glucose levels in the blood





## honeymoon Period of Type 1 DM

- “ After initially diagnosis, the child is stabilized by insulin dosage and condition may appear to improve
  - Insulin requirements decrease, child feels well
  - Supports parents phase of denial+
- “ Lasts a short time; therefore, parents must closely monitor blood glucose levels to avoid complications



# Diagnostic Tests for DM

- “ Random blood glucose
  - Blood is drawn at any time, no preparation; results should be within normal limits for both diabetic and nondiabetic patients
- “ Fasting blood glucose
  - If greater than 126 mg/dL on two separate occasions, and the history is positive, patient is considered as having DM and requires treatment
- “ Glucose tolerance test
  - Blood glucose level above 200 mg/dl is considered positive
- “ Glycosylated hemoglobin (HbA1c):
  - Values of 6% to 9% represent very good metabolic control
  - Values above 12% indicate poor control



# Diabetic Ketoacidosis (DKA)

- “ Also referred to as *diabetic coma*, even though patient may not be in one
- “ May results from a secondary infection and patient does not follow proper self-care
- “ May also occur if disease proceeds unrecognized
- “ Ketoacidosis is the end result of the effects of insulin deficiency



## Diabetic Ketoacidosis (DKA) (cont.)

- “ Signs and symptoms include
  - Ketonuria
  - Decreased serum bicarbonate concentration (decreased  $\text{CO}_2$  levels) and low pH
  - Hypertonic dehydration
  - Fruity odor to breath
  - Nausea
  - ALOC
- “ Symptoms range from mild to severe
  - Occur within hours to days



# Treatment Goals of DM

- “ Ensure normal growth and development through metabolic control
- “ Enable child to cope with a chronic illness, have a happy and active childhood, and be well-integrated into the family
- “ Prevent complications through tight blood glucose control



# Nursing Care of a Child with DM

- “ Parent and child education
  - Patient's age, financial, educational, cultural, and religious situations must be considered when developing a teaching plan
    - “ For example, pork-based insulin may not be accepted by some religions; therefore, compliance with treatment may be reduced



# g Care of a Child with DM

 (cont.)

- “ Children with DM are growing, additional dimensions of the disorder and its treatment become evident
  - Growth is not steady
  - Occurs in spurts and plateaus that affect treatment
  - Infants and toddlers may have hydration problems
  - Preschool children have irregular activity and eating patterns
  - School-age children may grieve over the diagnosis
  - May use illness to gain attention or to avoid responsibilities
  - Onset of puberty may require insulin adjustments
  - Adolescents often resent this condition and may have more difficulty in resolving conflict between dependence and independence; may lead to rebellion against parents and treatment regimen



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# Principles of Management for DM

- “ Well-balanced diet
- “ Precise insulin administration
- “ Regular exercise



# Teaching Plan for a Child with DM

- “ Physiology of the pancreas and its function
- “ Function of insulin
- “ Blood glucose self-monitoring
- “ Diet therapy (glycemic index of foods and cholesterol intake)
- “ Insulin management
- “ Exercise
- “ Skin care
- “ Foot care
- “ Infections
- “ Emotional upsets
- “ Urine check
- “ Glucose-insulin imbalances
- “ Travel
- “ Follow-up care
- “ Illness or surgery



# Nutritional Management of DM

- “ Ensure normal growth and development
- “ Distribute food intake so that it aids metabolic control
- “ Individualize the diet in accordance with the child's ethnic background, age, sex, weight, activity, family economics, and food preferences
  - Total estimated caloric intake is based upon body size or surface area
  - Most carbohydrate intake should consist of complex carbohydrates that absorb slowly and do not cause sudden and wide elevation of blood glucose



## Dietary Fiber and DM

- “ Soluble fiber has been shown to
  - Reduce blood glucose levels
  - Lower serum cholesterol values
  - Sometimes reduce insulin requirements
- “ Fiber appears to slow the rate of absorption of sugar by the digestive tract



## Safety Alert

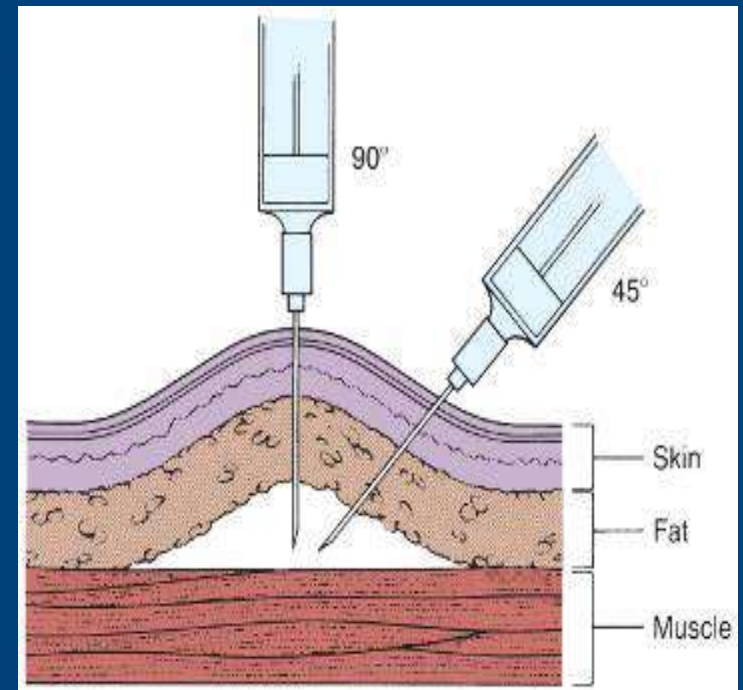
- “ Instruct the patient and family to read food labels carefully
  - The word *dietetic* does not mean *diabetic*
  - Dietetic merely means something has been changed or replaced
    - “ For example, the food may contain less salt or less sugar





# Insulin Administration

- “ Teach parents and child
- “ Insulin cannot be taken orally because it is a protein and would be broken down by the gastric juices
- “ Usual method of administration is subcutaneously



## Administration (cont.)

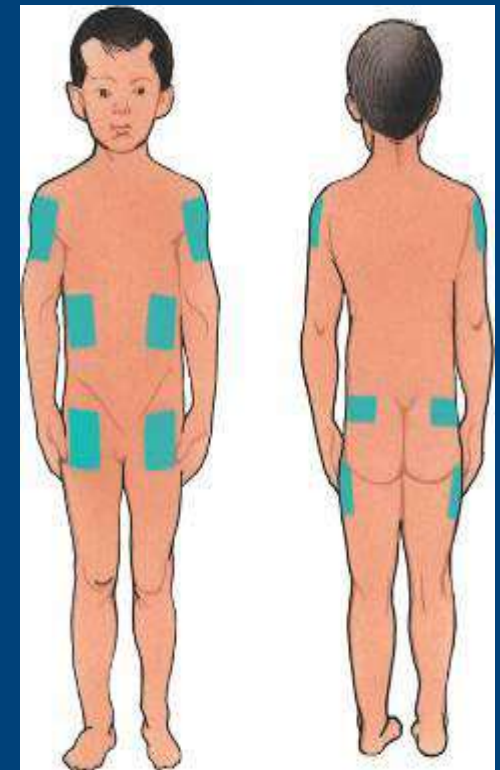
“ In general, a child can be taught to perform self-injection after 7 years of age





## Administration (cont.)

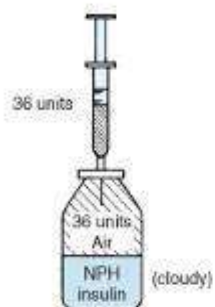
- “ Sites of injections are rotated to prevent poor absorption and injury to tissue
  - Lipoatrophy can occur if sites are not rotated
- “ Should not inject into areas that would have a temporarily increased circulation, such as in a child pedaling a bike, you would not inject into the leg



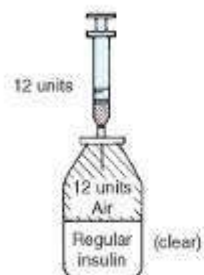


# Mixing Insulin

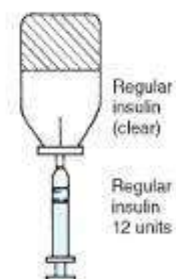
1. Wash your hands.
2. Gently rotate the intermediate insulin bottle.
3. Wipe off the tops of the insulin vials with an alcohol sponge.
4. Draw back an amount of air into the syringe equal to the total dose.
5. Inject air equal to the NPH dose into the NPH vial. Remove the syringe from the vial.



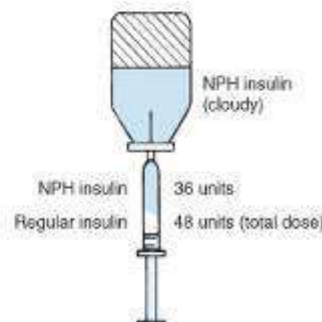
6. Inject air equal to the regular dose into the regular vial.



7. Invert the regular insulin bottle and withdraw the regular insulin dose.



8. Without adding more air to the NPH vial, carefully withdraw the NPH dose.





Insulin

- “ Main difference is in the amount of time required for it to take effect and the length of protection time
  - The response to any given insulin dose is highly individualized and depends on many factors, such as site of injection, local destruction of insulin by tissue enzymes, and insulin antibodies
- “ Insulin can also be given through a pump device





# Insulin Shock

- “ Also known as *hypoglycemia*
- “ Blood glucose level becomes abnormally low
- “ Caused by *too much* insulin

## “ Factors

- Poorly planned exercise
- Reduced diet
- Errors made because of improper knowledge of insulin and the insulin syringe





## Insulin Shock (cont.)

- “ Children are more prone to insulin reactions than adults because
  - The condition itself is more unstable in young people
  - They are growing
  - Their activities are more irregular

- “ Symptoms of insulin reaction
  - Irritable
  - May behave poorly
  - Pale
- “ May complain of feeling hungry and weak
- “ Sweating occurs
- “ CNS symptoms arise because glucose is vital to proper functioning of nerves



## Insulin Shock (cont.)

### “ Immediate treatment

- Administering sugar in some form, such as orange juice, hard candy, or a commercial product
- Begins to feel better within a few minutes and then may eat a small amount of protein or starch to prevent another reaction
- Glucagon is recommended in cases of severe hypoglycemia

# Rebound Hyperglycemia Phenomenon

- “ Rebound hyperglycemia
- “ Blood glucose levels are lowered to a point at which the body's counter-regulatory hormones (epinephrine, cortisol, glucagon) are released
- “ Glucose is released from muscle and liver cells which leads to a rapid rise in blood glucose levels

## Somogyi Phenomenon (cont.)

- “ Generally the result of chronic insulin use, especially in patients who required fairly large doses of insulin to regulate their blood sugars
- “ Hypoglycemia during the night and high glucose levels in the morning are suggestive of the phenomenon
- “ Child may need less insulin, not more, to rectify the problem



## Somogyi Phenomenon (cont.)

- “ Differs from the *dawn phenomenon* in which early morning elevations of blood glucose occur *without* preceding hypoglycemia but may be a response to growth hormone secretion that occurs in the early morning hours
- “ Together the Somogyi and dawn phenomena are the most common causes of instability in diabetic children



# Type 2 Diabetes Mellitus (DM)

- “ Thought to be precipitated by
  - Obesity
  - Low physical activity
  - Lipid-rich diet resulting in insulin resistance
- “ Diet is main emphasis of management along with exercise and other weight control measures
- “ Insulin, oral hypoglycemic medications contribute to stable control of blood glucose level





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## Question for Review

“ What is the difference between a blood glucose level and an HgbA<sub>1c</sub> level, as seen in the lab report of a child with diabetes mellitus?



# REVIEW

- “ Objectives
- “ Key Terms
- “ Key Points
- “ Online Resources
- “ Review Questions