Pancreas Disorders

Williams & Hopper

Chapter 40

Diabetes Mellitus (DM)

- Group of metabolic diseases in which a defect in either insulin secretion or action results in hyperglycemia.

Diabetes Mellitus (DM)

- Chronic disease
  - Carbohydrate metabolism
  - Fat & protein metabolism (lesser degree)
- Inadequate production/utilization of insulin
  - Hyperglycemia
  - Glycosuria
- ~ 20.8 million people w/ diabetes
  - Includes undiagnosed disease

Pathophysiology

- Glucose
  - Used for energy by cells
  - Broken down from dietary carbohydrates
    - Smaller amounts from protein & fats
- Insulin
  - Produced by islets of Langerhans (pancreas)
  - Combines with receptor on cell membrane
    - Allows glucose to enter cell
    - ↓ serum glucose
  - Allows for storage of glucose in liver
    - Glycogen

Pathophysiology

- Glucagon
  - Produced in islets of Langerhan
  - Raises blood sugar when needed
    - From storage in the liver
- Insulin & Glucagon
  - Work together
    - Maintain a normal serum glucose

Pathophysiology

- Diabetes Mellitus
  - Faulty production of insulin (hypoinsulinism) and/or
  - Inability of body to utilize insulin
  - Results in **hyperglycemia**

Type 1 DM

- Formerly called IDDM and "juvenile diabetes"
- Beta cells are destroyed
  - ***No*** insulin secreted
  - Exogenous source is needed
- Cause of destruction
    - Autoimmune component after a viral infection
    - Islet cell antibodies in blood
      - Present in ~ 90% of newly diagnosed pts
- Prone to ketoacidosis

Latent autoimmune diabetes of adulthood (LADA)

- Newly identified type of Type 1 diabetes.
  - Beta cell destruction occurs slower than type 1 diabetes.
  - Sometimes misdiagnosed as type 2 diabetes.

Type 2 DM

- Formerly called non-insulin dependent diabetes mellitus (NIDDM), or adult onset diabetes.
  - Hyperglycemia results from
    - Inadequate amounts of insulin produced

      (usually combined with)
    - Tissue resistance

Type 2 DM

- Causes
  - Heredity
    - 90 % of cases
  - Obesity
    - Contributes to insulin resistance in the tissues
  - Stress (trigger more than cause)
    - ↑ risk

Type 1 & Type 2 comparison

	Type 1	**Type 2**
Onset	Rapid	Slow
Age of onset	Usually < 40	Usually > 40
Risk factors	Virus, autoimmune response, heredity	Heredity, obesity
Body type	Lean	Obese
Complication due to high blood glucose	Ketoacidosis	Hyperosmolar hyperglycemic nonketotic syndrome
Treatment	Diet, exercise; must have exogenous insulin for survival	Diet, exercise, may need oral hypoglycemics or insulin to control glucose

Gestational Diabetes

- Pregnancy (stressor to body)
  - ↑ metabolic demands
  - Triggers onset of DM
    - hyperglycemia
- May occur in women w/type 2 DM risk factors
- Glucose returns to normal after delivery
  - Remains ↑ risk of developing type 2 DM

Prediabetes

- Glucose is above normal
- Not high enough to meet diagnostic criteria for DM
- Recently recognized & treated
  - Impaired fasting glucose if oral GTT 140-199 after 2 hours
  - Impaired fasting glucose if FBS is 110-125.

Secondary Diabetes

- Development of DM due to another cause
  - Illnesses
    - Pancreatitis
    - Cystic fibrosis
  - Drugs
    - Steroids
    - Thiazide diuretics
    - phenytoin (Dilantin)

Metabolic Syndrome
(Syndrome X, Cardiometabolic Syndrome)

- Group of disorders: abdominal obesity, ↑ triglycerides, ↓ HDL, HTN (>130/85)

- Greatly increases the risk of Type 2 diabetes.

Signs & Symptoms

- Three "P's" (classic in Type 1)
  - Polydipsia – excessive thirst
  - Polyuria (also nocturia – night time urination) – excessive urination
  - Polyphagia (not as prominent) – excessive hunger (weight loss)
- Glycosuria – glucose in urine
- Fatigue
- Blurred vision
- Abdominal pain
- Headaches
- ↑ ketones in blood & urine (in Type 1 DM)

Signs & Symptoms

- (Type 2)
  - May be none at presentation
  - Usually discovered on routine exam, screening or exam for other complaint
    - May be reason many pts undiagnosed
  - Often insidious (slow to develop)
  - Complication from undiagnosed DM may bring the pt for exam & diagnosis
    - Visual trouble
    - Pain in feet or foot ulcer
    - Impotence
    - Cardiovascular disorder

Recommended screening

1. All individuals 45 yrs of age of older
   - If normal – then q 3 years
2. Younger age (arbitrarily > 25) in high risk individuals to be done annually:
   1. Obese
   2. 1st degree relative w/DM of any type
   3. High-risk ethnic group (African American, Hispanic/Latino American, Native American, Asian American, Pacific Islander)
   4. Delivered a baby > 9lbs or dx w/gestational DM
   5. Hypertensive (≥ 140/90 mmHg)
   6. HDL ≤ 35mg/dl and/or triglycerides ≥ 250mg/dl
   7. Prediabetes
   8. (Have PCOS)
   9. (Have hx of vascular disease)

Diagnostic Tests

Diagnosis of diabetes if:

- Fasting Blood glucose
  - ≥ 126 mg/dl (on two separate occasions)

*100 – 125 is considered to be IFG.

- Random (casual) FBS
  - ≥200 with symptoms

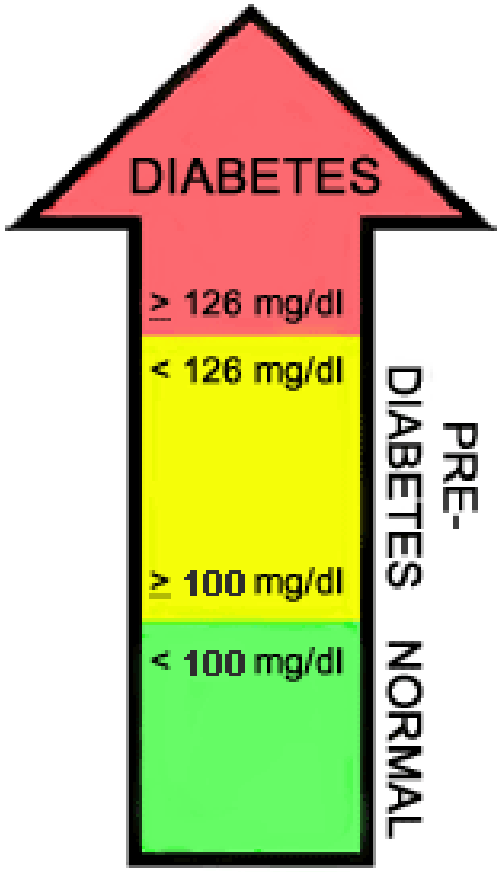
Diagnostic Tests

- Oral glucose tolerance test (OGTT)
  - Client drinks a concentrated carbohydrate drink
  - Measures glucose @ specific intervals

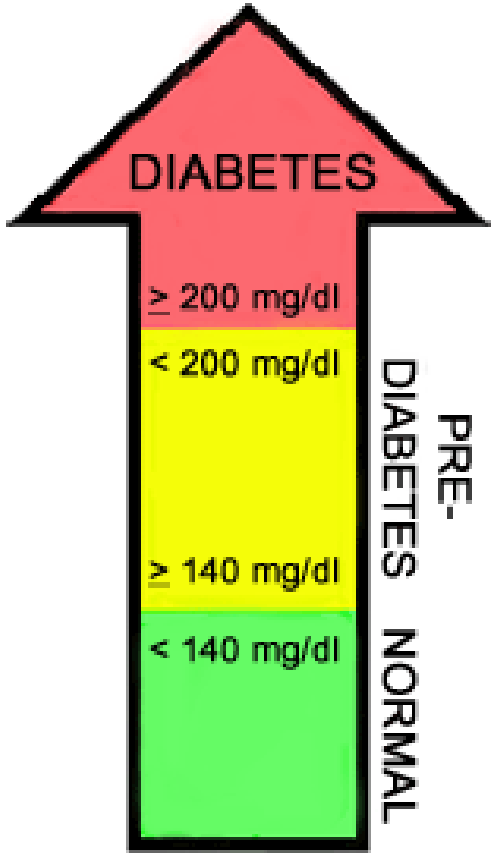
- Diagnosis is made if:
  - ≥ 200 for 2 hr postload
  - *140-199 diagnosed as IGT

Diagnostic Tests

- Glycohemoglobin test (HbA1c)
  - Not primary test for diagnosis
  - Useful for monitoring glycemic control
  - Reflects average blood glucose for past 2-3 months
  - Normal is 4 –7 %



Fasting Blood Sugar



Oral Glucose Tolerance Test

Treatment

- Only cure
  - Pancreas (or islet cell) transplant
- Goal of treatment
  - Glucose control
    - Diet
    - Exercise
    - Oral medications or insulin
    - Blood glucose monitoring
    - Education

Diet (Medical Nutrition Therapy)

- Consistent consumption of carbs, proteins & fats daily
- Do not exceed the insulin's ability to utilize.
- All diets limit fat intake
- Encourage complex carbohydrates
  - Grains, pastas, vegetables, fruits
  - Limit simple sugars (high GI)
- Should fit pt's lifestyle
- ADA diet – referral to a dietician/diabetes educator
  - Meal plan healthy for anyone
  - Only limits portion size
    - Can continue to eat socially while controlling glucose

Diet

- MyPyramid
- ADA exchange list
- Carbohydrate counting
- Glycemic Index (GI)

Exercise

- Helps controls blood glucose & lipids
  - ↓ glucose immediately & continuously 24’
  - Improves blood lipid levels & circulation
- Increases insulin sensitivity over time
  - Insulin not needed to allow glucose to enter exercising cells
- Facilitates weight loss

Exercise

- Pts should always carry quick sugar source
- Avoid exercising when glucose usually low
  - Have a protein or carbohydrate snack before exercising (especially if bld glu <100)
- Avoid insulin injection within 1 hr of exercise
- Avoid exercise when glucose > 250 mg/dl + ketones, or if >300 without ketones
  - Insufficient insulin available
  - Glycogen may be released further increasing bld glu.

Medications

- Insulin
  - Type 1 DM
    - Produce no endogenous insulin
  - Type 2 DM
    - If diet and/or oral hypoglycemics fail
  - Cannot be given by mouth
    - Insulin is a protein
      - Digested by gastric juices
        - Broken down & inactivated
  - Given subcutaneously
    - IM or IV in emergencies

Medications

- Insulin (cont.)
  - Rotate sites
    - Avoids tissue injury
  - Onset of action
    - Time elapsed before glucose starts to decrease
  - Peak
    - Blood glucose at lowest point
    - At risk for hypoglycemia
  - Duration
    - Length of time it takes for insulin effects to cease

Medications

- Rapid acting insulins (Very short-acting)
  - Humalog (lispro), NovoLog (aspart), Apidra (glulisine)
    - Onset ~15”
    - Peak 30 – 90”
    - Durations ~5 hrs

Medications

- Short acting insulins
  - *Regular* - Humulin R; Novolin R
    - Onset
      - 30 – 60”
    - Peak
      - 2-5 hrs
    - Duration
      - ~8 hrs

Medications

- Intermediate acting insulins
  - *NPH* – Novolin N (human); Humulin N (human)
    - Onset
      - 1 to 2 hrs
    - Peak
      - 6 to 12 hrs
    - Duration
      - 18 to 24 hrs

Medications

- Long acting insulins
  - Lantus (insulin glargine)
    - Onset ~ 1 hr
    - Peak – no significant peak
    - Duration – up to 24 hours
  - Levemir (insulin detemir)
    - Onset ~ 2 hrs
    - Peak – no significant peak
    - Duration – up to 24 hours

Medications

- Premixed insulins
  - **Humulin 50/50** (50% NPH, 50% Regular), **Humulin 70/30** (70% NPH, 30% Regular), **Novolin 70/30** (70% NPH, 30% Regular), **Novolog Mix 70/30** (70% insulin aspart protamine, 30% insulin aspart), **Humalog Mix 75/25** (75% insulin lispro protamine, 25% insulin lispro)

Medications

- Sliding scale
  - Used during stress or hospitalization
  - Dose determined by blood glucose
    - Usually ac & hs
  - Glucose "covered" with regular (short-acting) or rapid-acting insulin

Medications

- Problems with Insulin Use
  - Somogyi effect – Bld glu drops too low (usually at night) causing body to react by increasing glucose levels w/ hormones, then insulin is ↑ 'ed worsening the problem.
  - Dawn phenomenon – release of cortisol causes ↑ bld glucose in AM.

Medications

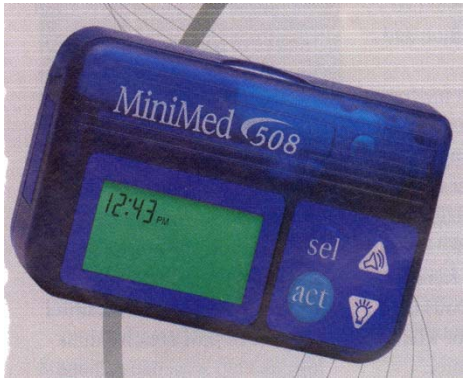
- **Insulin Pump**
  - Developed ~25 years ago
  - Continuous insulin infusion
  - Uses Humalog or Novolog
  - Basal and boluses are programmed in.
  - Can be used for Type 1 or 2

Insulin Pumps: Overview

- Insulin pump therapy, also referred to as continuous subcutaneous insulin infusion (CSII)

Fain JA. *Nursing*. 2003;33:51-53.

Sample Insulin Pumps



Medications

- **Insulin Pump** (cont.)

- Used for "tight" control – mimic physiologic pattern
  - Basal rate – preset determined by physiologic need
  - Bolus – to cover increases such as mealtime, or unexpected rises

Medications

- **Insulin Pump** (cont.)

- Candidates
  - Must have thorough comprehension of pump
  - Ability to self-monitor glucose at least 4X/day
  - Ability to carb count

Medications

- Oral hypoglycemics
  - Not oral insulin
  - Not useful for type 1 diabetics
    - Depend on some pancreas functioning
  - Can develop tolerance
    - Switch to another type
  - Eventually may no longer work
  - Insulin may become necessary
    - Pt still has type 2 DM
    - Insulin not needed to sustain life like in Type 2 DM

Medications

- Sulfonylureas
  - Glyburide (Micronase, Diabeta), glipizide(Glucotrol XL), glimipiride (Amaryl)
  - Mechanism of action
    - stimulate insulin production from beta cells
  - Side effects
    - Contribute to hyperinsulinemia & weight gain
      - Insulin resistance
    - Risk of hypoglycemia
    - May cause beta cell exhaustion quicker
      - Contributing to worsening of diabetes

Medications

- Meglitinides - nateglinide (Starlix) & repaglinide (Prandin)
  - Mechanism of action
    - Stimulate insulin secretion from beta cells
      - Similar to sulfonylureas
    - Much more rapid onset of action
      - Starts working within 15 – 30”
    - Shorter duration
      - Starlix – lasts ~ 2hrs
      - Prandin – lasts ~ 4 hrs
  - Side effects
    - hypoglycemia

Medications

- Biguanides – Metformin (Glucophage)
  - Mechanism of action
    - Suppresses glucose production in liver
    - Enhances peripheral tissue sensitivity to insulin
    - *Does not* stimulate pancreas to secret insulin
      - Reduces blood glucose w/o risk of hypoglycemia
    - Often suppresses appetite – weight loss
    - ↓ triglycerides & LDL, slight ↑ HDL
  - Side effects
    - Lactic acidosis – can lead to death
      - Do not use if cr > 1.5 mg/dl
  - Used in combination w/sulfonylureas

Medications

- Thiazolidinediones – rosiglitazone (Avandia) & pioglitazone (Actos)
  - Mechanism of action
    - Directly reduces insulin resistance in muscles.
    - To lesser degree: Inhibits glucose output by liver.
  - Side effects
    - Weight gain
    - Associated w/liver failure - Monitor LFTs
    - **BOTH HAVE BLACK BOX WARNINGS**

Medications

- Alpha-Glucosidase Inhibitors – Acarbose (Precose) & miglitol (Glyset)
  - Mechanism of action
    - Inhibits absorption of complex carbs from gut
    - No effect on glucose
    - Reduces post prandial hyperglycemia
  - Side effects
    - Flatulence
    - Abd pain
    - diarrhea

Medications

- Incretin mimetic - exenatide (Byetta)
  - Newest Type 2 diabetes drug
  - Enhances insulin secretion in response to ↑ glucose levels
  - Injectable only - twice daily dose, within 60 minutes before morning and evening meals.

Medications [Newer Agents]

- Symlin (pramlintide acetate)
  - Analog of naturally occurring hormone called amylin.
  - Suppresses glucagon secretion, induces satiety.
  - Given by injection
  - Can be used by Type 1 or 2 patients with IDDM.

Blood Glucose Monitoring

- Blood glucose monitoring (SMBG)
  - Integral part of diabetic care
  - Recommended for ALL insulin dependent (IDDM) pts
  - Use fingers whenever possible
    - *Continuous Glucose Monitoring now available

Blood Glucose Monitoring

4X/Day - Generally done ac & hs

- Requires education
- Desirable glucose range (ADA recommends preprandial level of 90-130)
  - Decided by physician
  - Different for all pts
  - Newer recommendations for testing 2 hours after meals **(post-prandial)** – should be <180

Urine Glucose/Ketone Monitoring

- Urine glucose testing – no longer recommended
  - **To check for ketones**
    - During acute illness & pregnancy
    - Glucose consistently > 300mg/dl
    - When symptoms of ketoacidosis are present
    - Notify MD if present

Blood Glucose/Urine Monitoring

- Result interpretation
  - Used to improve glucose control
  - Pt should keep a diary
    - Computer software is available
      - Graphs results
  - Pt education
    - Interpretation of trends

Acute Complications of Diabetes

- HYPERGLYCEMIA
- HYPOGLYCEMIA
- DIABETIC KETOACISOSIS (DKA)
- HYPEROSMOLAR HYPERGLYCEMIC NONKETOTIC SYNDROME (HHNK)

Acute Complications of Diabetes

- Hyperglycemia – high blood glucose
  - Calories eaten > available insulin
  - Stress
    - Release of epinephrine, cortisol, GH & glucogon
      - All ↑ glucose
  - Nurse responsibility
    - Teach pt to recognize s/s of hyperglycemia
    - May be similar to s/s at time of initial diagnosis

Acute Complications of Diabetes

- Hypoglycemia – low blood glucose
  - Calories < circulating insulin
  - Defined as glucose < 50 mg/dl
    - Some pts can have symptoms at higher levels
    - Sometimes symptoms can occur w/rapid glucose fall – even w/normal or high level
  - Repeated hypoglyemia
    - Can lead to permanent neurological damage
    - **Pt education**
      - Recognition of s/s of low blood glucose

Acute Complications of Diabetes

- Hypoglycemia (cont.)
  - Treatment w/ 15g glucose
  - If next meal > 1hr
    - Give protein or complex carb snack
      - Keeps sugar from dropping
  - If symptoms recur
    - Notify MD
    - IV or subq glucagon may be ordered

Acute Complications of Diabetes

- Diabetic Ketoacidosis (DKA)
  - Severe insulin insufficiency
  - Signs & Symptoms (in addition to s/s of hyperglycemia)
    - Severe hyperglycemia (250 – 800 mg/dl)
      - Glucose cannot get in cells
      - Cells starve
      - Fat breakdown – attempt to produce energy
        - Releases ketones (very acidic) builds up in blood
    - Kussmaul's respiration
      - Deep, sighing respiration w/fruity odor
      - Body's attempt to ↓ acidosis
        - Blowing off excess carbon dioxide

Acute Complications of Diabetes

- DKA (cont.)
  - Signs & Symptoms (cont.)
    - Dehydration
      - High glucose = polyuria
    - Hyperkalemia
      - High glucose
        - Causes K+ to leave cell & go into blood
    - If not treated
      - Loss of consciousness
      - Death

Acute Complications of Diabetes

- DKA (cont.)
  - Treatment
    - IV fluids
    - IV insulin
    - Blood glucose monitoring
    - Monitor K+ levels
      - Treatment will allow K+ to reenter the cells
        - hypokalemia

Acute Complications of Diabetes

- DKA (cont.)
  - Prevention
    - Careful blood glucose monitoring at home
      - Urine dipstick w/ glucose > 300 mg/dl
        - Detection of ketones
        - If present – **notify MD**

Acute Complications of Diabetes

- Hyperosmolar, Hyperglycemic, Nonketotic Syndrome (HHNKS)
  - Occurs primarily in Type 2 DM
    - Stress/illness (most common cause)
      - Causes ↑ glucose level
        - **600 – 2000** mg/dl
  - ↑ glucose causes polyuria
    - Profound dehydration
      - Blood become *Hyperosmolar* or concentrated

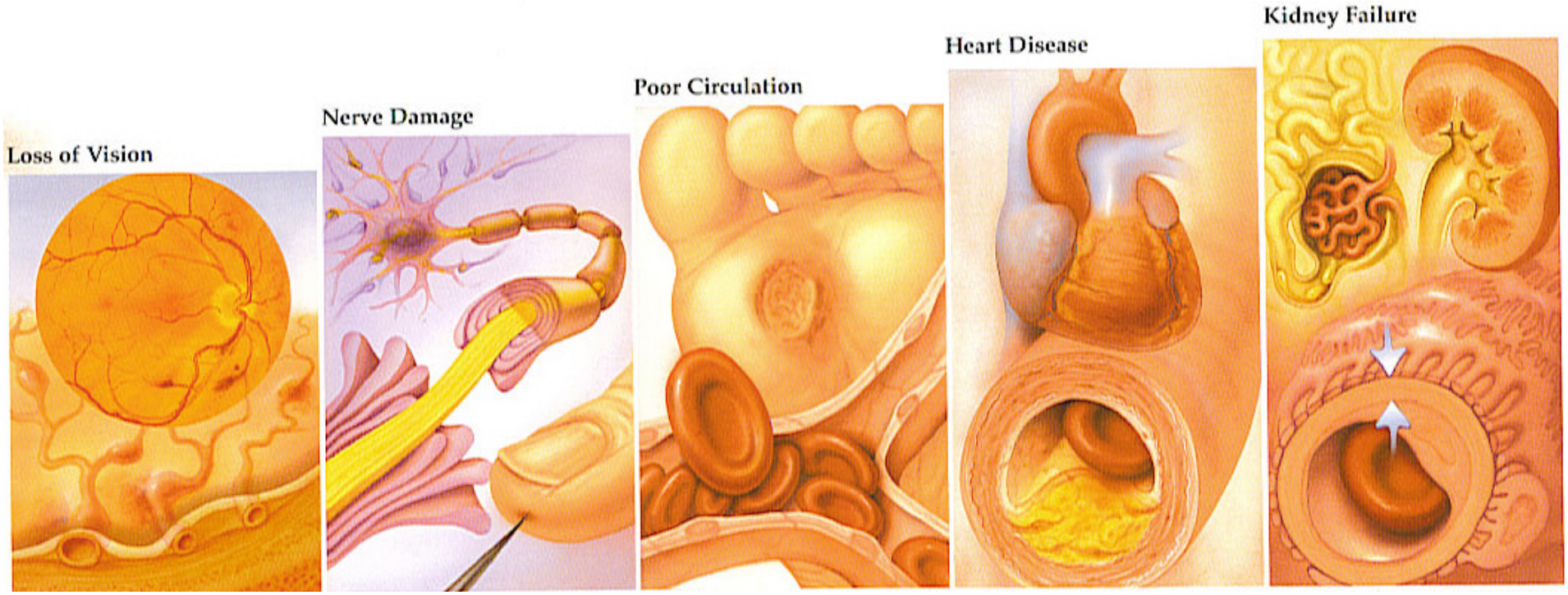
Acute Complications of Diabetes

- Hyperosmolar, Hyperglycemic, Nonketotic Syndrome (HHNKS)
  - Treatment
    - IV fluids
    - Insulin
    - Glucose monitoring
  - Prevention
    - Home glucose monitoring
      - Notify MD w/high sugars
      - ↑ fluids if glucose rises – esp w/stress and illness

Long Term Complications of Diabetes

- Systems/Organs usually affected
  - Circulatory system
  - Nervous system
  - Eyes
  - Kidneys
- The Diabetes Control & Complications Trail (DCCT)
  - Study comparing intensive glucose control to conventional treatment
    - Tight control = glucose between 70 – 120
    - Revealed pts had 39 – 76 % less long term complications

Long term complications of DM:



Long Term Complications of Diabetes

- Circulatory System
  - Developmental of premature atherosclerosis & arteriosclerosis
    - Higher incidence of stroke & MI
      - 2 -4 X's than general population
    - Leads to poor circulation in lower extremities
      - Slow & impaired healing of cuts or sores
        - Leading cause of leg amputation
      - Pt education re: feet care

Long Term Complications of Diabetes

- Eyes
  - Retinopathy
    - Directly related to severity & duration of hyperglycemic episodes
    - Disease of small blood vessels in eyes
      - Small hemorrhages
      - Can lead to blindness
        - Causes ~ 12,000 to 24,000 new cases of blindness each year
  - Higher incidence of cataracts
  - **Annual eye exam very important!**

Diabetic Retinopathy

Long Term Complications of Diabetes

- Kidneys
  - Nephropathy
    - Damage to small blood vessels in kidneys
    - Kidneys unable to remove waste products
    - Occurs 20 – 30% of diabetics to some degree
    - Correlates with episodes/duration of hyperglycemic episodes & length of DM
    - Major cause of end-stage renal disease (ESRD)
      - ~ 25% of all pts with end-stage renal disease
      - Dialysis or kidney transplant may become necessary

Long Term Complications of Diabetes

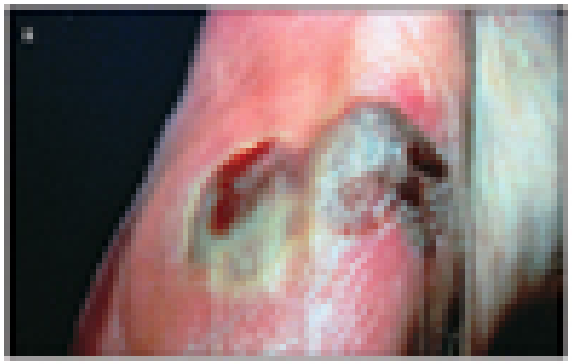
- Nephropathy (cont.)
  - Treatment
    - Teach importance of glucose control
    - Routine urine tests
      - Microalbuminuria – small amts protein in urine
        - Indicates kidney damage
        - Low protein diet
        - ACE inhibitor ex: ramipril (Altace), ARB valsartan (Diovan)

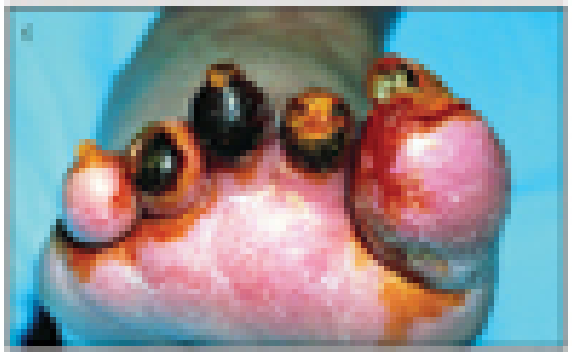
Long Term Complications of Diabetes

- Neuropathy
  - Damage to nerves
    - Due to chronic hyperglycemia
  - Signs & symptoms
    - Numbness & pain in extremities
    - Impotence, erectile dysfunction in males
    - **Gastroparesis** (delayed stomach emptying)
      - Nerves to GI system also affected
      - Tx: antidepressants, anticonvulsants, pregabalin (Lyrica), etc.

Long Term Complications of Diabetes

- More prone to infection
  - Slow healing
  - Poor circulation
    - For adequate blood supply
    - Poor systemic absorption of IV antibiotics
      - Topical antibiotics are used if localized infection
  - Sluggish immune response
    - WBC may be ineffective
      - Presence of hyperglycemia
  - Higher incidence of periodontal (gum) disease
    - Caused by bacteria in plaque
    - Teach good oral hygiene





A number of foot problems can occur in patients with neuropathy resulting from long-standing diabetes. Shown here are a fiction blister with accompanying cellulitis (a), a trophic ulcer of the great toe (b), and gangrene (c).


10

Special considerations: Diabetic Undergoing Surgery

- Surgery = Stress
  - ↑ blood glucose
  - More frequent glucose monitoring
    - Sliding scale of coverage
  - MD may order IVs w/glucose or insulin
  - Closely monitor pt for hyper/hypoglycemia

Nursing process

- Assessment
- Nursing diagnosis
- Planning & implementation
- Evaluation

Patient Education

- Begin as soon as possible
  - Videos often helpful
- Teach self care
  - Involvement of family/significant others
- Many institutions utilize a certified diabetes educator
- Referral to outpt diabetes classes
- Elderly may need special assistance
- Medic Alert bracelet

Reactive Hypoglycemia

- Abnormally low blood glucose
  - Usually < 50 mg/dl
  - Not in presence of diabetes mellitus
    - May be warning sign of impending DM
- Pathophysiology
  - Increased secretion of insulin by pancreas
    - Response to eating
    - More insulin produced than needed

Reactive Hypoglycemia

- Signs & Symptoms
  - Shaking
  - Sweating
  - Palpitations
  - Headache
  - Chills
  - Confusion

Reactive Hypoglycemia

- Diagnosis
  - 5 hour glucose tolerance test
    - Low glucose levels at 2 & 5 hrs – makes diagnosis
  - Pts may also be taught to monitor glucose at home
    - Done am, 2hrs pc & hs
    - Taken to MD for interpretation and diagnosis

Reactive Hypoglycemia

- Treatment
  - Frequent small meals
  - Avoid fasting
  - Avoid simple sugars
    - Can cause rapid rise and fall in glucose
  - High-protein, low carbohydrate diet