Diabetes mellitus

DM

- Group of common metabolic disorders that share the phenotype of hyperglycemia.
- In the US, DM is the leading cause of
  - end-stage renal disease (ESRD),
  - nontraumatic lower extremity amputations, and
  - adult blindness.

Etiologic classification

- Type 1 DM (5-10%) : immune mediated, idiopathic
- Type 2 DM (90-95%)
- Other specific type of DM (1-2%)
  - A. Genetic defects of ß-cell function
  - B. Genetic defects in insulin action
  - C. Diseases of the exocrine pancreas
  - D. Endocrinopathies
  - E. Drugs- or chemical-related
  - F. Infections
  - G. Uncommon forms of immune-mediated disorder
  - H. Other genetic syndromes associated with diabetes
- Gestational diabetes mellitus (3-5% of all pregnancy)

- Epidemiology
  - Total 180 mill-90% type 2 DM
  - Prevalence increasing rapidly
  - Geographic differences
    - type 1 -scandinavian(common), Japanese& Chinese (lowest)
    - Type -2-high prevalence in affluent soceity
  - Genetic/ethnic differences-pimma indians, African Americans, hispanics

Criteria for the Diagnosis of Diabetes Mellitus- ADA (American diabetes association)

- Symptoms of diabetes plus RBS >=11.1 mmol/L (200 mg/dL) *or*
- FBS>= 7.0 mmol/L (126 mg/dL) or
- Two-hour plasma glucose >=11.1 mmol/L (200 mg/dL) during an oral glucose tolerance test

- Note
  - Random blood sugar measurement is defined as without regard to time since the last meal.
  - Fasting blood sugar measurement is defined as no caloric intake for at least 8 h.
  - The test should be performed using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water; not recommended for routine clinical use.
  - In the absence of unequivocal hyperglycemia and acute metabolic decompensation, these criteria should be confirmed by repeat testing on a different day.

- IGT &IFT-pre-diabetes
  - IFG-FBS=10O-125mg/dl
  - IGT-2hr=140-199mg/dl
  - 25-40% risk of developing type 2 DM-over 5 yrs
  - Have increased risk of CV disease
- GDM-screening for high risk
  - marked obesity
  - personal history of GDM
  - Glycosuria or
  - strong family history of diabetes

- Pathogenesis

  Type 1 DM- results from interaction of genetic, environmental & immunologic factors-→ B-cell destruction

  - Genetic predisposition-----HLA-DR3/DR4
  - Environmental factors
    - infection-rubella,coxsacki,
    - Bovine milk protein
    - Nitrous urea compounds, rat poisons, casava
  - Insulitis---auto immune factors
    - Islet cell auto anti bodies (ICA)
      - auto abs. directed at insulin, GAD
    - Inflammatory Cells-increase cytokines
  - B-cell destruction-80% of B-cells should be destroyed
  - HONEY MOON PHASE

- Type 2 DM
- Genetic +environmental
  - Impaired insulin secretion
  - Increase hepatic gluconeogenesis
  - Increase insulin resistance
- Strong genetic component
- Concordance of type 2 DM-identical twins=70-90%
- Both parents DM—40% risk in sibling
- Polygenic & multifactorial

Insulin Resistance Syndromes

metabolic syndrome, the *insulin resistance syndrome*, or *syndrome X*

- insulin resistance
- hypertension
- dyslipidemia (low HDL and elevated triglycerides),
- central or visceral obesity,
- type 2 diabetes or IGT/IFG, and
- accelerated cardiovascular disease

clinical criteria	Type 1 DM	Type 2 DM
age	<30yrs	>30yrs
BMI	Lean body wt	Usually obese((80% , but elderly individuals may be lean)
HLA	HLA-DR3,DR4,chrom.6	No HLA ass.,polygenic
pathogenesis	Autoimmune,immune markers	Insulin resistance
Insulin level	Insulin def.complete	Partial decrease in insulin
C-peptide	Decrease or none	Normal or increase
complications	DKA	HHS
Insulin mx	Initial/all	50%,usually late
hereditory	Less common, id.twins-30-70%	Common, id. twins 70--90%
Response to OHD	no	yes
Associated conditions	Other autoimmune ds	HTN,dyslipidemia,CVD,PCOS…

- type 2 DM is markedly increasing among overweight children and adolescents.
- Some individuals with phenotypic type 2 DM present with DKA but lack autoimmune markers and may be later treated with oral glucose-lowering agents rather than insulin (have been termed *ketosis-prone type 2 DM*).
- Some individuals (5–10%) with the phenotypic appearance of type 2 DM do not have absolute insulin deficiency but have autoimmune markers suggestive of type 1 DM (termed *latent autoimmune diabetes of the adult*).

- LADA-late onset auto immune diabetes of adults (type 1)
  - Age >30yrs, more likely to be <50yrs
  - Immune markers for type 1 present (ICA, GAD autoantibodies)
  - personal or family history of other autoimmune disease.
  - Respond to oral agents early phase, more likely to require insulin treatment within 5 years
  - Complete B-cell destruction over 2-3yrs
  - Usually lean body wt(normal BMI)

- Screening for type 2 DM- ADA recommendation
- screening test - FBS
- Age >45yrs
  - all pts every 3yrs
  - With other risk factors every year
- Why screening?
  - Long asymptomatic period
  - 50% have at least one complication at the time of Dx
  - Epidemiology-for every diagnosed type 2 DM, there is one asymptomatic patient
  - Majority are unaware of the d/o
  - Treatment of type 2 DM may favorably alter the natural history of DM

Risk Factors for Type 2 Diabetes Mellitus

- Family history of diabetes (i.e. parent or sibling with type 2 diabetes)
- Obesity (BMI 25 kg/m^2)
- Habitual physical inactivity
- Race/ethnicity (e.g., African American, Latino, Native American, Asian American, Pacific Islander)
- Previously identified IFG or IGT
- History of GDM or delivery of baby >4 kg (>9 lb)
- Hypertension (blood pressure 140/90 mmHg)
- HDL cholesterol level <35 mg/dL and/or a triglyceride level >250 mg/dL
- Polycystic ovary syndrome or acanthosis nigricans
- History of vascular disease
- Age >45yrs

Acute Complications of DM

- Diabetic ketoacidosis (DKA)
- Hyperglycemic hyperosmolar state (HHS)
- Hypoglycemia

DKA

- Symptoms
  - Nausea/vomiting
  - Abdominal pain & tenderness may be severe and can resemble acute pancreatitis or surgical abdomen
  - Thirst/polyuria
  - SOB, Tachypnea / Kussmaul respirations/RD
  - Kussmaul respirations and a fruity odor on the patient's breath (secondary to metabolic acidosis and increased acetone)
  - Hyperglycemia leads to glucosuria, volume depletion, and tachycardia
  - Dry mucous membranes/reduced skin turgor
  - Dehydration / hypotension
  - Lethargy /obtundation / cerebral edema / possibly coma

Precipitating factors for DKA

- Omission or ↓g dose of insulin: commonest cause here
- Infection(pneumonia/UTI/AGE/sepsis): commonest Worldwide
- New Dx: 20% of Type 1DM pts initially come with DKA
- Stress (Trauma, surgery)
- Psychological factors
- Continuous insulin infusion – b/c of tube kinking, now improved
- Infarction (cerebral, coronary, mesenteric, peripheral)
- Burns, acute pancreatitis, PTE
- Drugs (cocaine, glucocorticoids , diuretics ,parentral or enteric nutrition, α & β blockes esp in elderly)
- Pregnancy
- increased insulin requirements, as might occur during a concurrent illness

Pathophysiology

- DKA results from relative or absolute insulin deficiency combined with counter regulatory hormone excess (glucagon, catecholamines, cortisol, and GH)
- decreased ratio of insulin to glucagon promotes gluconeogenesis, glycogenolysis, and ketone body formation in the liver, as well as increases in substrate delivery from fat and muscle (free fatty acids, amino acids) to the liver
- The increased levels of glucagon and catecholamines in the face of low insulin levels promote glycogenolysis.

- Insulin deficiency also reduces levels of the GLUT4 glucose transporter, which impairs glucose uptake into skeletal muscle and fat and reduces intracellular glucose metabolism
- *Ketosis results from a marked increase in free fatty acid release* from adipocytes, with a resulting shift toward ketone body synthesis in the liver.
- Reduced insulin levels, in combination with elevations in catecholamines and growth hormone, increase lipolysis and the release of free fatty acids

DKA diagnostic criteria **(ADA)**

- ✓ D: Hyperglycemia >250 mg/dl,
- ✓ K: Ketonemia- moderate ketonuria or ketonemia.
- ✓ A: Acidemia -arterial pH <7.3, serum HCO3 <15 mEq/dl
- In DKA, the ketone body, β-hydroxybutyrate, is synthesized at a threefold greater rate than acetoacetate; however, acetoacetate is preferentially detected by a commonly used ketosis detection reagent (nitroprusside).
- certain medications such as captopril or penicillamine may cause false-positive reactions. Serum or plasma assays for β- hydroxybutyrate more accurately reflect the true ketone body level
- Late conversion of β- hydroxybutyrate may result in ketonuria after the pt is out of DKA, giving false

- Euglycemic DKA
  - in which the serum glucose is normal or near normal (250mg/dl) but the patient requires insulin therapy for the clearance of ketoacidosis.
  - Occurs in the setting of
    - pregnancy,
    - poor oral intake or
    - treatment with insulin prior to arrival in the emergency department

Table 1—*Diagnostic criteria for DKA and HHS*

	DKA			HHS
	Mild (plasma glucose >250 mg/dl)	Moderate (plasma glucose >250 mg/dl)	Severe (plasma glucose >250 mg/dl)	Plasma glucose >600 mg/dl
Arterial pH	7.25–7.30	7.00 to <7.24	<7.00	>7.30
Serum bicarbonate (mEq/l)	15–18	10 to <15	<10	>18
Urine ketone*	Positive	Positive	Positive	Small
Serum ketone*	Positive	Positive	Positive	Small
Effective serum osmolality†	Variable	Variable	Variable	>320 mOsm/kg
Anion gap‡	>10	>12	>12	Variable
Mental status	Alert	Alert/drowsy	Stupor/coma	Stupor/coma

*Nitroprusside reaction method. †Effective serum osmolality: 2[measured Na^+ (mEq/l)] + glucose (mg/dl)/18. ‡Anion gap: $(Na^+) - [(Cl^- + HCO_3^-$ (mEq/l)]. (Data adapted from ref. 13.)

DDx of DKA

- Alcoholic Keto acidosis: $HCO_3 > 15$
- Starvation ketosis
- High anion gap metabolic acidosis
  - Lactic acidosis
  - Advanced CRF
  - Drugs: salcylates, Methanol, Ethylene glycol, paraldehyde

Complications of DKA

- Hypotension
- Thromboembolism, DIC
- UGIB
- Hypothermia
- Complication of Rx:
  - Hypoglycemia, hypokalemia,
  - cerebral edema especially in children
  - ARDS b/c of vigorous hydration
  - Hyperchloremic metabolic acidosis

Principles of management of DKA

1. Fluid replacement
2. Correction of hyperglycemia -insulin
3. Electrolyte replacement-especially potassium
4. Treatment of ppting causes & Complication
5. Conversion to a durable mx of DM
6. Prevention of recurrence.

Mx of DKA

1.Confirm diagnosis (plasma glucose, positive serum ketones, metabolic acidosis).

2. Admit to hospital;intensive-care setting may be necessary for frequent monitoring or if pH 7.00 or unconscious.

3. Assess:

   Serum electrolytes (K, Na, Mg2, Cl, bicarbonate, phosphate)

   Acid-base status—pH, HCO3, P_{CO2} , -hydroxybutyrate

   Renal function (creatinine, urine output)

4. Replace fluids: 2–3 L of 0.9% saline over first 1–3 h (5–10 mL/kg per hour);subsequently, 0.45% saline at 150–300 mL/h; change to 5% glucose and 0.45% saline at 100–200 mL/h when plasma glucose reaches 250 mg/dL (14 mmol/L).water deficit is 3-5L

5. Administer regular insulin: IV (0.1 units/kg) or IM (0.4 units/kg), then 0.1 units/kg per hour by continuous IV infusion; increase 2- to 10-fold if no response by 2–4 h. If initial serum potassium is 3.3 mmol/L (3.3 meq/L), do not administer insulin until the potassium is corrected to 3.3 mmol/L (3.3.meq/L).
6. Assess patient: What precipitated the episode (noncompliance, infection, trauma, infarction, cocaine)? Initiate appropriate workup for precipitating event (cultures, CXR, ECG).
7. Measure capillary glucose every 1–2 h; measure electrolytes (especially K, bicarbonate, phosphate) and anion gap every 4 h for first 24 h.
8. Monitor blood pressure, pulse, respirations, mental status, fluid intake and output every 1–4 h.
9. Replace K: 10 meq/h when plasma K 5.5 meq/L, ECG normal, urine flow and normal creatinine documented; administer 40–80 meq/h when plasma K 3.5 meq/L or if bicarbonate is given.
10. Continue above until patient is stable, glucose goal is 150–250 mg/dL, and acidosis is resolved. Insulin infusion may be decreased to 0.05–0.1 units/kg per hour.
11. Administer intermediate or long-acting insulin as soon as patient is eating. Allow for overlap in insulin infusion and subcutaneous insulin injection

Hyperglycemic Hyperosmolar State

C/F

- prototypical pt with HHS is an elderly individual with type 2 DM, with a several week history of polyuria, weight loss, and diminished oral intake that culminates in mental confusion, lethargy, or coma.
- p/E reflects profound dehydration and hyperosmolality and reveals hypotension, tachycardia, and altered mental status.
- Notably absent are symptoms of nausea, vomiting, and abdominal pain and the Kussmaul respirations characteristic of DKA.
- HHS is often precipitated by a serious, concurrent illness such as myocardial infarction or stroke. Sepsis, pneumonia, and other serious infections are frequent precipitants and should be sought
- In addition, a debilitating condition (prior stroke or dementia) or social situation that compromises water intake usually contributes to the development of the disorder.

Pathophysiology

- **Relative insulin deficiency and inadequate fluid intake are the underlying causes of HHS.**
- **Hyperglycemia induces an osmotic diuresis that leads to intravascular volume depletion, which is exacerbated by inadequate fluid replacement**.
- **insulin deficiency is only relative and less severe than in DKA**.
- **the insulin/glucagon ratio does not favor ketogenesis.**

HHS diagnostic criteria **(ADA)**

- HHS: blood glucose >600 mg/dl, arterial pH >7.3, bicarbonate >15 mEq/l, mild ketonuria or ketonemia, and effective serum osmolality >320 mOsm/kg H_2O

- Laboratory Abnormalities and Diagnosis
  - marked hyperglycemia
  - hyperosmolality
  - prerenal azotemia.
  - The measured serum sodium may be normal or slightly low despite the marked hyperglycemia.
  - The corrected serum sodium is usually increased [add 1.6 meq to measured sodium for each 5.6-mmol/L (100 mg/dL) rise in the serum glucose].
  - In contrast to DKA, acidosis and ketonemia are absent or mild.
  - A small anion gap metabolic acidosis may be present secondary to increased lactic acid.
  - Moderate ketonuria, if present, is secondary to starvation.

Hyperglycemic Hyperosmolar State: Treatment

- Same as DKA
- some patients can later switch to oral glucose lowering agents
- Less insulin requirement
- HHS has a substantially higher mortality than DKA—up to 15%
- The calculated free water deficit (which averages 9–10 L) should be reversed over the next 1–2 days

	DKA	HHS
age	young	Middle age to elderly
Duration of decompensation	Hrs to days	Days to wks
Type of DM	Type 1 common/can occur type 2	Type 2
N &V	yes	no
Mental status change	May present in severe DKA	more common
Acidotic breathing	yes	no
Abdominalpain/ tenderness	yes	no
↑PR	yes	yes
BP	N/↓	↓↓
BMI	lean	obese
PH	<7.3	>7.3
RBS	250-600	600-1200
HCO3	<15	>20
creatine	slightly↑	Moderately ↑

Hypoglycemia

- Definition

  Plasma glucose level < 40-50 mg/dL
- Whipple’s triad

  A. symptoms consistent with hypoglycemia (neuroglycopenic/autonomic)

  B. a low plasma glucose concentration

  C. relief of symptoms after the plasma glucose level is raised

- cause
  - ↑ dose of Rx
  - missed meal
  - exercise
  - renal failure
- Adrenergic sx
  - palpitation,sweating,nausea,tremor,anxiety
- Neuroglycopenic sx
  - Headache ,confusion, delirium, coma

- Management
  - Insulin induced
    - Give 40% dextrose push then maintain
    - Proper education
    - Can be treated at OPD level
  - Sulfonylurea induced
    - Admit and observe for 24 to 48 hr
    - Give 40% dextrose push then maintain on 10%
    - Glucagon 1mg IM
    - Encourage feeding
    - Proper health education

Chronic Complications of DM

VASCULAR

- Microvascular
  1. Retinopathy, macular edema
  2. Neuropathy (sensory, motor, autonomic)
  3. Nephropathy
- Macrovascular
  1. Coronary artery disease
  2. Peripheral vascular disease
  3. Cerebrovascular disease

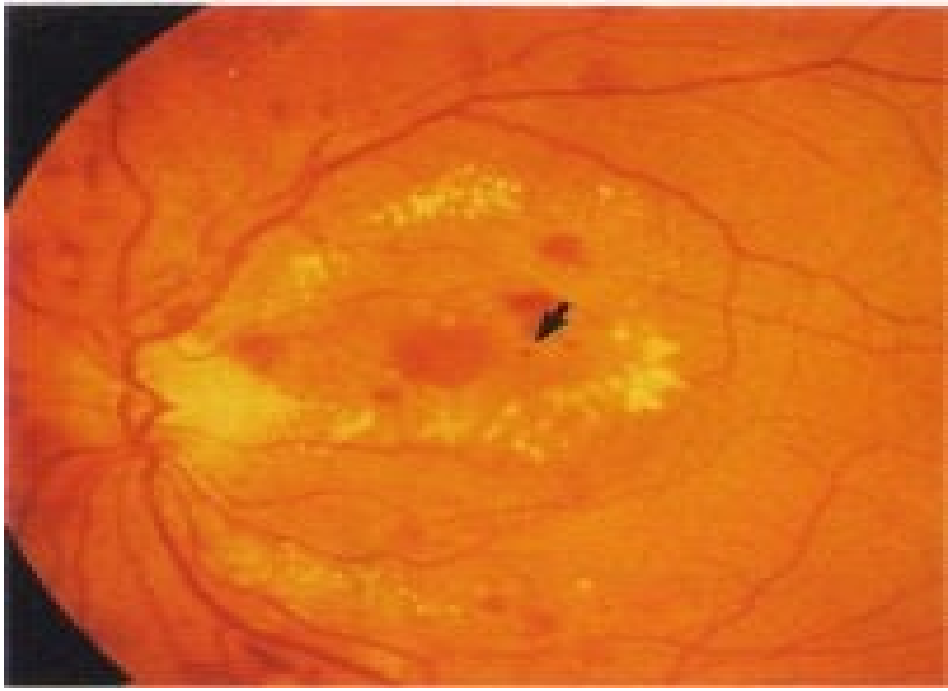
Non-Vascular

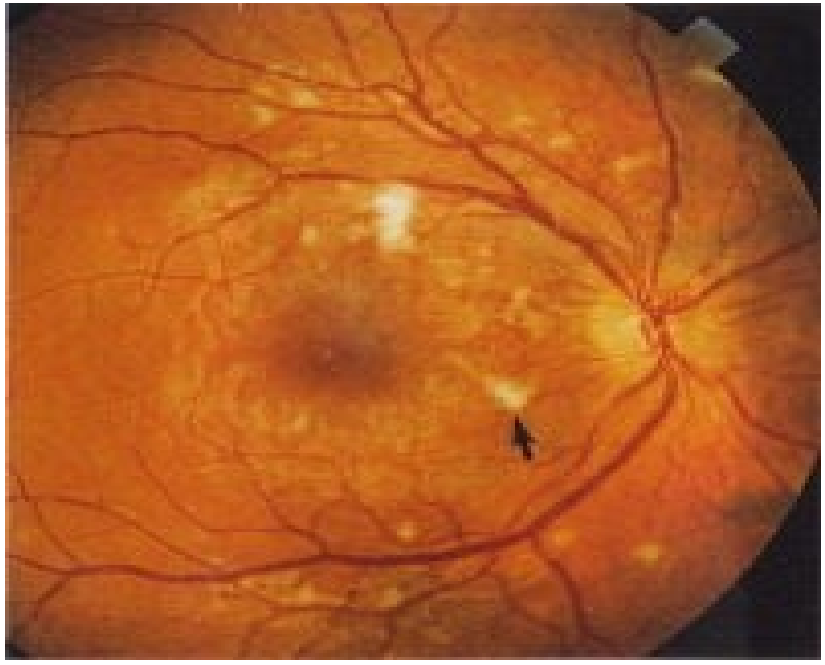
1. GI dysfunction (gastroparesis, diarrhea)
2. GU dysfunction (uropathy, sexual dysfunction)
3. Dermatologic
4. infection
5. Cataracts
6. Glaucoma
7. Periodontal disease

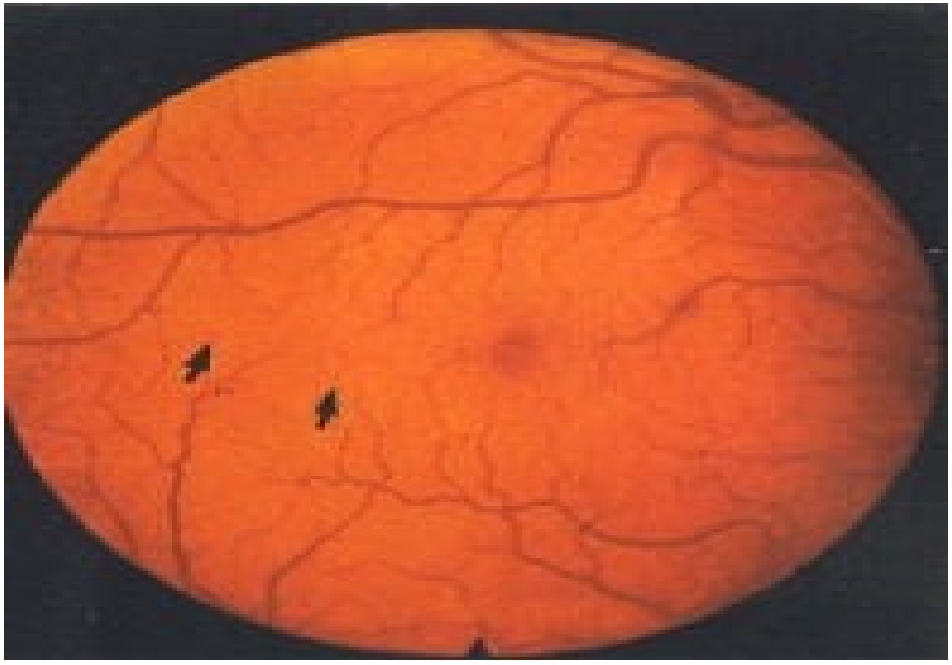
- Pathogenitic mechanism of Complications of DM
- Hyperglycemia
  - nonenzymatic glycation of proteins-↑AGE
  - Polyol pathway- ↑sorbitol
  - ↑DAG- ↑ PKC activation-
    - » ↑growth factors
    - » change in gene expression
    - »change in enzyme function

- Microangiopathies
- 1. ocular Cx-leading cause of blindness in developed countries
    - Retinopathy
        - non-proliferative-micro aneurysms, dot/blot hemorrhage, cotton wool spot
        - Proliferative-neovascularization, rubeosis iridis
    - Cataract
    - Macular edema
    - Glaucoma-due to rubeosis iridis
    - Retinal detachment
    - Vitreous hemorrhage
    - Duration of DM +degree of glucose control, HTN, genetic susceptibility
    - Mx
        - good glycemic control
        - blood pressure control
        - Pan/focal retinal photocoagulation

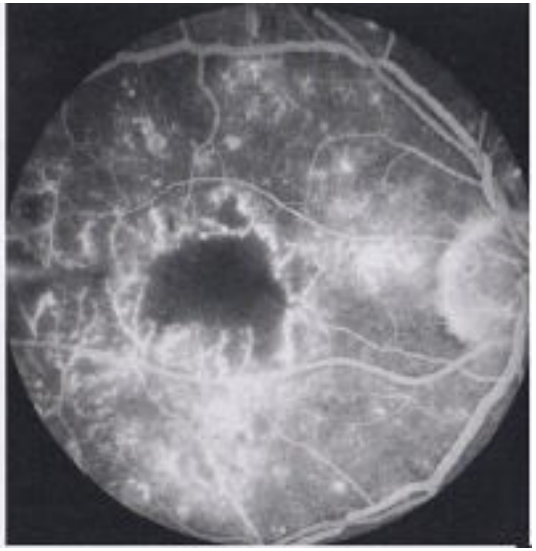






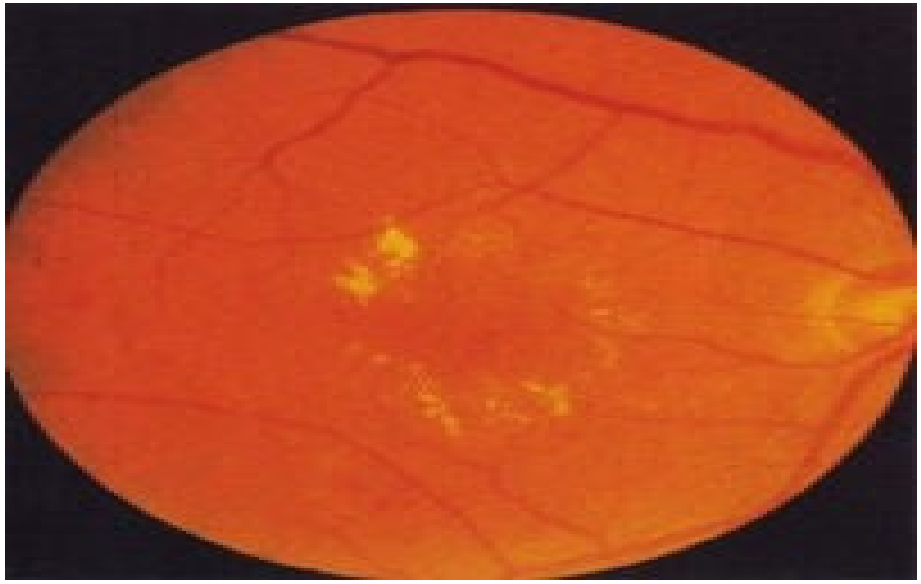




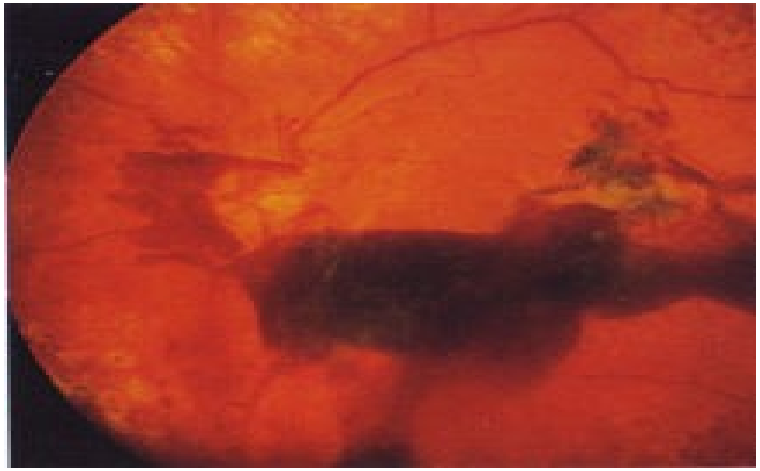




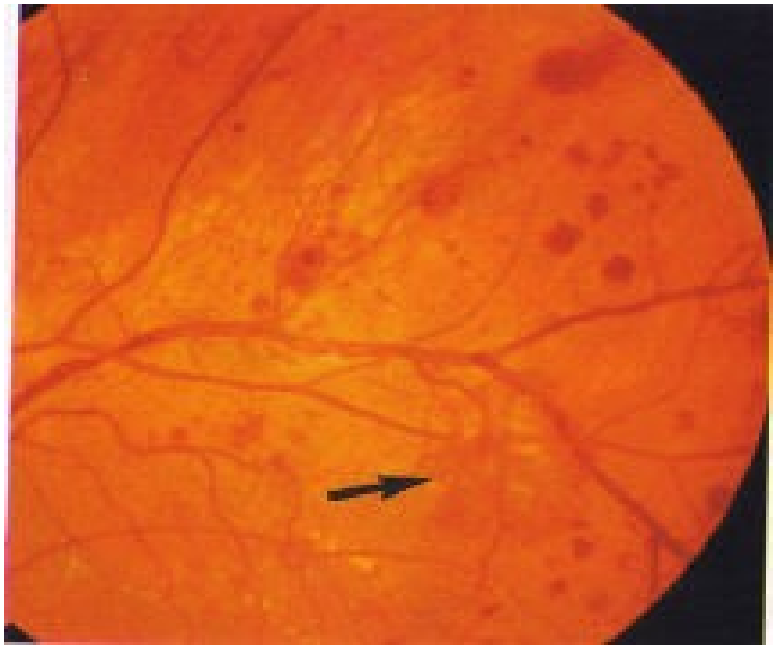












- Diabetic nephropathy
  - Leading cause of ESRD in developed world
  - Almost always associated with retinopathy
  - Proteinuria is the hall mark-↑CV risk, ↓survival
  - Usu. 15-25 yrs after DX
  - Smoking
  - Stages of DN
    1. ↑GFR $_{+}$ renomegaly….>1-5 yrs
    2. N-GFR +Thickening of GBM >5 yrs
    3. Micro albuminuria (30-300mg/d) (Incipient Nephropathy) >10 yrs
    4. Microalbuminuria (>300mg/dl) >15 yrs
    5. ESRD >20 yrs

- Microalbuminuria in type 1 DM is the 1st important predictor of progression to ESRD/overt proteinuria & irreversible renal pathology.
- Nephropathy in type 2 DM

  -can be found at time of DX

  -HTN →microalbuminuria

  -microalbuminuria Is less predictive of progression to overt Nephropathy

- Mx
  - Treat HTN-goal-130/80mmHg-no protein urea
    120/75mmHg-protein urea
  - Good glycemic control
  - Prevent /delay proteinuria-ACE inhibitor
  - OHD contraindicated if RF
  - ↓dietary protein-0.8g/KG/day-microalb.
    -0.6g/kg/day-overt alb.
- N.B.-Proteinuria is important risk factor for cardiovascular mortality & morbidity

- Diabetic neuropathy
  - Distal symmetric poly neuropathy
    - Glove &stocking distribution
    - +/-pain
  - Mononeuropathy-CN-III,IV,VI,VII
  - Radiculopathy, D.Amyotrophy
  - Autonomic neuropathy
    - GI,GU,CVS
    - Sudomotor-hyper hydrosis-upper
    - - anhydrosis-lower
    - Hypoglycemia unawareness

- Macroangiopathy
  - Diabetic risk factor
  - Duration of DM
  - ↑age
  - HTN
  - Hyperlipidemia
  - proteinuria

Diabetic foot

- 15%-life time risk
- 6% of diabetic admission
- Leading cause of non-traumatic amputation
- Risk factors
  - Male sex
  - P.neuropathy +A.neuropathy
  - DM >10yrs
  - PVD
  - Hx of previous amputation
  - Infection
  - Visual impairment
  - Poor glycemic control
  - Hx of ulceration/trauma
  - Foot deformity, callus formation, anhydrosis, altered superficial blood flow

Pathogenetic mechanism

- Neuropathy
- PVD
- Abnormal Foot biomechanics
- Poor wound healing

Wagner’ staging of diabetic foot ulcer

0.normal but at risk

1.hyperemia,cracks

2.superficial ulcer

3.deep ulcer +bone involvement

4.localized gangrene-digital amputation

5.huge gangrene –limb amputation

- Evaluation of diabetic foot
  - Inspection
    - Foot deformities
    - Fissures, toe nails, ulcer, blister, dry skin, shiny, loss of hair
  - Palpation
    - Temperature, capillary feeling time
  - Do sensory exam, DTR
  - Ankle/brachial SBP index
    - N->1
    - abnormal <0,9
    - limb at risk of amputation <0.45
  - Doppler U/S,

	Ischemic	neuropathy
symptoms	Claudication, rest pain synd.	-painless -painful neuropathy
inspection	Trophic changes, dependant rubor	-foot deformities, no trophic changes
palpation	Cold, pulseless, poor capillary feeling	Warm, pounding pulse
ulcers	Painful, heels &toe	Painless. plantar-head of metatarsals

Management of diabetic foot ulcers

Depends on staging

Stage 1&2

- adequate pressure relief
- antibiotic Rx, wound Mx
- glycemic control
- Ix for circulation

Stage 3+

- urgent admission
- X-ray, bone scan
- Rx of infection
- glycemic control
- detailed vascular assesment, surgery

- ADA identified six interventions with demonstrated efficacy in diabetic foot wounds:

(1) off-loading,

(2) debridement,

(3) wound dressings,

(4) appropriate use of antibiotics,

(5) revascularization, and

(6) limited amputation

The six principles prevention diabetic foot

1. Podiatric care-risk assessment
   - Regular foot exam. &care
   - Early detection &aggressive Rx of new lesion
2. Pulse exam.
3. Protective shoe
4. Pressure reduction-cushioned in soles
5. Prophylactic surgery
   - Correction of deformity
   - Prevention of recurrent ulcers
   - Intervention at opportune time
6. Preventive education

Infections in DM

- ↑frequency & severity of infection common in the general population - TB
- ↑ infection with rare organisms – staph., Gram^{-ve} ,fungus
- Exclusive in DM
  1. Rhinocerebral mucormycosis
  2. malignant otitis externa
  3. emphysematous cholecystitis
  4. papillary necrosis.

Dermatologic CX

- Delayed wound healing
- Necrobiosis Lipoidica Diabeticorum
- Diabetic skin spots
- vitiligo

→Acantosis Nigricans

- Scleroderma
- Lipodystrophy - atrophy /hypertrophy

- **Musculoskeletal**
  - dupuytren’s contracture
  - Diabetic chieroarthropathy
  - Foot deformities
    - claw toe
    - hammer
    - brunner’s deformity

- **Long term MX of DM**

❖ Comprehensive diabetic care

-involve all medical & psychosocial disciplines

-patient should be involved

Goal of Rx - avoid sx of hyperglycemia

-↓↓/delay/treat chronic cx of DM

-help pt to lead NL life style

Glycemic Goal

- A1C-<7
- Pre prandial capillary plasma glucose-90-130
- Peak postprandial capillary plasma glucose-<180

BP Goal

<130/80,125/75 if proteinurea

Lipid Goal

- LDL-<1oo
- HDL->40
- TAG-<150

Pt education

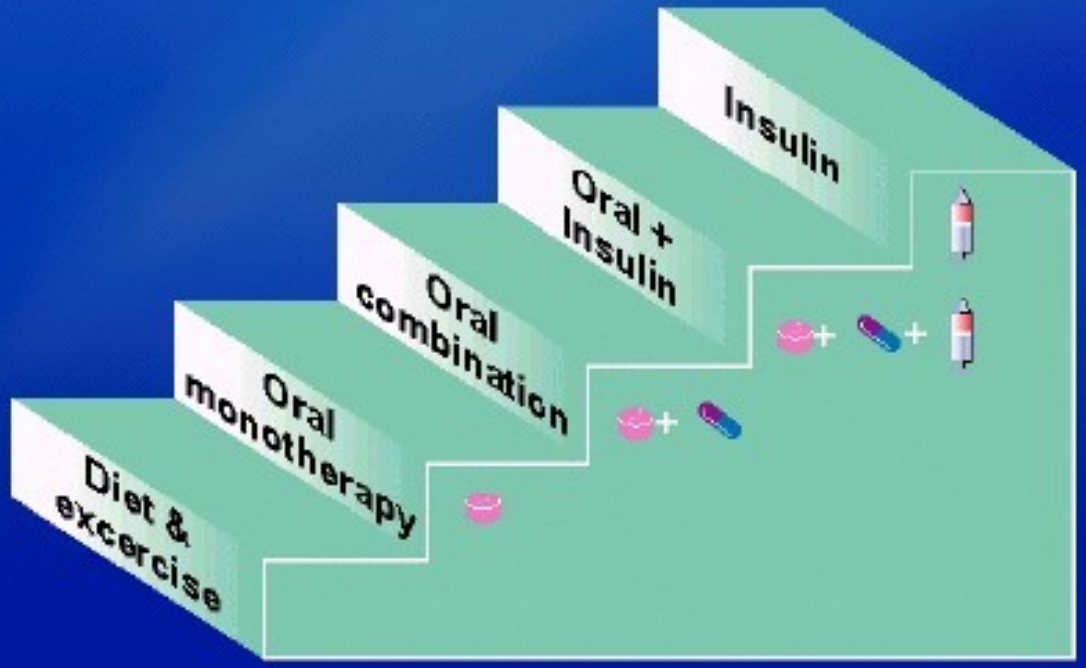
- prevention - diet, exercise
- SMBG, urine ketone
- Mx during acute illnesses
- Mx of hypoglycemia
- foot & skin care
- Mx b/n ,during & after exercise
- modify risk factors

- Diet
  - Daily calory intake
  - Protein-10-35%,High protein diet not recommended
  - Sat. fat-<7%
  - Poly unsaturated fat-<10%
  - Carbohydrate -45-65%
  - Avoid easily absorbable CHO
  - ↑fibrous diet
  - Daily cholesterol-<200mg/dl
  - diet that includes fruits, vegetables, fiber-containing foods, and low-fat milk is advised

- Exercise
  - ↓CVS risk ,↓BP, ↓body fat, ↓blood glucose
  - Maintain muscle mass
  - Increase insulin sensitivity
  - Can lead to hyper/hypoglycemia based on
    - Pre exercise glycemic level
    - Pre exercise insulin level
    - Extent of exercise
  - Monitor RBS before, during &after ex.
  - Delay if RBS <100mg/dl or >250
  - Eat meal 1-3hr before ex. Or take supplemental CHO at least every 30min.
  - ↓insulin doses
  - Avoid injection of insulin to the exercising limb
  - Relative CI-DRP&DNP-since vigorous ex may lead to retinal hemorrhage/detachment in un treated PDRP

	Type 1 DM	Type 2 DM
Glycemic control	Diet Insulin +/- exercise	Diet Exercise pharmacologic
Treat associated conditions		HTN, obesity, CAD dyslipidemia
Screen & manage cx	+/-	+

Stepped management of type 2 diabetes



- Oral agents
  - insulin secretogoues-sulfonylureas, meglitinides
  - Biguanides-metformin
  - ą-glucosidase inhb.-acarbose, migliton
  - Thiazolidindiones-rosiglitazone, pioglitazone
  - →Can use combination
  - Commonly used combinations
    1. Secretogogues +metformin/thiazolidindiones
    2. Sulfolnylureas +AGE
    3. Insulin +metformine/thiazolidindiones

Insulin preparations				
preparation	onset	peak	Effective duration	Total duration
Short acting -Lispro -regular	15min 30-60min	30-90min 2-3hr	3-4hr 3-6hr	4-6hr 6-8hr
Intermediate action -NPH -Lente	2-3hr 3-4hr	6-10hr 6-12hr	10-16hr 12-18hr	14-18hr 16-20hr
Long acting -Ultra lente -glargine	6-10hr 4hr	10-16hr -	18-20hr 24hr	20-24hr >24hr

Monitoring the Level of Glycemic Control

- Self-monitoring of blood sugar (individual frequency)
- HbA1C testing (2-4 times/year)
- Patient education (annual)
- Eye examination (annual)
- Foot examination (daily by patient, annual by physician)
- Screening for nephropathy (annual)
- Blood pressure measurement
- Lipid profile (annual)

Approach to DM patient

- Hx
  - Family hx of DM & its cx
  - Wt change
  - Risk factors for CVD
  - Exercise, alcohol use, smoking, nutritional hx
  - Symptoms of hyperglycemia
    - polyuria, polydipsia, weight loss, fatigue, weakness, blurry vision
    - Frequent superficial skin infections (vaginitis, fungal skin infections),
    - Delayed wound healing after minor trauma

- If known DM
  - type of Rx
  - Level of glycemic control-Hgb A1c,FBS
  - frequency of hypoglycemia
  - Diabetic cx
  - pt’s knowledge about DM, exercise, and nutrition
  - DM-related comorbidities - HTN, CVD, dyslipidemia

- P/E-complete+special attention on
  - BMI
  - BP –supine & sitting, orthostatic blood pressure -AN
    - > 130/80 mmHg is considered HTN in DM.
  - Oral hygiene, teeth and gums, periodontal disease is more frequent
  - Peripheral pulses
  - Extremities
    - Callus, nail disease
    - Fungal superficial infections, ulcer, fissures
    - deformity (hammer or claw toes and Charcot foot)
  - Injection sites
  - retinal examination
  - peripheral neuropathy
    - ankle reflexes
    - Vibratory sensation, touch with a monofilament, pinprick sensation

- Classify they type of DM
- Laboratory Assessment
  - To meets Dx of DM-FBS,RBS,OGT
  - level of glycemic control HgA1C.
  - screened for DM-associated conditions or Cx
    - U/A-protein- microalbuminuria
    - Lipid profile---dyslipidemia,
    - TFT---------thyroid dysfunction
    - Cardiac stress test—if CVD risk.
  - laboratory test help in classification of the type of DM
    - Serum insulin or C-peptide - do not always distinguish type 1 from type 2 DM but low C-peptide level confirms a patient's need for insulin.
    - Many individuals with new-onset type 1 DM retain some C-peptide production.
    - islet cell antibodies at the time of diabetes onset may be useful if the type of DM is not clear based on the characteristics described above.