DIABETES MELLITUS: AN OLD DISEASE WITH NEW CHALLENGES

CDR Scott Gaustad
Therapist category day 2008
5,000 years ago, Susruta, an Indian physician, described a disease as

“brought on by gluttonous overindulgence in rice, flour, and sugar,” in which urine is “like an elephant’s in quantity.”
What is Diabetes?

Diabetes is a group of diseases marked by high levels of blood glucose resulting from defects in insulin production, insulin action, or both. Diabetes can lead to serious complications and premature death, but people with diabetes can take steps to control the disease and lower the risk of complications (CDC National Diabetic Fact Sheet for 2005).

Diabetes is a disease in which the body does not produce or properly use insulin. Insulin is a hormone that is needed to convert sugar, starches and other food into energy needed for daily life. The cause of diabetes continues to be a mystery, although both genetics and environmental factors such as obesity and lack of exercise appear to play roles (American Diabetes Association, 2008).
Historical Perspective

History of Diabetes

- 1552 B.C Earliest known record of diabetes - recorded on Egyptian papyrus by physician Hesy-Ra
- Mentioned polyuria as a symptom
- 250 B.C Diabetes described by Arateus as “the melting down of flesh and limbs into urine.”
- 1164 A.D Greek physician Galen of Pergamum mistakenly diagnoses diabetes as an ailment of the kidneys
- 1425 Diabetes first appears in the English language as the Middle English word ‘diabete’ – Greek for siphon and later ‘Mellitus’ – a term for honey is added.
Historical Perspective

History of Diabetes

- **16th Century**: Swiss physician Paracelsus identifies diabetes as a serious general disorder.
- **Early 19th Century**: First chemical tests developed to indicate and measure the presence of sugar in urine.
- **Late 1850’s**: French physician, Priorry, advises diabetes patients to eat extra large quantities of sugar as treatment.
- **19th Century**: French researcher Claude Bernard, studies the workings of the pancreas and the glycogen metabolism of the liver.
Historical Perspective

History of Diabetes

- Late 19th Century: Italian diabetes specialist, Catoni, isolates his patients under lock and key in order to get them to follow their diets

- 1869: Paul Langerhans, a German medical student, announces in a dissertation that the pancreas contains two systems of cells. One set secretes the normal pancreatic juice, the function of the other is unknown. Several years later they are identified as the ‘islets of Langerhans’

- 1901: American pathologist Eugene Opie of John Hopkins University in Baltimore establishes a connection between the failure of the islets of Langerhans in the pancreas and occurrence of diabetes

- Summer 1921: Dr Banting work leads to the discovery of insulin. A de-pancreatized dog is successfully treated with insulin
Historical Perspective

**History of Diabetes**

- 1940’s: Link is made between diabetes and long-term complications (kidney and eye disease)
- 1944: Standard insulin syringe is developed, helping patients with self-management
- 1955: Oral anti-glycemic drugs are introduced
- 1959: Two major types of diabetes are recognized: type 1 (insulin-dependent) and type 2 (non-insulin dependent) diabetes
- 1970: Blood glucose meters and insulin pumps are developed.
- 1983: First biosynthetic human insulin is introduced
Historical perspective

History of Diabetes

1993: *Diabetes Control and Complications Trial* (DCCT) report is published. The DCCT results clearly demonstrate that intensive therapy delays the onset and progression of long-term complications in individuals with *type 1 diabetes*.

1998: The *United Kingdom Prospective Diabetes Study* (UKPDS) is published. UKPDS results clearly identify the importance of good glucose control and good blood pressure control in the delay and/or prevention of complications of *type 2 diabetes*.

1999: Scientists conduct the first successful islet transplant at the University of Alberta Hospital – known as “The Edmonton Protocol”.

The International Diabetes Federation estimates that 246 million adults worldwide have diabetes mellitus.

- Estimated that by 2025, the figure is expected to reach 380 million.
- Diabetes pandemic parallels that of the obesity
  - 2005, about 400 million adults were obese; it is anticipated that this will almost double by 2015.

Diabetes accounts for ~6% of total global mortality, with 50% of diabetes-associated deaths being attributed to cardiovascular disease. (1)

An estimated 22 million children worldwide are obese or overweight, and, unsurprisingly, the greater occurrence of obesity in young people has been accompanied by an increase of early onset of type 2 diabetes. This form of diabetes might have a more aggressive phenotype than that of adult onset. (1)

20.8 million children and adults in the United States, or 8% of the population, have diabetes. While an estimated 14.6 million have been diagnosed, unfortunately, 6.2 million people (or nearly one-third) are unaware that they have the disease. (2)
Epidemiology of Diabetes

- Diabetes is the sixth leading cause of death listed on U.S. death certificates, contributing to ~225,000 deaths annually.

- Approximately 1.3 million new cases of diabetes are diagnosed each year in the United States,
  - type 1 diabetes accounting for 5-10% of cases
  - type 2 diabetes accounting for 90-95%

- More than 90% of older adults have type 2 diabetes characterized by insulin resistance with relative insulin deficiency.
  - Increase in insulin resistance with aging is associated with increased visceral adiposity and evidenced by elevated fasting insulin levels
Epidemiology of Diabetes

- **Amputations**
  - Lower-extremity amputation rates increase with age
    - 12 per 10,000 <44 years of age
    - 45 per 10,000 age 45-64
    - 100 per 10,000 > 65 years of age

- **Blindness**
  - Diabetes is the most common cause of blindness
  - **Diabetes** and hypertension are responsible for majority of dialysis cases
  - **Gestational diabetes** is also spiraling upwards, now affecting up to 5% of pregnancies.
Epidemiology of Diabetes

- **Economic Costs**: The total estimated cost of diabetes in 2007 is $174 billion, including $116 billion in excess medical expenditures and $58 billion in reduced national productivity. (3)

- Medical costs attributed to diabetes include $27 billion for care to directly treat diabetes, $58 billion to treat the portion of diabetes-related chronic complications that are attributed to diabetes, and $31 billion in excess general medical costs. (3)

- People with diagnosed diabetes incur average expenditures of $11,744 per year, of which $6,649 is attributed to diabetes. (3)

- People with diagnosed diabetes, on average, have medical expenditures that are 2.3 times higher than what expenditures would be in the absence of diabetes. (3)

(3) *Diabetes Care* 31:1–20, 2008
Epidemiology of Diabetes

- Diabetes is particularly common among middle-aged and older American Indians and Alaska Natives.
  - Among the Pima Indians of Arizona, *about 50 percent of people between the ages of 30 and 64 have diabetes*. Diabetes rates are highest in Pima children whose parents developed diabetes at an early age.

- Becoming increasingly common among American Indian children ages 10 and older.

- Between 1986 and 1988, the death rate for diabetes in American Indians was estimated to be 4.3 times the rate in non-Hispanic whites. *Diabetes contributes to several of the leading causes of death in American Indians: heart disease, cerebrovascular disease, pneumonia, and influenza.*
Clinical Evaluation

- Thorough medical history and evaluation:
  - Age
  - Eating patterns
  - Previous diabetic education
  - Review of previous treatment regimens
  - Current treatment regimens
  - DKA frequency,
  - Hypoglycemic awareness
  - History of diabetic complications
    - Microvascular disease, including autonomic
    - Macrovascular disease
    - Psychological problems and
    - Dental disease
Clinical Evaluation

- Physical Examination:
  - Height, weight and BMI
  - Vital signs
  - Skin examination
  - Foot examination with classification
    - Inspection
    - Palpation for pulse
    - MSR
    - Determination of proprioception, vibration (128Hz) and monofilament test (10g/5.07 Simmes Weinstein)
    - Diabetic Risk Categories (0, 1, 2, 3)
Clinical Evaluation

What are the symptoms of diabetes mellitus?

- Polydipsia
- Polyuria
- Weight loss
- Blurred vision/Presbyopia
- Increased hunger
- Frequent skin, bladder or gum infections
- Irritability
- Tingling or numbness in hands or feet – paresthesia
- Slow to heal wounds
- Extreme unexplained fatigue
- Sometimes there are no symptoms with type 2 diabetes
Clinical Evaluation

- **Laboratory evaluation – what to order**
  - A1C, if results not available in past 2-3 months
  - If not performed in the past year:
    - Fasting lipid profile – LDL and HDL and triglycerides
    - Liver function tests
    - Urine albumin
    - Serum creatinine
    - TSH in type 1 diabetics

- **Referrals – when to refer**
  - Annual eye exam requirement
  - Medical Nutrition Therapy (MNT)
  - Diabetes self-management education (CDE)
  - Dental examination
  - Mental health professional – high prevalence of depression
Clinical Evaluation

- In 1997, ADA issued diagnostic and classification criteria (16)
- Four clinical cases:
  - **Type 1 diabetes** (Beta cell destruction - insulin deficiency)
  - **Type 2 diabetes** (progressive insulin secretory defects – insulin resistance)
  - **Gestational diabetes mellitus (GDM)**
  - **Other** specific types
    - Genetic defects in beta-cell function
    - **Pre-diabetes** (IFG 100-125mg/dl or IGT 2hr PG 140mg/dl to 199 mg/dl)
    - Diseases of the exocrine pancreas (ie: Cystic Fibrosis)

(16) Diabetes Care; January 2008; 31, Research Library, pg. S12
Clinical Evaluation

**Diagnosis of diabetes**

- Criteria for non-pregnant adults and children:
  - FPG > 126mg/dl. Fasting is defined as no caloric intake for 8 hours
  - or
  - Symptoms of hyperglycemia and casual plasma glucose >200mg/dl. Casual sx’s = polyuria, polydipsia, unexplained weight loss
  - or
  - 2 hour plasma glucose >200mg/dl during an OGTT
    (OGTT, although more sensitive than FPG, it is poorly reproducible and difficult to perform in practice)
Clinical Evaluation

Testing for type 2 diabetes in asymptomatic adults

Standards of Medical Care in Diabetes – 2008, recommends testing to be considered in all adults who are overweight ($BMI > 25kg/m^2$) and have the additional risk factors:

- Physical inactivity
- First degree relatives with diabetes
- Members of a high-risk ethnic population
- Women who delivered a baby weighing > 9lbs. or diagnosed with GDM
- Hypertensive > 140/90mmHg or on therapy for hypertension
- IGT or IFG on previous testing

In the absence of the above, testing for pre-diabetes and diabetes should begin at 45 years of age

If tests are normal, testing should be repeated at least at 3-yr intervals
Clinical Evaluation

- **Testing for type 2 diabetes in children:**
  - Overweight (BMI > 85th percentile for age and sex). Plus **any two** of the following risk factors:
    - Family history of type 2 diabetes in the first or second-degree relative
    - Race and ethnicity (Native American, African American, Latino, Asian American and Pacific Islander)
    - Signs of insulin resistance or conditions associated with: **Acanthosis nigricans**, HTN, dyslipidemia

Additionally, anterior and posterolateral cervical skin folds.
Clinical Evaluation

**Screening for type 1 diabetes**

- **No** current consensus as to follow-up testing if positive antibody test
- Incidence of type 1 diabetes is low, <0.5%
- Typically individuals present with acute symptoms and/or have already been diagnosed with hyperglycemia
Pathophysiology of Diabetes

- **Lung function related to Diabetes Mellitus**
  - Predisposition to:
    - Infections
    - Aspiration
    - Pulmonary edema
    - Bronchomotor dysregulation
    - Disordered breathing during sleep
    - Abnormal lung mechanics and gas exchange
  - Diminished ability to perceive inspiratory resistive loads
  - Restrictive ventilatory defect with proportional reductions (8-20%) in lung volume, FVC, FEV₁ and forced expiratory flow in midrange of VC.
  - TLC, lung elastic recoil and dynamic lung compliance are abnormally reduced in type 1 diabetics
Pathophysiology of Diabetes

- **Lung function related to Diabetes Mellitus**
  - Elevated fasting blood glucose alone is associated with reduced lung function\(^{(5)}\)
  - **Normative Aging Study**
    - Adult men before, at and after being diagnosed with diabetes – men who developed type 2 diabetes had lower \(FEV_1\) and \(FVC\) at all time points \(^{(6)}\)
  - ** Freemantle Diabetes Study**
    - Declining spirometry and lung volume indices – directly related to poor glycemic control \(^{(7)}\)
  - Diabetic angiopathy erodes pulmonary vascular reserves, thereby increasing susceptibility to complications induced by other pathological processes and by aging.

\(^{(5)}\) American Journal of Respiratory and Critical Care Medicine 2003;167:911-916
\(^{(6)}\) Respiratory Medicine 2005;99:1583-1590
\(^{(7)}\) Diabetes Care 2004; 27:752-757
Pathophysiology of Diabetes

-Lung function related to Diabetes Mellitus-

- Detrimental effects of DM
  - on alveolar capillaries were found to be correlated with age,
  - duration of DM and urinary albumin excretion
  - Microalbuminuria was the only significant predictor of DLCO/VA.  (8)

- Lung is functionally involved in children with type 1 early on in the course of the disease  (9)

- Type 1 diabetics show a reduced TLC and DLCO – features consistent with pulmonary restrictive dysfunction  (10)

(9) Pediatric Pulmonology 2004 Jan; 37(1): 17-23
(10) Medical Principles of Practice 2003 Apr-Jun; 12(2): 87-91
“if a man is as old as his arteries you should, according to one traditional axiom, add 20 years for diabetes...”
Pathophysiology of Diabetes

**Cardiovascular function related to Diabetes Mellitus**

- Individuals with type 2 diabetes mellitus have increased cardiovascular disease (11)(18)
- The effect of tight glycemic control did not seem to reduce cardiovascular risk in clinical trials! (11)
  - [http://www.theheart.org/article/874809.do](http://www.theheart.org/article/874809.do)
- Glucose increases oxidative stress which stresses the artery wall - promotes LDL oxidation (11)
- Hyperglycemia enhances monocyte adhesion to arterial endothelial walls - impaired Nitric Oxide production (11)
- Diabetic dyslipidemia is strongly related to atherosclerosis (11)
- Reduced HDL in type 2 diabetics (11)

(18) Cardiology Clinics, Vol 19, No 3, August 1001
Cardiovascular function related to Diabetes Mellitus

Blood pressure should be measured at **every** visit
- **Systolic >130mmHg or diastolic > 80mmHg** - monitor
- **Systolic 130-139 or diastolic 80-89mmHg** – advised to begin or continue with lifestyle therapy for 3 months – then recheck
- **Systolic >140mmHg or diastolic >90mmHg** it is recommended the patient begin a regimen of ACE or ARB (except in pregnant patients) and/or diuretics

Type 1 diabetes hypertension is often the result of underlying nephropathy, while in type 2 diabetes, it usually other cardiometabolic risk factors.

Cardiovascular risk factors should be assessed at least once a year
- Dyslipidemia
- Hypertension
- Smoking
- Family history
- Micro or macroalbuminuria
Pathophysiology of Diabetes

- Cardiovascular function related to Diabetes Mellitus

- Delayed wound healing (12)
  - Macro and microvascular pathology
  - Decrease in IGF-1 and IGF-II, keratinocyte growth factor, VEGF and PDGF occurs in diabetics
  - Abnormal angiogenesis and reduction of nerve growth factor (proangiogenic)

(12) Diabetes Care, Vol 30, No 12, December 2007
The median time for a diabetic foot ulcer to heal is 6 months... and only 2/3rds of these will heal!

A need for diabetic foot guidelines?
Neuro function related to Diabetes Mellitus

- Neuropathy
  - All patients should be screened for diabetic polyneuropathy (DPN) at diagnosis and at least annually
  - Education of all patients about self-care of their feet
  - Use of NCV/NCS can confirm DPN and is a great clinical tool
  - Most common neuropathies
    - Sensory
    - Autonomic – cardiovascular autonomic neuropathy has a high mortality and morbidity
    - Motor

- Foot care
  - Comprehensive foot examination upon diagnosis
    - Monofilament, tuning fork, PPG, digital toe pressures, ABI, SPPS, TCOM
Pathophysiology of Diabetes

- **Neuro function related to Diabetes Mellitus**
  - Diabetic autonomic neuropathy
    - Resting tachycardia
    - Exercise intolerance
    - Orthostatic hypotension
    - Constipation
    - Sudomotor dysfunction
  - Impaired mobility and functional disability through altered balance and posture
    - Gait and balance assessment tools – Tinetti
    - Gait
      - Evidence that diabetic patients walk slower with greater step variability and have higher plantar pressure (13)

(13) Diabetes/Metabolism Research and Reviews 2008; 24:173-191
Pathophysiology of Diabetes

Glycemic Control

Two primary techniques for health care providers

- Patient self-monitoring of blood glucose (SMBG)
  - Should be carried out 3 or more times a day for patients using:
    - Multiple injections
    - Insulin pump
  - SMBG has been found to reduce A1C ~0.4%

A1C%

- Performed at least 2 times per year (if meeting treatment goals)
- Perform A1C% test quarterly in patients whose therapy has changed or not meeting glycemic goals
- Use point-of-care testing - for A1C% as you feel is necessary
A1C% continued

- A1C% does not provide a measure of glycemic variability, hypoglycemia and not recommended as a diagnostic tool
- For variability analysis – use both A1C% and SMBG results
- DCCT - A1C% and mean plasma glucose level correlation:

<table>
<thead>
<tr>
<th>A1C(%)</th>
<th>Mean plasma glucose (mg/dl)</th>
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<tr>
<td>6</td>
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**Glycemic goals:**
- Lowering A1C% to an average of at or below 7%
  - Reduces microvascular complications
  - Reduces neuropathic complications
  - Possibly macrovascular complications (evidence E)

**Recommendations**
- Pre-prandial capillary plasma glucose
  - 70-130mg/dl
- A1C%
  - <7.0%
- Peak postprandial capillary plasma glucose
  - <180mg/dl
Diabetes Care

- Oral medications used for Diabetes Mellitus
  - *Sulfonylureas: Micronase (Glyburide)
    - Decrease A1C% by ~ 1-2%
    - Action:
      - Increase insulin (12-24 hours)
      - Interaction with exercise:
        - Post-exercise hypoglycemia
  - *Biguanide: Metformin
    - Decrease A1C% ~ 1-2%
    - Action:
      - inhibit hepatic gluconeogenesis, glycogenolysis and enhances insulin sensitivity
      - Interaction with exercise:
        - Impaired hepatic glucose production

* Most common (gold standards in oral treatment of DM)
Diabetes Care

- Oral medications used for Diabetes Mellitus
  - Thiazolidinediones: Rosiglitazone
    - Decrease A1C% ~ .5-1.4%
    - Action:
      - Increase muscle/fat insulin sensitivity
      - Interaction with exercise
        - Enhanced skeletal muscle glucose uptake
  - Glucosidase inhibitors: Acarbose and Miglitol
    - Action:
      - Impair carbohydrate absorption
      - Interaction with exercise
        - Hypoglycemia if exercise is postprandial

- First line of offense is MNT and physical activity
Physical Activity/Exercise

In the 3rd National Health and Nutrition Examination Study – 31% of individuals with type 2 diabetes reported not regularly exercising. (17)

May stave off type 2 diabetes for at least 3 years – DPP study sponsored by NIDDK (14)

Lifestyle intervention and modification – AHEAD (Action for Health in Diabetes) study found (14):
- Reduced the risk of DM by 58% and Metformin by 31%
- Participants 60 years and older reduced their risk of DM by 71%
- Progression from pre-diabetes to type 2 diabetes decreased by 31-63% in adults with IGT

Physical Activity/Exercise

- In persons with type 2 diabetes, **90 to 150** minutes of accumulated moderate-intensity physical activity per week and/or resistance/strength training distributed over at least three days per week and with no more than two consecutive days without physical activity is recommended. 50-70% of maximum heart rate. (4)
- Surgeon General's 1996 report recommended adults accumulate at least 30’ of moderate-intensity activity on most, ideally all day of the week.
- Decrease of A1C% by ~ 0.67% - 1.2% with physical activity – type 2 and ~ 1 – 2% with MNT and activity
- Physical exercise does not generally improve the control of type 1 DM

(15) Diabetes/Metabolism Research and Reviews 2006; 22:300-306
(4) Diabetes Care; Jan 2008; 31 Research Library, S-22
Diabetes Care

**Physical Activity/Exercise**

- Patients with type 2 diabetes have lower aerobic capacity compared to non-diabetics
- Post-exercise
  - Complete replacement of muscle glycogen stores can take as long as 24 hours after exercise.
  - Hypoglycemia in type 2 diabetics is increased by Sulfonylureas and insulin injections
  - Hyperglycemia can occur in type 1 diabetics

**Recommendations:**

- Measure blood glucose before, during and after exercise
- Take extra carbohydrates for unplanned/spontaneous exercise (20-30 g/30 minutes of exercise)
- Decrease insulin dosages by 50% for planned exercise
- Have easily absorbable carbohydrates in the clinic during exercise
- **Supervise** brittle type 1 and 2 diabetics in your clinic – monitor for signs of hyperglycemia and hypoglycemia respectively.
Diabetes Care

- **Physical Activity/Exercise**
  - Recommendations continued
  - ACSM recommendations (19)
    - Monitor blood glucose prior to exercise – especially when modifying exercise regimen
    - Late onset of hypoglycemia can occur up to 48 hours post-exercise
    - Avoid exercise if fasting plasma glucose is greater than 250mg/dL and ketosis is present or greater than 300mg/dL and no ketosis
    - To lower the risk of hypoglycemia associated with exercise, avoid injecting insulin into the extremities. Inject into the abdomen
    - Patients with autonomic neuropathy cannot detect s/s of hypoglycemia
    - Monitor s/s of poor thermoregulation
    - Monitor for signs of silent ischemia and widening Q-T interval
    - p.m. exercise – intake of additional carbohydrates is necessary to avoid nocturnal hypoglycemia

Helmrich et al. Found that for every 500 kcal of additional physical activity per week was associated with a 6% reduction in diabetes risk.
Potential problems during exercise

- Hyperglycemia
  - Increase in hepatic glucose production, ketogenesis

- Hypoglycemia
  - Excess insulin – too much pre-exercise insulin
  - Increased exercise-induced sensitivity
  - Increase absorption from injection site
  - Medication – Sulfonylureas, insulin (injection site)
  - Insufficient glucose/carbohydrates
Diabetes Care

- **Potential problems during exercise**
  - Worsening of existing complications
    - Retinopathy
    - Proteinuria (acute)
  - Consequence of existing complications
    - Peripheral neuropathy – foot injuries
    - Coronary artery disease
    - Autonomic neuropathy causing arrhythmias (prolong QT interval – correlates to sudden death), lower stroke volumes and decreased ejection fractions
  - Nephropathy
    - Dialysis limits exercise capacity because of anemia, myopathy, hypotensive state, and submax heart rate response
Types of exercise

**Light activities**
- Light housework
- Strolling, 1.0mph
- Golf, using a power cart
- T’ai Chi
- Arm/chair exercises
- Aquatic exercises

**Moderate activities**
- Cycling, 5.5mph
- Walking, 3.0mph
- Golf, pulling a cart, carrying clubs
- Rowing, 2.5mph
- Swimming, .25mph
- Doubles in tennis

**Strenuous activities**
- Vigorous dancing “dancing with the stars”
- Cycling, 10mph
- Walking, 5mph
- Singles tennis
- Hill climbing, 100’/hour
- Chopping wood

Brittle type 1 and 2 diabetics
Nephropathic patients with and/or without diabetes
Patients with autonomic neuropathy

(20) Cardiology Clinics; Vol 19, No 3, August 2001. pp. 498-499
Diabetes Care

Resistance exercise improves insulin sensitivity to about the same extent as aerobic exercise. Clinical trials have provided strong evidence for the A1C% lowering value of resistance training in older adults with type 2 DM.
Prevention/Delay of Diabetes

**Recommendations**

- Patients with IGT or IFG should be given counseling (MNT/CDE) on weight loss of 5-10% of body weight and increase in physical activity to at least 150 min/wk of moderate exercise – walking (4).
- In addition to lifestyle counseling, Metformin may be considered in those who are at very high risk and/or are obese and under 60 years of age.
- Monitoring of the development of diabetes in those with pre-diabetes every year.
- Intensive Lifestyle modification program (RCT) shown to be very effective ~ 58% reduction after 3 years.

(4) Diabetes Care; Jan 2008; 31 Standards of Medical Care in Diabetes, Research Library, S-22
Future Challenges Trends in Diabetes Management

- AMP-Activated Protein Kinase
  - Stimulation of glucose uptake – even in the absence of insulin
  - Treatment of type 2 DM
- Continuous Glucose Monitoring
  - Applying science into practice
- Islet Cell Transplantation
  - Alberta, Canada … success
- Glycosaminoglycans urinary excretion as a marker of the early stages of diabetic nephropathy and disease progression
- Stem Cell Research
- Genetic Research
Future Challenges Trends in Diabetes Management

- Monitoring serum protein patterns in newly diagnosed type 2 diabetes mellitus
- Role of Vitamin D alters insulin synthesis – *Archives of Disease in Childhood, June 2008* – “supplemental vitamin D to children for at least the first 2 years of life.
- Monitoring glucose homeostasis in the gastrointestinal tract
- Erythropoietin in the management of anemia and diabetes
  - Controlling iron deficiency in diabetics
- Early infant feeding
  - Duration of breastfeeding and age at introduction to bottle-feeding were inversely associated with type 1 diabetes
Future Challenges Trends in Diabetes Management

- Atrophy of foot muscles in diabetic patients – detection with ultrasonography (Rehabilitative Ultrasound Imaging - RUSI)
- Prognosis of serum liver enzymes levels in type 2 DM
  - Gamma glutamyltranspeptidase elevated levels is associated with increased mortality for C-V disease and cancers.
- A1C% as a diagnostic tool?
  - Currently not recommended by the ADA – lack of reliable research
- Skin Autofluorescence increases post-prandially in-lieu of fasting glucose and A1C%
- Oral insulin sprays…FDA difficulty
- Mediterranean Diet!
  - 83% reduction in the risk of developing type 2 diabetes
    - Intake in fiber, vegetable fat, low intake of trans-fatty acids and saturated fats and moderate intake of alcohol…
Olser, M.D. in 1892 stated “that the personal hygiene of a diabetic patient is of first importance. Sources of worry should be avoided and the patient should live in an equable climate. Flannel or silk should be worn…” a low carbohydrate diet was prescribed and the medicine of choice was opium…
Questions?

Case Study next slide…
Case Study:

Hector Ramirez is a 17 year old hispanic male who is a high school student and offensive tackle on his football team. He presents to his high school nurse complaining of blurred vision, nocturia, thirsty, and fatigue. He has noticed that his speed and agility on the football field has slowed.

PMHx:
An obese healthy male who had received all of his childhood immunizations and had the normal childhood illnesses. He was 10#2oz at birth. He was in the 96th percentile for weight and 60th percentile for height as a child. He is rather sedentary except when he is practicing and playing football. He has a positive family history of DM (mother and father).

Physical Examination:
5’8”, 234#
BMI is 35.6Kg/m^2.
Blood pressure is 135/88
Central obesity is present
No diabetic retinopathy
Case Study:

Physical Examination cont.
  - Skin: no Acanthosis nigricans or open wounds are noted
  - MSR: normal, 2+ and equal
  - Sensation: intact to LT, pressure, pain and bilateral distal
  - LEs are sensate to 5.07 monofilament (10/10)

Labs are Ordered:
  - Random blood PG: 356.0mg/dL
  - Creatinine: 0.9mg/dL
  - HCO3: 24.0mEq/L (normal range is 22-26mEq/L)
  - HDL-C: 29.0mg/dL
  - LDL-C: unable to calculate secondary to TG
  - TG: 948.0mg/dL
Case Study:

What type of diabetes does this 17 y/o male have?
1) type 1 DM
2) type 2 DM
3) Latent autoimmune diabetes of the adult (LADA)
4) Maturity-onset diabetes of the youth (MODY)

What additional laboratory tests would have been valuable?
1) A1C%
2) Insulin
3) C-peptide
4) OGTT

What should be the first course of treatment for Hector?
1) Medical Nutrition Therapy and physical activity
2) Metformin
3) Insulin
4) 1 and 2
Case Study:

What is the best approach to treating Hector’s TG levels?
1) Medical Nutritional Therapy and reducing glucose level
2) Statins
3) Fish Oil
4) Start a fibric acid derivative (“fibrates”) used to treat high cholesterol

What further steps should be taken with respect to Hector’s blood pressure?
1) His B/P is normal and no further assessment/action is required
2) A repeat B/P should be measured in 2-3 weeks and treated if it remains high
3) An ACE inhibitor should be recommended immediately
4) An urine/creatinine ratio should be obtained
5) Answers #2 and #4

Send your responses to scott.gaustad@ihs.gov