Diabetes Mellitus: Physiology, Oral Health and Exercise

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Learning Objectives

• Develop and disseminate information addressing health problems of geriatric patients, with specific focus on diabetes mellitus.

• Utilize an interprofessional approach to geriatric disease treatment and prevention with an open exchange of information and skill building from faculty and participants.

• Provide interprofessional training for faculty and providers who care for geriatric patients with a focus on team/patient bidirectional communication, prevention of co-morbidities and cultural sensitivity.

• Introduce and develop interprofessional team building skills using standardized patient teaching and simulation training.
Physiological Overview of Diabetes

• Diabetes defined
• Types of diabetes
• What is Glycosylated Hemoglobin A1C? (HgA1C, A1C)
• Treatment
• Chronic complications
• Aging and diabetes
Diabetes Mellitus (DM) Defined

• “Clinical diabetes mellitus is a syndrome of disordered metabolism with inappropriate hyperglycemia due either to absolute deficiency of insulin secretion or reduction in the biologic effectiveness of insulin or both”

Greenspan & Gardner, 2004
Type 1 Diabetes Mellitus

- Severe form associated with ketosis if untreated
- Catabolic disorder which circulating insulin is virtually absent, plasma glucagon is elevated and pancreatic β cells fail to respond
- Patients must have insulin to treat this disease
Type 2 Diabetes Mellitus

- Relative insulin deficiency, not absolute insulin deficiency
- Accounts for 80-90% of DM in the USA
- Insulin not needed to survive, though over time secretory capacity to produce insulin by the pancreatic β cells often diminishes over time
- Etiology is complex mix of genetics, tissue insensitivity and lifestyle factors
Subgroups of type 2 diabetes

• Obese
  – Insensitivity to endogenous insulin correlated with abdominal fat, distended adipocytes, over nourished liver and muscle cells develop resistance to insulin; hyperplasia of pancreatic β cells and increased insulin; with progression of disease, secondary failure of the pancreatic β cell production with exposure to prolonged fasting hyperglycemia
Subgroups of Type 2 Diabetes

• Metabolic Syndrome (Syndrome X)
  – Syndrome with key elements: hyperglycemia often associated with hyperinsulinemia, dyslipidemia, hypertension and visceral obesity

• Non-Obese
  – Deficient insulin release by the pancreatic β cells seems to be the major defect but there is also a combination of insulin resistance; ethnicity and genetics play a factor in development
What Is Hemoglobin A1c?

- Hemoglobin formed by exposure to plasma glucose over time
- Used as a marker for average blood glucose levels over the previous 3 months
- The normal range of HbA1c is 4-5.9%
- Runs >= 8.0% in poorly controlled DM
- Maintained at < 6.0% to 7.0% in well controlled DM
HgA1C Interpreted

- HgA1C is usually checked every three months by the treating provider
- This is the ability to monitor long-term serum glucose regulation
- The HgA1C level is proportional to average blood glucose concentration over the previous 4 weeks to 3 months
- Calculating the A1C: HgA1C x 35.6 – 77.3 = Average daily glucose
- Example: HgA1C = 11.4%
  - 11.4 x 35.6 = 405.84 – 77.3 = 328
  - 6.5 x 35.6 = 231.4 – 77.3 = 154
  - 5.3 x 35.6 = 188.68 – 77.3 = 111
Treatment of Diabetes Mellitus

- Diet
- Exercise
- Weight loss
- Pharmacotherapy
  - Oral agents
  - Injectables
Chronic Complications of DM

- Neurologic
- Oral
- Vascular
- Ophthalmologic
- Renal
- Cardiovascular
- Skin
- Bone and Joint
- GI/GU
Aging and Diabetes Mellitus

- Prevalence of DM approximately 26.9% of 10.9 million patients >65 years (National Diabetes Information Clearinghouse, 2011)
- Many with diabetes mellitus are obese and have other contributing characteristics such as age, gender, ethnicity, and BMI
- DM contributes to functional limitations
- Inflammatory markers: C-reactive protein (CRP) contribute to functional limitations in geriatric patients
DM and the Geriatric Patient

• Increased risk factors:
  – Increased BMI
  – Increased waist circumference
  – Hypertension
  – Age, gender, ethnicity

• Multidisciplinary assessment:
  – Physiological: medical, dental, nursing
  – Functional
  – Psychological
Oral Health and Diabetes

• Why is oral health important?
• Common oral manifestations
• Periodontal and gingival tissues
• Periodontal disease
• Oral Mucosa
• Salivary glands
Why is Oral Health Important?

- Teeth are for a lifetime!
- There is a strong link between oral health and general health.
- “Oral health is essential to general health and well-being”

The U.S. Surgeon General
Common Oral Manifestations

Dental tissue
  – Dental caries

[Insert clinical image(s) of dental caries ]
Periodontal and Gingival Tissues

- Gingivitis
- Periodontitis

[Insert clinical/microbiological image(s) of plaque, gingivitis and periodontitis]
Periodontal Disease

- Diet accumulation of biofilm on the retentive surfaces of dentition affect 64% elderly.
- Oral bacteria penetrate blood vessels, connective tissue, and progress to invade tissue, organs, systemic pathways that contribute to systemic disease.
- Poorer glycemic control is particularly associated with elevated IL-1β cytokine levels found in gingival crevicular fluid that increase severity of gingivitis and periodontitis.
Periodontal Disease - continued

• Is a sequelae of diseases
• Accounts for 30-35% of tooth loss
• >Men, ↑ in 30-40’s and older
• Risk Factors
  – Diabetes
  – Medications which dry the mouth
    • Hypertension, renal, diuretics
  – Smoking
  – Hormonal changes
Oral Mucosa

- Glossodynia (Burning tongue)
  - Etiology: idiopathic
- Fungal infection
- Poor wound healing

[Insert clinical images]
Salivary Glands

- Xerostomia (dry mouth)
- Salivary hypofunction
- Sialadenosis (enlargement of salivary glands)

[Insert clinical images]
Exercise and Diabetes

- What is the best intervention?
- Exercise intensity
- Exercise prescription
  - Adults with and without diabetes
- Challenges of safe exercise
Exercise and Diabetes
What is the Best Intervention?

• Many studies in past 10+ years have shown that Hemoglobin A1c levels are decreased with aerobic ex, resistance ex, or a combination in individuals with Type 2 diabetes

• However, many of these studies were underpowered in terms of comparing the types of exercise

- Diabetes Aerobic and Resistance Exercise (DARE) Study – well powered & controlled
- All ex groups showed reduced HbA1c compared to control group
- Combination group had a larger reduction (1.0%) compared with the resistance groups (0.4%) & aerobic groups (0.5%)
Study by Sigal, et al, 2007 (cont)

• Combination group performed 135 minutes (38.5 mins/dy if 7 dys/wk) of resistance and 135 minutes (38.5 mins/dy if 7 dys/wk) of aerobic exercise per week for a total of 270 minutes of exercise per week.

• The question was: Was the greater decrease due to the combination or due to the much higher time of exercise?

• Church et al, 2010 performed the Health Benefits of Aerobic & Resistance Training (HART-D) study to compare exercise forms.
Church et al, 2010 – HART-D Study

- Sedentary men & women with type 2 diabetes
- Maintained similar weekly training durations
- 9 month intervention
- Control group and 3 exercise groups
  - Aerobic training only
  - Resistance training only
  - Combination
- 262 subjects randomized (mean age 55.8)
Exercise Intensity in Church et al, 2010 Study

• Aerobic & combination groups performed aerobic exercise at 65% of their VO2 max 3 times per week & aerobic group averaged 140 mins/week (46 mins/visit)

• Resistance group lifted weights 3 times per week averaging 141 mins/wk (47 mins/visit) and averaging 2376 lbs/wk

• Combination group averaged 110 mins/week (37 mins/visit) on the treadmill & 35 mins/wk lifting weights averaging 2333 lbs/wk (778 lbs/visit)
Church et al, 2010 Results

- Mean change in HbA1c in combination group compared to control was -0.34% (p=.03)
- Mean changes in HbA1c for resistance training compared to control was -0.16% (p=.32)
- Mean changes in HbA1c for aerobic training compared to control was -0.24% (p=.14)
- Only the combination group increased maximum oxygen consumption (p<.05) compared with the control group
Church et al, 2010 Results - continued

• All exercise groups lost waist circumference compared to the control group
• The resistance group and the combination group lost mean fat mass compared to the control group (p<0.05)
• Conclusion: the combination of resistance and aerobic exercise improved HbA1c levels significantly more than each exercise alone
Exercise Prescription
Healthy Adults and Adults w/ Type II DM

- Submaximal endurance test (such as 1 mile walk) should be performed by a PT to estimate VO2max to measure baseline for improvement & compare to norms for age (ACSM’s Guidelines for Exercise Testing & Prescription, 7th ed) or the Six Minute Walk Test to compare distance to norms for the less fit
- Frequency and Intensity: at least 5 days of the week for moderate intensity aerobic exercise defined as 3-6 METS or 150 Kcal/day (CDC, NIH, ACSM, 1995) or vigorous intensity aerobic exercise for 20 minutes 3 days/wk (ACSM & AHA, 2007) for healthy adults
Examples of 3 to 6 MET Activities

• 3 MET
  – Walking 2.5 mph level

• 4 MET
  – Biking <10 mph leisure
  – Walking 3.5 mph level, brisk

• 5 MET
  – Stationary bike – 100 Watts (5.5), light effort
  – Low impact aerobics
  – Walking 4 mph level

• 6 MET
  – Biking 10-11.9 mph leisure
Exercise Prescription
Healthy Adults and Adults w/ Type II DM

• Church et al, 2010 recommend 46 minutes of vigorous aerobic exercise (60-80% of VO2max) 3 days per week for HbA1c decreases in adults with Type II diabetes

• ACSM & AHA, 20007 recommend activities to increase strength at least 2 days/wk; 8-10 exercises of large muscle groups; 8-12 repetitions to fatigue for healthy adults

• Church et al, 2010: Work up to 47 minutes of resistance exercise 3 days/wk for adults with Type II diabetes but dilemma: How to prescribe? Individualized and supervised initially and periodically

• Mode: any exercise that uses large muscle groups to an appropriate level of the patient’s capacity, needs, & interest

• Warm-up and cool-down
Challenges of Safe Exercise

• Recommend that patients see a physical therapist for initial evaluation and instruction in exercise program (2-3 visits plus 1-2 F/U visits over time)

• Many older adults have musculoskeletal problems and other co-morbidities that mean that the exercise prescription would have to be tailored to each individual patient as much as possible

• Precaution: Acute cardiac events significantly associated with episodic physical activity so must progress vigor of activity slowly (Dahabrch IJ & Paulus JK. JAMA. 2011 Mar 23/30; 305(12): 1225-1233)
The Cost of Diabetes in the US

• In 2007, total costs were $174 billion
  – Direct medical costs = $116 billion – after adjusting for population age and sex differences, average medical expenditures among people with diagnosed DM were 2.3 times higher than what expenditures would be without diabetes
  – Indirect costs = $58 billion – disability, work loss, premature mortality
Cost and Payment for Health Care

- Most geriatric patients enrolled in Medicare have significant out of pocket expenses related to outpatient care and dental services.
- Outpatient physician providers = 15% cost covered by patient.
- Dental care = 76% covered by patient.
- Physical therapy outpatient costs = approximately 19%.
Retirement Income

• Median income for age 65 and older in 2010 = $25,757 (Social Security Administration)
• The poverty rate for people age 65 and over was 8.7%
• Average spend 12-14% of their income on healthcare or $3,090 - $3,605
Summary: Chronicity of DM

- Neurologic
- Oral
- Vascular
- Ophthalmologic
- Renal
- Cardiovascular
- Skin
- Bone and Joint
- GI/GU
References


• Dahabreh IJ, Paulus JK. Association of episodic physical and sexual activity with triggering of acute cardiac events: systematic review and meta-analysis. JAMA. 2011;305(12):1225-33.


References - continued


