THE EPIDEMIC OF DIABETES IN LOUISIANA

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OBJECTIVES

▸ Define the scope of diabetes
▸ Impact of Diabetes on morbidity and mortality
▸ Define the financial burden of diabetes management
▸ Review the impact of screening and early detection through a brief review of the ADA guidelines.
The Impact of Diabetes Mellitus in the United States

Epidemiology, Costs, and Future Projections
Section 1

EPIDEMIOLOGY
Epidemiology of Diabetes

- 30.3 million Americans, 9.3% of the population, have diabetes
  - Diagnosed: 22.2 million
  - Undiagnosed: 8.1 million
- 1.25 million have type 1 diabetes
- Leading cause of kidney failure, nontraumatic lower-limb amputation, new cases of blindness among adults
- Major cause of heart disease and stroke
- Seventh leading cause of death

Diagnosed and Undiagnosed Diabetes in Adults ≥20 2015

- 1.7 million are newly diagnosed each year
- 30.3 million (9.4%) have diabetes
  - 23.1 million are diagnosed
  - 7.2 million are undiagnosed.
- 84.1 million Americans have prediabetes
- By age
  - <20 years 208,000
  - 20-44 4.3 million (4.1%)
  - 45-64 13.4 million (16.2%)
  - >65 years, 11.2 million (25.9%)
- By sex
  - Men: 15.7 million (13.6%)
  - Women: 14.6 million (11.2%)

### Racial/Ethnic Differences in Diagnosed Diabetes

2010-2014 data for people ages ≥20 Years or Older

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Hispanic whites</td>
<td>7.6</td>
</tr>
<tr>
<td>Asian Americans</td>
<td>9.0</td>
</tr>
<tr>
<td>Hispanics/Latinos</td>
<td>12.8</td>
</tr>
<tr>
<td>Cuban Americans</td>
<td>9.3</td>
</tr>
<tr>
<td>Central and South Americans</td>
<td>8.5</td>
</tr>
<tr>
<td>Mexican Americans</td>
<td>13.9</td>
</tr>
<tr>
<td>Puerto Ricans</td>
<td>14.8</td>
</tr>
<tr>
<td>Non-Hispanic blacks</td>
<td>13.2</td>
</tr>
<tr>
<td>American Indians/Alaska Natives</td>
<td>15.9</td>
</tr>
</tbody>
</table>

New Cases of Diagnosed Diabetes

Estimated number of new cases of diagnosed diabetes among people ≥20 years, by age group, 2010

Source: 2005-2008 National Health and Nutrition Examination Survey estimates projected to the year 2010

Number of Americans with Diagnosed Diabetes, 1980-2011

Centers for Disease Control and Prevention www.cdc.gov/diabetes/statistics
Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

1994

Obesity (BMI ≥ 30 kg/m²)

Diabetes

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2004

**Obesity (BMI≥30 kg/m²)**

- Missing Data
- <14.0%
- 14.0%–17.9%
- 18.0%–21.9%
- 22.0%–25.9%
- ≥26.0%

**Diabetes**

- Missing data
- <4.5%
- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%


Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2013

Obesity (BMI≥30 kg/m²)

- Missing Data
- <14.0%
- 14.0%–17.9%
- 18.0%–21.9%
- 22.0%–25.9%
- ≥26.0%

Diabetes

- Missing data
- <4.5%
- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%
PREVALENCE OF DIABETES IN LOUISIANA

- 521,294 persons living in Louisiana have diabetes (13.9%)
- 124,000 persons living in Louisiana have undiagnosed diabetes.
- 1,272,000 persons living in Louisiana have prediabetes (37.5%)
- Every year, an estimated 32,000 people in Louisiana are diagnosed with diabetes.
PREVALENCE OF DIABETES IN MISSISSIPPI

- An estimated 371,662 people in Mississippi have diabetes (15.4%)
- 79,000 people in Mississippi have undiagnosed diabetes.
- 810,000 people in Mississippi have prediabetes (37.5%)
Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2013

Obesity (BMI≥30 kg/m²)

- 14.0%–17.9%
- 22.0%–25.9%
- ≥26.0%

Diabetes

- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%

THE EPIDEMIC OF DIABETES

PREVALENCE OF DIABETES IN COLORADO

- Approximately 416,301 people in Colorado have diabetes (9.8%)
- 118,000 people have undiagnosed diabetes
- 1,342,000 people in Colorado have prediabetes (34.8%)
Incidence and Prevalence of Diabetes in Youth, 2012

- About 208,000 people younger than 20 have been diagnosed with diabetes (type 1 and type 2), about 0.25% of American youth.
- In 2008-2009, 18,436 people younger than 20 years in the U.S. newly diagnosed with type 1 diabetes annually, and 5,089 diagnosed with type 2 diabetes.
Complications of Diabetes

- Hypertension
- Hyperlipidemia
- Heart disease and stroke
- Blindness, eye problems
- Renal disease
- Amputations
- Other complications

Complications of Diabetes
Heart Disease, Stroke, Hypertension

• In 2009–2012, of adults aged ≥18 years with diagnosed diabetes, 71% had blood pressure ≥140/90 mmHg or used blood pressure medications.

• In 2003–2006 cardiovascular disease death rates were about 1.7 times higher among adults aged ≥18 with diagnosed diabetes than among adults without diagnosed diabetes.

• In 2010 hospitalization rates for heart attack were 1.8 times higher and stroke were 1.5 times higher among adults with diagnosed diabetes ≥20 compared to those without diagnosed diabetes.

Complications of Diabetes
Blindness, Eye Problems

• Diabetes is leading cause of new cases of blindness among adults ages 20–74 years

• Of people with diabetes aged $\geq 40$ years, 4.2 million (28.5%) had diabetic retinopathy in 2005-2008

• 655,000 (4.4% of those with diabetes) had advanced diabetic retinopathy that could lead to severe vision loss
Complications of Diabetes Renal Disease

- In 2011, diabetes was leading cause of kidney failure, accounting for 44% of all new cases of renal failure
- 49,677 people with diabetes began treatment for end-stage renal disease (ESRD)
- 228,942 people with ESRD due to diabetes were living on chronic dialysis or with a kidney transplant

Trends in age-standardized rates of diabetes-related complications among U.S. adults with diabetes, 1990-2010

Complications of Diabetes
Nervous System Disease

• ~60%–70% of people with diabetes have mild to severe forms of nervous system damage
  – Impaired sensation or pain in feet or hands
  – Slowed digestion of food in the stomach
  – Carpal tunnel syndrome
  – Erectile dysfunction
• Severe forms are a major contributing cause of lower-extremity amputations: About 60% occur in people with diabetes ages ≥20
Deaths Among People with Diabetes

- In 2010, diabetes was the seventh leading cause of death based on death certificates
  - 69,071 underlying cause
  - 234,051 contributing cause
- Likely to be underreported as a cause of death
- Overall, risk for death among those with diabetes is about twice that of people with similar age but without diabetes

Section 2
COSTS
Economic Costs of Diabetes, 2012

Total cost of diabetes: $245 billion

- $176 billion in direct medical costs, which includes costs for hospital and emergency care, office visits, and medications.
- $69 billion in indirect medical costs, which includes costs for absenteeism, reduced productivity, unemployment

Medical Expenditures Attributed to Diabetes, 2012

- Hospital inpatient care (43%)
- Retail prescriptions to treat complications of diabetes (18%)
- Diabetes medication and supplies (12%)
- Physician office visits (9%)
- Nursing/residential facility stays (8%)

  - The absolute cost of hospital inpatient care for people with diabetes rose from $58 billion in 2007 to $76 billion in 2012. However, hospital inpatient care costs fell from 50 percent to 43 percent of total direct medical costs.
Costs Incurred by People with a Diagnosis of Diabetes in 2012

- Average annual expenditures: $13,700
  - $7,900 attributed to directly to diabetes
- Medical expenditures for people with diabetes are 2.3 times higher than for those without diabetes.
  - More than 1 in 5 health care dollars in the U.S. goes to the care of people with diagnosed diabetes
  - More than 1 in 10 health care dollars in the U.S. are spent directly on diabetes and its complications

# Health Care Expenditures in the U.S Attributed to Diabetes, 2012

<table>
<thead>
<tr>
<th>Health resource</th>
<th>Dollars ($ millions)</th>
<th>% of U.S. total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Institutional care</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital inpatient</td>
<td>75,872</td>
<td>16%</td>
</tr>
<tr>
<td>Nursing/residential facility</td>
<td>14,748</td>
<td>17%</td>
</tr>
<tr>
<td>Hospice</td>
<td>32</td>
<td>0.3%</td>
</tr>
<tr>
<td><strong>Outpatient care</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office-based physician visits</td>
<td>15,221</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>6,654</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>218</td>
<td>11%</td>
</tr>
<tr>
<td>Emergency visits</td>
<td>5,027</td>
<td>6%</td>
</tr>
<tr>
<td>Ambulance services</td>
<td>4,466</td>
<td>9%</td>
</tr>
<tr>
<td>Hospital outpatient</td>
<td>212</td>
<td>12%</td>
</tr>
<tr>
<td>Home health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Podiatry</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Indirect Costs Attributed to Diabetes, 2012

<table>
<thead>
<tr>
<th>Cost component</th>
<th>Productivity loss</th>
<th>Total cost attributable to diabetes ($ billions)</th>
<th>Proportion of indirect costs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workdays absent</td>
<td>25 million days</td>
<td>5.0</td>
<td>7</td>
</tr>
<tr>
<td>Reduced performance at work</td>
<td>113 million days</td>
<td>20.8</td>
<td>30</td>
</tr>
<tr>
<td>Reduced productivity days for those not in labor force</td>
<td>20 million days</td>
<td>2.7</td>
<td>4</td>
</tr>
<tr>
<td>Reduced labor force participation due to disability</td>
<td>130 million days</td>
<td>21.6</td>
<td>31</td>
</tr>
<tr>
<td>Mortality</td>
<td>246,000 deaths</td>
<td>18.5</td>
<td>27</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>68.6</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
## Mortality Costs Attributed to Diabetes, 2012

<table>
<thead>
<tr>
<th>Primary cause of death</th>
<th>Total US deaths</th>
<th>Deaths attributed to diabetes</th>
<th>% of total of US deaths</th>
<th>Value of lost productivity ($ millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>73,000</td>
<td>73,000</td>
<td>100.0</td>
<td>7,147</td>
</tr>
<tr>
<td>Renal disease</td>
<td>46,000</td>
<td>25,000</td>
<td>55.0</td>
<td>2,004</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>136,000</td>
<td>38,000</td>
<td>28.0</td>
<td>1,484</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>687,000</td>
<td>110,000</td>
<td>16.0</td>
<td>7,827</td>
</tr>
<tr>
<td>Total</td>
<td>NA*</td>
<td>246,000</td>
<td>NA*</td>
<td>18,462</td>
</tr>
</tbody>
</table>

*Total comprises mortality for reasons other than those listed here

Economic Costs of Prediabetes, GDM and Diabetes, 2012

- Total national cost: $322 billion
- Higher medical costs: $244 billion
- Productivity loss: $78 billion
  - $245 billion for diagnosed diabetes
  - $32.8 billion for undiagnosed diabetes
  - $43.9 billion for prediabetes
  - $1.3 billion for gestational diabetes

The Epidemic of Diabetes

Diabetes in Louisiana - The Financial Burden

- Diabetes and Prediabetes in Louisiana cost an estimated $5.4 billion dollars in health care expenses per year.

- In 2015, the National Institute of Diabetes and Digestive and Kidney Diseases invested $9,446,235 in diabetes related research projects in Louisiana.

- In 2016, the Division of Diabetes Translation at the CDC spent $483,802 on diabetes prevention and educational programs in Louisiana.
Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2013

Obesity (BMI ≥30 kg/m²)

- Missing Data
- 14.0%–17.9%
- 18.0%–21.9%
- 22.0%–25.9%
- ≥26.0%

Diabetes

- Missing data
- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%

DIABETES COSTS IN COLORADO

- Diabetes and Prediabetes in Colorado cost an estimated $2.8 billion dollars in health care expenses per year.

- In 2015, the National Institute of Diabetes and Digestive and Kidney Diseases invested $29,283,094 in diabetes related research projects in Colorado.

- In 2016, the Division of Diabetes Translation at the CDC spent $1,144,548 on diabetes prevention and educational programs in Colorado.
Section 3

FUTURE PROJECTIONS
IDF Global Projections for Number of People with Diabetes, 2010-2030

<table>
<thead>
<tr>
<th>REGION</th>
<th>2010 Millions</th>
<th>2030 Millions</th>
<th>INCREASE %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>12.1</td>
<td>23.9</td>
<td>98%</td>
</tr>
<tr>
<td>Middle East and North Africa</td>
<td>26.6</td>
<td>51.7</td>
<td>94%</td>
</tr>
<tr>
<td>South-East Asia</td>
<td>58.7</td>
<td>101.0</td>
<td>72%</td>
</tr>
<tr>
<td>South and Central America</td>
<td>18.0</td>
<td>29.6</td>
<td>65%</td>
</tr>
<tr>
<td>Western Pacific</td>
<td>76.7</td>
<td>112.8</td>
<td>47%</td>
</tr>
<tr>
<td>North America and Caribbean</td>
<td>37.4</td>
<td>53.2</td>
<td>42%</td>
</tr>
<tr>
<td>Europe</td>
<td>55.2</td>
<td>66.2</td>
<td>20%</td>
</tr>
<tr>
<td>World</td>
<td>284.6</td>
<td>438.4</td>
<td>54%</td>
</tr>
</tbody>
</table>
## Estimated Number of People with Diabetes Worldwide, 2010 and 2030

<table>
<thead>
<tr>
<th>Country/Territory</th>
<th>2010 Millions</th>
<th>Country/Territory</th>
<th>2030 Millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 India</td>
<td>50.8</td>
<td>1 India</td>
<td>87.0</td>
</tr>
<tr>
<td>2 China</td>
<td>43.2</td>
<td>2 China</td>
<td>62.6</td>
</tr>
<tr>
<td>3 USA</td>
<td>26.8</td>
<td>3 USA</td>
<td>36.0</td>
</tr>
<tr>
<td>4 Russian Federation</td>
<td>9.6</td>
<td>4 Pakistan</td>
<td>13.8</td>
</tr>
<tr>
<td>5 Brazil</td>
<td>7.6</td>
<td>5 Brazil</td>
<td>12.7</td>
</tr>
<tr>
<td>6 Germany</td>
<td>7.5</td>
<td>6 Indonesia</td>
<td>12.0</td>
</tr>
<tr>
<td>7 Pakistan</td>
<td>7.1</td>
<td>7 Mexico</td>
<td>11.9</td>
</tr>
<tr>
<td>8 Japan</td>
<td>7.1</td>
<td>8 Bangladesh</td>
<td>10.4</td>
</tr>
<tr>
<td>9 Indonesia</td>
<td>7.0</td>
<td>9 Russian Federation</td>
<td>10.3</td>
</tr>
<tr>
<td>10 Mexico</td>
<td>6.8</td>
<td>10 Egypt</td>
<td>8.6</td>
</tr>
</tbody>
</table>
Annual U.S. Diabetes Burden in 2050

- By 2050, prevalence of total diabetes (diagnosed and undiagnosed) is projected to increase from 1 in 10 adults to between 1 in 5 and 1 in 3 adults.
- Incidence: from 8 in 1000 to 15 in 1000.
- Largely attributed to three key factors:
  - Aging of the U.S. population
  - Increasing size of higher-risk minority populations
  - Declining mortality among those with diabetes

Trends in age-standardized rates of diabetes-related complications among U.S. adults with diabetes, 1990-2010

PREDIABETES

Strategies for Effective Screening, Intervention and Follow-up
Learning Objectives

- Define prediabetes
- List risk factors and clinical signs in individuals at risk for type 2 diabetes
- Identify interventions to modify risk factors to preventing type 2 diabetes
- Develop a strategic management plan to proactively screen, assess, follow-up, and evaluate patients with prediabetes
- Discuss the benefits of a team-based approach to assist individuals with prediabetes to achieve their target goals and objectives
What is Prediabetes?

**Fasting Plasma Glucose**
- Diabetes Mellitus: 126 mg/dL
- Prediabetes: 100 mg/dL
- Normal: 100 mg/dL

**2-hour Plasma Glucose On OGTT**
- Diabetes Mellitus: 200 mg/dL
- Prediabetes: 140 mg/dL
- Normal: 140 mg/dL

**Hemoglobin A1C**
- Diabetes Mellitus: 6.5%
- Prediabetes: 5.7%
- Normal: 5.7%

*Any abnormality must be repeated and confirmed on a separate day*

The diagnosis of diabetes can also be made based on unequivocal symptoms and a random glucose >200 mg/dL.

Prediabetes

- An important risk factor for future diabetes and CV disease
- Risk for prediabetes is a continuum
- Important to identify early and begin intervention immediately
- Interventions can reduce the rate of progression from prediabetes to diabetes
  - Healthy diet
  - Physical activity
  - Weight loss

Prediabetes

- Long-term consequences include
  - Hypertension$^1$
  - Cancer$^2$
    - Risk increased by 15%
    - Stomach/colorectal, liver, pancreas, breast, endometrium
  - Alzheimer’s disease$^3$

Impaired Fasting Glucose and Impaired Glucose Tolerance

- IFG and IGT are risk factors for diabetes and cardiovascular disease
- Associated with:
  - Physical inactivity
  - Obesity (especially abdominal, or visceral)
  - Dyslipidemia
    - High triglycerides and/or low HDL cholesterol
  - Hypertension

37% (86 million) U.S. adults aged 20 years or older have prediabetes\textsuperscript{1} 
- Percentage was similar by race
  - 51% aged $\geq 65$ years

Only 11% were aware they had it\textsuperscript{2} 
- In adolescents aged 12 to 19 years, prevalence of prediabetes and diabetes increased from 9% to 23%\textsuperscript{3}

Projecting the Future Diabetes Population: It Is Growing

U.S. Population with Diabetes (%)

- 2020: 20.4%
- 2025: 23.2%
- 2030: 25.6%
- 2035: 28.7%
- 2040: 29.6%
- 2045: 31.4%
- 2050: 32.7%

Determinants of Prediabetes/Type 2 Diabetes: A Call to Action

- There is an association between social and environmental factors and development of obesity and type 2 diabetes
- Better understanding needed
  - Variables that influence behaviors that lead to obesity, prediabetes, and diabetes
  - How to modify these variables
- Perform research conducted on community-level interventions
- Identify individuals at risk

Prediabetes
*Process for Diagnosing*

S  Screen
A  Assess and Advise
F  Follow-up
E  Evaluate progress
S Screen
A Assess and Advise
F Follow-up
E Evaluate progress
Criteria for Screening for Prediabetes/Type 2 Diabetes in Asymptomatic Adult Individuals

DIABETES RISK FACTORS

- Physical inactivity
- First-degree relative with diabetes
- High-risk race/ethnicity
- Women who delivered a baby weighing >9 lb or were diagnosed with GDM
- Hypertension (≥140/90 mmHg or on therapy for hypertension)
- HDL-C <35 mg/dL and/or a TG >250 mg/dL
- A1C ≥5.7%, IGT, or IFG on previous testing
- Other clinical conditions associated with insulin resistance, such as severe obesity, acanthosis nigricans, PCOS
- History of CVD

- Consider testing (screening) all adults with a BMI* ≥25 kg/m² and additional risk factors
  - If no risk factors, consider screening no later than age 45 years

- If normal results, repeat testing (screening) at ≥3-year intervals
  - More frequently depending on initial test results and risk factors
  - Test yearly if prediabetes

*At-risk BMI may be lower in some ethnic groups

Adapted from:
# Modifiable Risk Factors of Diabetes/Prediabetes for CV Disease

<table>
<thead>
<tr>
<th>Non-modifiable</th>
<th>Modifiable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Physical inactivity</td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td>Overweight/Obesity</td>
</tr>
<tr>
<td>Gender</td>
<td>Hypertension</td>
</tr>
<tr>
<td>Family history</td>
<td>Smoking</td>
</tr>
<tr>
<td></td>
<td>Abnormal lipid metabolism</td>
</tr>
<tr>
<td></td>
<td>High plasma glucose levels</td>
</tr>
</tbody>
</table>
CHILDREN/ ADOLESCENTS

**S** Screen
**A** Assess and Advise
**F** Follow-up
**E** Evaluate progress
Screening Children for Prediabetes and Diabetes

Consider for all children who are overweight and have 2 of any of the following risk factors:

- Family history of type 2 diabetes in first- or second-degree relative
- High-risk race/ethnicity
- Signs of insulin resistance or conditions associated with insulin resistance
- Maternal history of diabetes of GDM during child’s gestation

Begin screening at age 10 years or onset of puberty

Screen every 3 years

A1C test is recommended for diagnosis in children

Adapted from:
GESTATIONAL DIABETES (GDM)

S  Screen
A  Assess and Advise
F  Follow-up
E  Evaluate progress
With GDM, the risks for abnormal glycemia can persist even after the early postpartum period.

Risk factors included:
- ↑ 3-month postpartum glucose
- ↑ Leptin
- ↓ HDL-C
- ↑ LDL-C
- ↑ Triglycerides
- ↓ Adiponectin

Risk of Prediabetes in Adolescent Offspring of Mothers with GDM


Obese adolescents with normal glucose tolerant (NGT) (N=255)

No Exposure to GDM (n=210; 82.3%)

Exposure to GDM (n=45; 17.7%)

Series 1

Approx 5.75 times increase in risk; $p < .001$

NGT

IGT/T2DM

Percentage (%)

100. 80. 60. 40. 20. 0.
ECONOMIC IMPACT OF PREDIABETES
The Cost of Prediabetes

- National annual medical costs of prediabetes exceeded $25 billion; an excess of $443 per person (average)

<table>
<thead>
<tr>
<th>Cost Component</th>
<th>US Average</th>
<th>Excess Associated with Prediabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>By Service Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outpatient visit</td>
<td>$215</td>
<td>$67</td>
</tr>
<tr>
<td>Physician office visit</td>
<td>$553</td>
<td>$183</td>
</tr>
<tr>
<td>Medications</td>
<td>$528</td>
<td>$194</td>
</tr>
<tr>
<td>By Complication Group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neurological symptoms</td>
<td>$16</td>
<td>$5</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>$49</td>
<td>$5</td>
</tr>
<tr>
<td>Hypertension</td>
<td>$74</td>
<td>$57</td>
</tr>
<tr>
<td>Endocrine/metabolic complications</td>
<td>$16</td>
<td>$11</td>
</tr>
<tr>
<td>All other medical conditions</td>
<td>$1,017</td>
<td>$355</td>
</tr>
</tbody>
</table>

## Diabetes Prevention Program
### 4-Year Cost-Effectiveness

<table>
<thead>
<tr>
<th>Active interventions (vs placebo)</th>
<th>Intensive Lifestyle</th>
<th>Metformin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay onset of type 2 diabetes by</td>
<td>11.1 years</td>
<td>3.4 years</td>
</tr>
<tr>
<td>Reduce incidence of type 2 diabetes by</td>
<td>20%</td>
<td>8%</td>
</tr>
<tr>
<td>Increase life expectancy by</td>
<td>0.5 years</td>
<td>0.2 years</td>
</tr>
<tr>
<td>Cost per QALY</td>
<td>$1,124</td>
<td>$31,286</td>
</tr>
</tbody>
</table>

Diabetes Prevention Program 10-Year Cost-Effectiveness

- Lifestyle cost-effective, metformin marginally cost-saving vs placebo
- Investment in lifestyle, metformin interventions for diabetes prevention in high-risk adults provides good value

<table>
<thead>
<tr>
<th>Societal Perspective</th>
<th>Lifestyle vs Placebo</th>
<th>Metformin vs Placebo</th>
<th>Lifestyle vs Metformin</th>
<th>DPP Group Lifestyle vs Placebo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undiscounted</td>
<td>11,274</td>
<td>Cost-saving</td>
<td>44,562</td>
<td>Cost-saving</td>
</tr>
<tr>
<td>Discounted</td>
<td>14,365</td>
<td>Cost-saving</td>
<td>42,753</td>
<td>1,681</td>
</tr>
</tbody>
</table>

Impact of ILI on Cost of Healthcare: Look AHEAD

Total Costs

DSE: $78,361
ILI: $73,081

Overall 10-year difference: $5,280 ($3,385, $7,175)
Annual cost per individual: $8,321 (ILI) vs. $8,916 (DSE); p = 0.002

DSE=diabetes support and education; ILI=intensive lifestyle intervention

Adapted from:
S  Screen
A  Assess and Advise
F  Follow-up
E  Evaluate progress
Assessing Patients With Prediabetes (Con’t)

● Evaluate the spectrum of predisposing risk factors
  o Existence of one may mean others might also exist
● Talk with the patient about their disease
● Involve them in developing a management strategy, especially changes in lifestyle
  - Weight loss
  - Increase activity
  - Healthy eating
● Refer to
  o Other members of the healthcare team
  o Tools and other sources of educational information
MANAGEMENT STRATEGIES

S  Screen
A  Assess and Advise
F  Follow-up
E  Evaluate progress
Benefits of Physical Activity

- Increased insulin sensitivity
- Improved lipid levels
- Lower blood pressure
- Weight control
- Improved blood glucose control
- Reduced risk of CVD
- Prevent/delay type 2 diabetes

Overview of Trials in Prediabetes

**Lifestyle Modification Intervention**

- Lifestyle intervention continues to have an effect, even after 20 years

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Intervention</th>
<th>Treatment</th>
<th>Risk Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Da Qing¹,²</td>
<td>577</td>
<td>Lifestyle</td>
<td>6 years</td>
<td>34% - 69%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20 years</td>
<td></td>
</tr>
<tr>
<td>Finnish DPS³,⁴</td>
<td>523</td>
<td>Lifestyle</td>
<td>3+ years</td>
<td>58%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 years</td>
<td></td>
</tr>
<tr>
<td>Diabetes Prevention Program (DPP)⁵,⁶</td>
<td>3324</td>
<td>Lifestyle</td>
<td>3 years</td>
<td>58%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 years</td>
<td>34%</td>
</tr>
</tbody>
</table>

Pharmacologic intervention provides benefit but with increased adverse effects with some drugs

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Intervention</th>
<th>Treatment</th>
<th>Risk Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes Prevention Program (DPP)(^1,2)</td>
<td>IGT</td>
<td>3324</td>
<td>Metformin</td>
<td>3 years 10 years</td>
</tr>
<tr>
<td>DREAM(^3)</td>
<td>IGT</td>
<td>5269</td>
<td>Rosiglitazone</td>
<td>3 years</td>
</tr>
<tr>
<td>STOP-NIDDM(^4,5)</td>
<td>IGT</td>
<td>1429</td>
<td>Acarbose</td>
<td>3 years</td>
</tr>
<tr>
<td>ACT NOW(^6)</td>
<td>IFG</td>
<td>~600</td>
<td>Pioglitazone</td>
<td>3 years</td>
</tr>
</tbody>
</table>

Members of the Healthcare Team

Healthcare professionals take a team approach to assist patients with diabetes

- Physician
- Nurse practitioner/Physician assistant
- Certified diabetes educator
- Registered dietitian
- Pharmacist
- Exercise physiologist
- Social worker/psychologist

Benefits of DSME and DSMS

- 4-times higher risk of diabetes complications for those who never received DSME
- Shown to positively impact:
  - Diabetes knowledge
  - Self-care behaviors
  - Glycemic control
  - Reduction in emergency department visits and hospitalizations

Benefits of DSME and DSMS

For those with or at risk for diabetes, DSME and DSMS:

- Encourage behavior change
- Maintenance of healthy diabetes-related behaviors
- Address psychosocial concerns
- Are on-going processes

Screen
Assess and Advise
Follow-up
Evaluate progress
Follow-up Counseling

- Shown to be important to success
- Provide annual screenings for the development of diabetes
  - Every 12 months for those with prediabetes
  - Every 3 years if screening is negative
- On a regular basis, search EHR to determine who needs to be screened/rescreened
- Continually screen for modifiable risk factors at each interaction

Follow-up Counseling (Con’t)

- Emphasize long-term goals of treatment
  - Monitor weight loss progress
  - Provide ongoing counseling for lifestyle modification
  - Consider pharmacologic therapy (e.g., metformin) if appropriate
    - IGT, IFG and/or A1C of 5.7-6.49%
    - Especially if BMI >35 kg/m²
    - Age <60
    - Women with prior gestational diabetes

- Provide referrals to other members of the healthcare team

S Screen
A Assess and Advise
F Follow-up
E Evaluate progress
Evaluating Progress
What to Do

- Assess patient's concerns
- Reconcile their medications and lifestyle
- Revise the management plan as needed
  - If it doesn’t work in the patient’s life, it doesn’t work
- Ask the patient to identify one strategy/goal they would like to accomplish
- Provide information about materials available to achieve goals, such as weight loss or physical activity log

Adapted from:
Funnell M. Role of Diabetes Education in Patient Management. Therapy for Diabetes Mellitus and Related Disorders.
Prediabetes Materials for Patients

- **Patient Handouts**
  - diabetes.org/toolkit
- **Diabetes Risk Test**
  - diabetes.org/risktest
- **National Diabetes Prevention Program**
  - www.cdc.gov/diabetes/prevention/
- **My Health Advisor**
  - diabetes.org/mha
- **CheckUp America**
  - checkupamerica.org
- **Internet-based and cell phone apps for weight loss**
- **Various websites**
Prediabetes Materials for Professionals

- ADA Clinical Practice Recommendations
  - Professional.diabetes.org/cpr
- On-line self-assessment programs
  - Cardiometabolic Risk
  - Diagnosing Prediabetes and Lifestyle Modification
    - professional.diabetes.org/ce
- ADA Diabetes is Primary webcasts
  - Professional.diabetes.org/primary
Prediabetes
Conclusions

As a member of the healthcare team, **YOU** can make a difference

- *Only 11% of people with prediabetes are aware they have it*
- **Identify those at risk for developing diabetes: be SAFE**
  - Proactively **Screen/rescreen**
  - **Assess/advise with management strategies**
  - Continually **Follow-up and Evaluate**
- **Provide educational tools for success**
- **Collaborate with other members of the healthcare team**
A 48 year old HM presents to your clinic for a wellness examination. He is concerned about his risk for the development of type 2 diabetes. There is a +FHx of DM2.

Next step?
CASE STUDIES

- A 27 year old WF presents to you for her annual preemployment physical. Screening labs include a fasting blood glucose of 128 mg/dl and an HbA1C of 6%.

  - Diagnosis?

  - Next Step?
To those whom much is given, much is expected.

John F. Kennedy
Thank You
Main Pathophysiological Defects in T2DM

- Incretin effect
- Gut carbohydrate delivery & absorption
- Hepatic glucose production
- Peripheral glucose uptake

HYPERGLYCEMIA

Adapted from: Inzucchi SE, Sherwin RS in: Cecil Medicine 2011
# Table of Contents

**COMPREHENSIVE TYPE 2 DIABETES MANAGEMENT ALGORITHM**

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<th>Title</th>
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</thead>
<tbody>
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<tr>
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<td>Lifestyle Therapy</td>
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<td>III.</td>
<td>Complications-Centric Model for Care of the Patient with Overweight/Obesity</td>
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<td>V.</td>
<td>ASCVD Risk Factor Modifications Algorithm</td>
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<td>VI.</td>
<td>Goals for Glycemic Control</td>
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<td>VII.</td>
<td>Glycemic Control Algorithm</td>
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<td>VIII.</td>
<td>Algorithm for Adding/Intensifying Insulin</td>
</tr>
<tr>
<td>IX.</td>
<td>Profiles of Antidiabetic Medications</td>
</tr>
</tbody>
</table>
## Principles of the AACE/ACE Comprehensive Type 2 Diabetes Management Algorithm

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Lifestyle modification underlies all therapy (e.g. weight, exercise, sleep, etc.)</td>
</tr>
<tr>
<td>2.</td>
<td>Avoid hypoglycemia</td>
</tr>
<tr>
<td>3.</td>
<td>Avoid weight gain</td>
</tr>
<tr>
<td>4.</td>
<td>Individualize all glycemic targets (A1c, FPG, PPG)</td>
</tr>
<tr>
<td>5.</td>
<td>Optimal A1c is $\leq 6.5%$, or as close to normal as is safe and achievable</td>
</tr>
<tr>
<td>6.</td>
<td>Therapy choices are affected by initial A1c, duration of diabetes, and obesity status</td>
</tr>
<tr>
<td>7.</td>
<td>Choice of therapy reflects cardiac, cerebrovascular, and renal status</td>
</tr>
<tr>
<td>8.</td>
<td>Comorbidities must be managed for comprehensive care</td>
</tr>
<tr>
<td>9.</td>
<td>Get to goal as soon as possible – adjust at $\leq 3$ months until at goal</td>
</tr>
<tr>
<td>10.</td>
<td>Choice of therapy includes ease of use and affordability</td>
</tr>
</tbody>
</table>
Lifestyle Therapy
RISK STRATIFICATION FOR DIABETES COMPLICATIONS

INTENSITY STRATIFIED BY BURDEN OF OBESITY AND RELATED COMPLICATIONS

**Nutrition**
- Maintain optimal weight
- Calorie restriction (if BMI is increased)
- Plant-based diet; high polyunsaturated and monounsaturated fatty acids

**Physical Activity**
- 150 min/week moderate exertion (e.g., walking, stair climbing)
- Strength training
- Increase as tolerated

**Sleep**
- About 7 hours per night
- Basic sleep hygiene

**Behavioral Support**
- Community engagement
- Alcohol moderation

**Smoking Cessation**
- No tobacco products

**Strategies**
- Avoid trans fatty acids; limit saturated fatty acids
- Structured counseling
- Meal replacement
- Structured program
- Wearable technologies
- Medical evaluation/clearance
- Medical supervision
- Screen OSA
- Home sleep study
- Referral to sleep lab
- Discuss mood with HCP
- Formal behavioral therapy
- Nicotine replacement therapy
- Referral to structured program

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Complications-Centric Model for Care of the Patient with Overweight/Obesity

**STEP 1**
**EVALUATION FOR COMPLICATIONS AND STAGING**

- **CARDIOMETABOLIC DISEASE | BIOMECHANICAL COMPLICATIONS**
  - **BMI < 25**
    - NO OVERWEIGHT OR OBESITY
  - **BMI ≥ 25**
    - OVERWEIGHT OR OBESITY

**STEP 2**
**SELECT:**
- Therapeutic targets for improvement in complications
- Treatment modality
- Treatment intensity based on staging

**Lifestyle Therapy:**
Physician/RD counseling, web/remote program, structured multidisciplinary program

**Medical Therapy (BMI ≥ 27):**
Individualize care by selecting one of the following based on efficacy, safety, and patients’ clinical profile: phentermine, orlistat, lorcaserin, phentermine/topiramate ER, naltrexone/bupropion, liraglutide 3 mg

**Surgical Therapy (BMI ≥ 35):**
Gaстрic banding, sleeve, or bypass

**STEP 3**
If therapeutic targets for complications not met, intensify lifestyle, medical, and/or surgical treatment modalities for greater weight loss. Obesity is a chronic progressive disease and requires commitment to long-term therapy and follow-up.

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ASCVD Risk Factor Modifications Algorithm

**DYSLIPIDEMIA**

**LIFESTYLE THERAPY** (Including Medically Assisted Weight Loss)

**LIPID PANEL:** Assess ASCVD Risk

If TG > 500 mg/dL, fibrates, Rx-grade omega-3 fatty acids, niacin

If statin-intolerant

Try alternate statin, lower statin dose or frequency, or add nonstatin LDL-C-lowering therapies

Repeat lipid panel; assess adequacy, tolerance of therapy

Intensify therapies to attain goals according to risk levels

<table>
<thead>
<tr>
<th>RISK LEVELS</th>
<th>HIGH</th>
<th>VERY HIGH</th>
<th>EXTREME</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDL-C (mg/dL)</td>
<td>&lt;100</td>
<td>&lt;70</td>
<td>&lt;55</td>
</tr>
<tr>
<td>Non-HDL-C (mg/dL)</td>
<td>&lt;130</td>
<td>&lt;100</td>
<td>&lt;80</td>
</tr>
<tr>
<td>TG (mg/dL)</td>
<td>&lt;150</td>
<td>&lt;150</td>
<td>&lt;150</td>
</tr>
<tr>
<td>Apo B (mg/dL)</td>
<td>&lt;90</td>
<td>&lt;80</td>
<td>&lt;70</td>
</tr>
</tbody>
</table>

If not at desirable levels:

- Intensify lifestyle therapy (weight loss, physical activity, dietary changes) and glycemic control; consider additional therapy

To lower LDL-C:

- Intensify statin, add ezetimibe, PCSK9i, colesveleam, or niacin

To lower Non-HDL-C, TG:

- Intensify statin and/or add Rx-grade OM3 fatty acid, fibrate, and/or niacin

To lower Apo B, LDL-P:

- Intensify statin and/or add Rx-grade OM3 fatty acid, fibrate, and/or niacin

To lower LDL-C in FH:**

- Statin + PCSK9i

Assess adequacy & tolerance of therapy with focused laboratory evaluations and patient follow-up

* EVEN MORE INTENSIVE THERAPY MIGHT BE WARRANTED  ** FAMILIAL HYPERCHOLESTEROLEMIA

**HYPERTENSION**

**GOAL:** SYSTOLIC <130, DIASTOLIC <80 mm Hg

**ACEi or ARB**

For initial blood pressure >150/100 mm Hg:

- DUAL THERAPY: Calcium Channel Blocker + β-blocker

- Thiazide

If not at goal (2–3 months)

- Add calcium channel blocker, β-blocker or thiazide diuretic

If not at goal (2–3 months)

- Add next agent from the above group, repeat

If not at goal (2–3 months)

- Additional choices (α-blockers, central agents, vasodilators, aldosterone antagonist)

Achievement of target blood pressure is critical

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Algorithm for Adding/Intensifying Insulin

**START BASAL (Long-Acting Insulin)**

- **A1C < 8%**
  - TDD 0.1-0.2 U/kg

- **A1C > 8%**
  - TDD 0.2-0.3 U/kg

**Insulin titration every 2-3 days to reach glycemic goal:**

- Fixed regimen: Increase TDD by 2 U
- Adjustable regimen:
  - FBG > 180 mg/dL: add 20% of TDD
  - FBG 140-180 mg/dL: add 10% of TDD
  - FBG 110-139 mg/dL: add 1 unit
  - If hypoglycemia, reduce TDD by:
    - BG < 70 mg/dL: 10% - 20%
    - BG < 40 mg/dL: 20% - 40%

**Consider discontinuing or reducing sulfonylurea after starting basal insulin (basal analogs preferred to NPH)**

**Glycemic Goal:**

- <7% for most patients with T2D; fasting and premeal
- BG < 110 mg/dL; absence of hypoglycemia
- A1C and FBG targets may be adjusted based on patient's age, duration of diabetes, presence of comorbidities, diabetic complications, and hypoglycemia risk

**INTENSIFY (Prandial Control)**

- **Add GLP-1 RA**
  - Or SGLT-2i
  - Or DPP-4i

- **Add Prandial Insulin**

**Basal Plus 1, Plus 2, Plus 3**

- Begin prandial insulin before largest meal
- If not at goal, progress to injections before 2 or 3 meals
- Start: 10% of basal dose or 5 units

**Basal Bolus**

- Begin prandial insulin before each meal
- 50% Basal / 50% Prandial
- TDD 0.3-0.5 U/kg
- Start: 50% of TDD in three doses before meals

**Insulin titration every 2-3 days to reach glycemic goal:**

- Increase prandial dose by 10% or 1-2 units if 2-h postprandial or next premeal glucose consistently > 140 mg/dL
- If hypoglycemia, reduce TDD basal and/or prandial insulin by:
  - BG consistently < 70 mg/dL: 10% - 20%
  - Severe hypoglycemia (requiring assistance from another person) or BG < 40 mg/dL: 20% - 40%
## Profiles of Antidiabetic Medications

<table>
<thead>
<tr>
<th></th>
<th>MET</th>
<th>GLP-1 RA</th>
<th>SGLT-2i</th>
<th>DPP-4i</th>
<th>AGi</th>
<th>TZD (moderate dose)</th>
<th>SU GLN</th>
<th>COLSVL</th>
<th>BCR-QR</th>
<th>INSULIN</th>
<th>PRAML</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYPO</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Moderate/Severe</td>
<td>Mild</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Moderate to Severe</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>Slight Loss</td>
<td>Loss</td>
<td>Loss</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Gain</td>
<td>Gain</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Gain</td>
</tr>
<tr>
<td>RENAL / GU</td>
<td>Contraindicated if eGFR &lt; 30 mL/min/1.73 m²</td>
<td>Exenatide Not Indicated CrCl &lt; 30</td>
<td>Genital Myotic Infections</td>
<td>Neutral</td>
<td>Neutral</td>
<td>More Hypo Risk</td>
<td>More Hypo Risk</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>GI Sx</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Moderate</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Mild</td>
<td>Moderate</td>
<td>Neutral</td>
<td>Moderate</td>
</tr>
<tr>
<td>CHF</td>
<td>Neutral</td>
<td>See #1</td>
<td>See #2</td>
<td>See #3</td>
<td>Neutral</td>
<td>Moderate</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>CHF Risk</td>
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<tr>
<td>CARDIAC</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Mild Fracture Risk</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Moderate Fracture Risk</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>ASCVD</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Mild Fracture Risk</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Moderate Fracture Risk</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>BONE</td>
<td>Neutral</td>
<td>Neutral</td>
<td>DKA Can Occur in Various Stress Settings</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Moderate Fracture Risk</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
</tbody>
</table>

1. Liraglutide—FDA approved for prevention of MACE events.
2. Empagliflozin—FDA approved to reduce CV mortality. Canagliflozin shown to reduce MACE events.
3. Possible increased hospitalizations for heart failure with alogliptin and saxagliptin.
# Impact of Intensive Therapy for Diabetes: Summary of Major Clinical Trials

<table>
<thead>
<tr>
<th>Study</th>
<th>Microvasc</th>
<th>CVD</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>UKPDS</td>
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<tr>
<td>DCCT / EDIC*</td>
<td><img src="#" alt="down" /></td>
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<td><img src="#" alt="left" /></td>
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<td><strong>ACCORD</strong></td>
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<td><strong>ADVANCE</strong></td>
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<td><strong>VADT</strong></td>
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</tbody>
</table>

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Kendall DM, Bergenstal RM. © International Diabetes Center 2009

Main Pathophysiological Defects in T2DM

- gut carbohydrate delivery & absorption
- incretin effect
- pancreatic glucagon secretion
- pancreatic insulin secretion
- hepatic glucose production
- peripheral glucose uptake

HYPERGLYCEMIA

Adapted from: Inzucchi SE, Sherwin RS in: Cecil Medicine 2011
## Approach to management of hyperglycemia:

<table>
<thead>
<tr>
<th>Aspect</th>
<th>More Stringent</th>
<th>Less Stringent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient attitude and expected treatment efforts</td>
<td>Highly motivated, adherent, excellent self-care capacities</td>
<td>Less motivated, non-adherent, poor self-care capacities</td>
</tr>
<tr>
<td>Risks potentially associated with hypoglycemia, other adverse events</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Disease duration</td>
<td>Newly diagnosed</td>
<td>Long-standing</td>
</tr>
<tr>
<td>Life expectancy</td>
<td>Long</td>
<td>Short</td>
</tr>
<tr>
<td>Important comorbidities</td>
<td>Absent</td>
<td>Few/mild</td>
</tr>
<tr>
<td>Established vascular complications</td>
<td>Absent</td>
<td>Few/mild</td>
</tr>
<tr>
<td>Resources, support system</td>
<td>Readily available</td>
<td>Limited</td>
</tr>
</tbody>
</table>

*Figure 1*