Diabetes and the Transplant Patient: What’s New?

Mary M. Sullivan RN, DNP, ANP-BC, CDE
Diabetes Mellitus is a group of metabolic disorders characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both.
Incidence

- Affects 25.8 million Americans (8.3% of population)
- 18.8 million diagnosed; 7 million undiagnosed
- 79 million with Prediabetes
- 1 out of 4 children/adolescents

ADA, 2011
Age-adjusted Percentage of U.S. Adults with Obesity or Diagnosed Diabetes

**Obesity (BMI ≥ 30 kg/m²)**

- **1994**
- **2000**
- **2009**

**Diabetes**

- **1994**
- **2000**
- **2009**

The Diabetes Epidemic: Global Projections, 2010–2030

World:
- 2011 = 366 million
- 2030 = 552 million
- Increase = 51%

Regional Projections:
- Latin America: 37.7 million (51.2 million in 2011), 51% increase
- Northern Europe: 14.7 million (28.0 million in 2011), 90% increase
- Asia: 71.4 million (120.9 million in 2011), 69% increase
- Africa: 52.8 million (64.2 million in 2011), 22% increase
- Middle East: 32.6 million (59.7 million in 2011), 83% increase
- North America: 25.1 million (39.9 million in 2011), 59% increase
- Australia and Oceania: 131.9 million (187.9 million in 2011), 42% increase

IDF. Diabetes Atlas 5th Ed. 2011
Criteria for Diagnosis

- A1C $\geq 6.5\%$
- FPG $\geq 126\text{mg/dL}$ and no calorie intake X 8 hours
- 2 hour post prandial $\geq 200\text{mg/dL}$
- Random plasma glucose $\geq 200\text{mg/dL}$
Magnitude of Complications

- Leading cause of blindness in working age adults
- Diabetic Retinopathy

- 2-fold to 4-fold increase in cardiovascular mortality and stroke
- Stroke

- Leading cause of end-stage renal disease
- Diabetic Nephropathy

- Cardiovascular Disease

- Leading cause of nontraumatic lower extremity amputations
- Diabetic Neuropathy

Impact of Hyperglycemia

- Increase in inflammatory response
- Impairs phagocytosis
- Creates electrolyte and volume imbalance
- Enhances antigen presentation and apoptosis
- Increases risk for delayed graft function
- Increases renal ischemic injury
Molnar et al. (2011), Diabetes Care, 34, 2536-2541

- Using Davita database, studied 2,872 patients who underwent first kidney transplant
- Found that poor pre transplant glycemic control was associated with decreased post transplant survival in kidney transplant recipients when pre transplant A1C > 8%
Parekh et al. (2011) 
J. Transplant

- In a prospective study of 40 patients found that intraoperative hyperglycemia increases ischemic reperfusion injury in renal transplant patients
UCSF Hyperglycemia in Renal Transplantation (HIRT) Study

- Investigator: Parekh - currently recruiting participants
- Randomized study of the impact of peri-operative glucose control on short term renal allograft function after transplantation
Management

- Glycemic Control
- Control Blood Pressure
- Control Lipids
- Provide Diabetes Education- referral for diabetes self-management education to learn how to “Think Like a Pancreas”
ADA-EASD Position Statement: Management of Hyperglycemia in T2DM

Glycemic targets

- **HbA1c < 7.0%** (mean PG ~150-160 mg/dl [8.3-8.9 mmol/l])

- **Individualization** is key:
  - Tighter targets (6.0 - 6.5%) - younger, healthier
  - Looser targets (7.5 - 8.0%+) – older, presence of comorbidities (coronary artery disease, heart failure, chronic kidney disease, liver dysfunction, hypoglycemia, hypoglycemia unawareness)

PG = plasma glucose
# Guidelines for Glycemic, BP, & Lipid Control

<table>
<thead>
<tr>
<th></th>
<th>American Diabetes Assoc. Goals</th>
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<tbody>
<tr>
<td><strong>HbA1C</strong></td>
<td>&lt; 7.0% <em>(individualization)</em></td>
</tr>
<tr>
<td><strong>Preprandial glucose</strong></td>
<td>70-130 mg/dL (3.9-7.2 mmol/l)</td>
</tr>
<tr>
<td><strong>Postprandial glucose</strong></td>
<td>&lt; 180 mg/dL</td>
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<tr>
<td><strong>Blood pressure</strong></td>
<td>&lt; 130/80 mmHg</td>
</tr>
<tr>
<td><strong>Lipids</strong></td>
<td><strong>LDL:</strong> &lt; 100 mg/dL (2.59 mmol/l)</td>
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<tr>
<td></td>
<td>&lt; 70 mg/dL (1.81 mmol/l) <em>(with CVD)</em></td>
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<tr>
<td></td>
<td><strong>HDL:</strong> &gt; 40 mg/dL (1.04 mmol/l) ♂</td>
</tr>
<tr>
<td></td>
<td>&gt; 50 mg/dL (1.30 mmol/l) ♀</td>
</tr>
<tr>
<td></td>
<td><strong>TG:</strong> &lt; 150 mg/dL (1.69 mmol/l)</td>
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</tbody>
</table>

ADA. *Diabetes Care.* 2012;35:S11-63
## Percentage of Adults with Diabetes Who Report Receiving Preventive Care Practices, 2009-2010

<table>
<thead>
<tr>
<th>Preventive Practice</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Flu Vaccine</td>
<td>50.1</td>
</tr>
<tr>
<td>Ever Attended Diabetes Self-Management Class</td>
<td>57.4</td>
</tr>
<tr>
<td>A1C checked &gt;= 2 times a Year</td>
<td>68.5</td>
</tr>
<tr>
<td>Annual Foot Exam</td>
<td>67.5</td>
</tr>
<tr>
<td>Daily Self Monitor Blood Glucose</td>
<td>63.6</td>
</tr>
<tr>
<td>Annual Eye Exam</td>
<td>62.8</td>
</tr>
</tbody>
</table>

CDC Diabetes Report Card, 2012
ADA-EASD Position Statement: Management of Hyperglycemia in T2DM

ANTI-HYPERGLYCEMIC THERAPY

• **LIFESTYLE**

  - Weight optimization (lose 5-7% of body weight)
  - Healthy diet
  - Increased activity level (150 min/week)

Diabetes Care, Diabetologia. 19 April 2012 [Epub ahead of print]
Diabetes Self-Management Education

1. Self Blood Glucose Monitoring
2. Carbohydrate awareness
3. Therapy adjustment for carbohydrate in meals, exercise, illness
4. Symptoms and Treatment of Hypoglycemia

www.dtc.ucsf.edu
Carbohydrate Awareness

• Read Labels
• Learn to count the amount of carbohydrates in the meal
• Use carbohydrate ratios to determine nutritional insulin dose for rapid-acting insulin e.g., 1 unit of aspart per 15 grams of carbohydrates
• Or use fix carb amount per meal e.g., Eat 60 grams of carbohydrates per meal
Insulin and Glucose Patterns

Think Like a Pancreas

• Dose Insulin based upon:
  – Nutrition – amount of carbohydrates in meal
  – High Blood Glucose Correction
  – Basal Needs
ANTI-HYPERGLYCEMIC THERAPY

• **Insulin Types**
  - Regular
  - NPH
  - Basal analogues (glargine, detemir)
  - Rapid analogues (lispro, aspart, glulisine)
  - Pre-mixed 70/30
INSULIN DURATION OF ACTION

- **Rapid** (Lispro, Aspart, Glulisine)
- **Short** (Regular)
- **Intermediate** (NPH)
- **Long** (Detemir)
- **Long** (Glargine)
Insulin Regimens

Relative Insulin Level

Time

MN Breakfast Lunch Dinner
Insulin Regimens

- TID lispro/aspart/glulisine and hs glargine
- Lispro/aspart/glulisine
Insulin Regimens

Relative Insulin Level

Midnight  Breakfast  Lunch  Dinner  Time

Insulin pump
Lispro/aspart
Humalog®
insulin lispro injection
(rDNA origin)
Insulin Administration Using Pens

- Studies have shown that patients prefer insulin pens over syringes/vials.
- Patients find insulin pens: enhance dose accuracy, are easy to use, portable, discreet, socially acceptable, less painful as pen needle doesn’t have to be inserted into a vial.

Korytkowski et al. (2003). Clin Ther. 25, 2836-2848
Stockl et al. (2007). Curr Med Res Opin. 23(1), 133-146
• Studies have found that insulin pens help to improve medication adherence

• Lee et al. (2006) found that converting patients from insulin syringes to insulin pens was associated with improvement in medication adherence and less hypoglycemia and annual healthcare costs decreased by $1,590 per patient from $16,359 to $14,769 P< 0.01

  » Lee et al. (2006). Clin Ther. 28(10), 1712-1725
Need to Avoid IM Injections

- Alters pharmacodynamics
- Increases chance of hypoglycemia
- More painful

Absorption is independent of subcutaneous depth

Order Correct Needle Size
4 Mm 32 G Insulin Pen Needle

- Skin thickness is not greater than 2.8mm thick
- Hirsch et al. (2012) evaluated the 4mm insulin pen needle in patients with BMI ranging from 20-49 kg/m2 and found that the 4mm pen needle provided equivalent glycemic control in both obese and non-obese patients as compared to 5mm and 8mm pen needles.

Hirsch et al. (2012). Current Medical Research & Opinion. 28(8) 1305-1311
Inject-Ease

For 30, 50, and 100 unit disposable insulin syringes

Becton Dickinson • PharmaPlast
Subcutaneous Insulin Pumps

• Machine that infuses insulin subcutaneously using rapid-acting insulin
• Two Delivery Modes
  – Continuous preprogrammed basal rate for 24 hours
  – Bolus for carbohydrates and high Blood Glucose Correction
• Has Smart features- can do math for boluses
Candidates for Insulin Pump

• Type 1 DM who checks BG levels, knows how to count carbs
• Type 2 DM
Self-Monitoring of Blood Glucose

- SMBG is recommended in patients on insulin; type 1 patients should check BG at least 3 X day
- SMBG is recommended in patients treated with oral hypoglycemic agents
- SMBG is recommended in patients not fulfilling their therapeutic target
Most people draw blood from sides of fingertips to avoid pain. The nerves, which allow pain to be felt, are more concentrated in inner part of finger pad.
WORLD'S SMALLEST BLOOD SAMPLE

1/3 microliter FreeStyle
1 microliter OneTouch® Ultra
2 microliters Glucometer Elite®
4 microliters® Accu-Chek Advantage®
10 microliters OneTouch® Basic®
Continuous Glucose Monitoring Systems (CGMS)

- Measures interstitial fluid glucose levels not plasma glucose
- Displays glucose trends and determines rate of change in glucose levels
- Doesn’t replace self blood glucose monitoring
Does A 6.4% A1c Mean the Same Level of Control?

- Which patient has achieved “control?”

**Patient A:**
HIGH VARIABILITY
A1c = 6.4%
(average = 151 mg/dl)

SD = 91
IQR = 104

**Patient B:**
LOW VARIABILITY
A1c = 6.4%
(average = 151 mg/dl)

SD = 64
IQR = 72
CGM Technology

**Goal**
- Automated
- Stand alone, no SBGM required
- Closed loop
- Durable
- Invisible

**Reality**
- Calibration required
- SBGM required
- Open Loop
- Sensor last 3-7 days
- External sensor
Let's get right to the point.

Needles don't belong in the garbage. They can injure your garbageman.

FREE - sharps container at these locations. Return full containers to the same locations for proper disposal:

- All San Francisco Walgreens Drug Stores.
- S.F. Health-Department District Health Centers.
- San Francisco General Hospital and UCSF patient clinic pharmacies.
- S.F. Household Hazardous Waste Collection Facility 501 Tunnel Avenue Thursday-Saturday 8 a.m.-4 p.m.

San Francisco Safe Needle Disposal Program
554-2780