Understanding and Treating Diabetes in the Post-Transplant Patient

Ann Hackett, APRN-BC, MSN, CDE
Glucose Management Service
Disclosures

• None to disclose.
Diabetes in the Transplant Patient

- Risk Factors, Screening, Diagnosis
- Inpatient Management
- Outpatient Management
Diabetes in the Transplant Patient

- Risk Factors, Screening, Diagnosis
- Inpatient Management
- Outpatient Management
Solid Organ Transplant in US Since 1988

Risk Factors

- Meds: Chemotherapeutic agents, Immunosuppressants
- Nutrition: TPN, TF
- Infection
- Stress
- Age >40-45
- Obesity

- AA, Hispanic Races
- Family History
- Hepatitis C, CMV
- Polycystic Kidney Ds
- Certain Genetic Mutations

Pre-existing diabetes risk:
- Age (>40 y), BMI (>25 kg/m²)
- Race/ethnicity, +FH, DM candidate genes,
- Pre-diabetes, Metabolic syndrome
  (particularly ↓HDL)

Other:
- PCKD in Kidney
- CF in lung TX
- Statins?
- ↓Vit D?
- ↓Mg?

Risk for PTDM

Inflammation:
- HepC, CMV, HLA mismatch,
  Deceased donor,
  Rejection

Immunosuppressants:
- Corticosteroids
- Calcineurins
- mTOR Inhibitors

Rates of Occurrence

• Diabetes occurs post-transplant at
  – Kidney Transplant: 10-74%
  – Heart Transplant: 11-38%
  – Liver Transplant: 7-30%
  – Lung Transplant: 32%
Screening

**Outpatient Monitoring:**
- Monitor blood sugar **prior** to transplant, typically fasting qam. Alert provider to BG >126 mg/dL.

- Monitor blood sugar **post** transplant with FBS weekly X4, recheck in 3 months, 6 months and annually thereafter if no abnormality presents.

**Inpatient Initiation of Monitoring:**
- Check blood sugar ACHS and begin treatment with BG >140 mg/dL.
A diagnosis of diabetes must be confirmed on a subsequent day, by measurement of FPG, 2-h PG, or random plasma glucose (if symptoms are present).

Post-Transplant DM Diagnosis

- October, 2013 → 2nd International Consensus Panel enacted key changes:
  - Change terminology from New Onset Diabetes After Transplant (NODAT) to Post-Transplant DM (PTDM)
  - Recommend evaluation/diagnosis outpatient, stable, and on long-term maintenance immunosuppression doses
  - HbA1c can be used to diagnose DM if elevated (>6.5%) but should not be used alone as a screen for PTDM (particularly in 1st year)
- Unclear full significance of timing of DM diagnosis (1 vs. 5 vs. 20 years post-transplant)
Types of Diabetes

• Pre-Existing Type 1 or Type 2
• Post-Transplant DM
Pre-Existing Diabetes

- **Type 1:**
  - Steroids increase insulin requirement and dose. Consider starting with double prandial and ss coverage if pt is well controlled at baseline.

- **Type 2:**
  - Cannot use all oral agents. Mostly consider SFU for postprandial hyperglycemia.
  - Usually requires insulin, at least short-term.

- Both: Insulin and/or oral agent dose will increase from ESRD to having a working kidney
Post-Transplant Diabetes Mellitus

- Insulin resistant phenotype
- Usually requires some insulin, at least short-term
- May be possible to taper to oral agents or monitor with lifestyle modifications alone
- Adjustments in regimen may be necessary at any time based on steroids and other factors
Diabetes in the Transplant Patient

- Risk Factors, Screening, Diagnosis
- Inpatient Management
- Outpatient Management
Diabetes in the Transplant Patient

• Risk Factors, Screening, Diagnosis

• Inpatient Management:
  – Goals and Factors to Consider
  – Weight-Based Dosing
  – Transitioning from Drip to SQ
  – Making Adjustments to Your Regimen
  – When to involve Endocrine

• Outpatient Management
Guidelines From Professional Organizations on the Management of Glucose Levels in the ICU

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Patient Population</th>
<th>Treatment Threshold</th>
<th>Target Glucose Level</th>
<th>Definition of Hypoglycemia</th>
<th>Updated since NICE-SUGAR Trial, 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>AACE and ADA</td>
<td>ICU patients</td>
<td>180</td>
<td>140-180</td>
<td>&lt;70</td>
<td>Yes</td>
</tr>
<tr>
<td>2009</td>
<td>Surviving Sepsis Campaign</td>
<td>ICU patients</td>
<td>180</td>
<td>150</td>
<td>Not stated</td>
<td>Yes</td>
</tr>
<tr>
<td>2009</td>
<td>Institute for Healthcare Improvement</td>
<td>ICU patients</td>
<td>180</td>
<td>&lt;180</td>
<td>&lt;40</td>
<td>Yes</td>
</tr>
<tr>
<td>2008</td>
<td>American Heart Association</td>
<td>ICU patients w/ ACS</td>
<td>180</td>
<td>90-140</td>
<td>Not stated</td>
<td>No</td>
</tr>
</tbody>
</table>
Goals

- Goal: BG 140-180 mg/dL
- Treatment should be started initially with insulin
- Several studies have assessed the benefit of tight control in hospitalized patients, but findings are not consistently positive.
- Tighter control (such as 80-110 mg/dL) increases risk of hypoglycemia.
- Know when to adjust your target BG or A1c.

Factors to Consider

- **Medications** (pressors and glucocorticoids) and severity of illness impact insulin secretion and insulin resistance.
- **Food intake** can be unpredictable
- **Tests and procedures** interrupt meals and medication dosing
- **Prior history** of DM and type if pre-existing as well as degree of prior control (A1c)
- **Nutritional status** (NPO, enteral, parenteral)

### Steroid Potency

- Consider strength of steroid when adjusting insulin.
- All steroids are not the same!
Weight-Based Dosing

• Stop all orals and non-insulin injectables

• Calculated starting Total Daily Dose (TDD)
  • 0.2-0.3 unit/kg if ≥70 yo or GFR <60 ml/min
  • 0.4 unit/kg if BG 140-200
  • 0.5 unit/kg if BG 201-400

• Divide TDD:
  – 50% as basal
  – 50% as nutritional (equally divided)

- Modified from J Clin Endocrinol Metab, January 2012, 97(1):16 –38
Sliding Scale

- If patient able and expected to eat: usual
- If patient not able to eat: sensitive Q6H
- If fasting and pre-meal BG persistently >140 without hypoglycemia: resistant

![Table showing BG levels and corresponding insulin sensitivity categories.](image)

Modified from J Clin Endocrinol Metab, January 2012, 97(1):16–38
Example #1

- Snow White is a 40 yo F who presents following DDKT, now stable on POD 1.

- Home regimen is Linagliptin (Tradjenta) 5 mg qday, Glucotrol (Glipizide) 5 mg BID. Pt states compliance. A1c is 9.0%.

- No additional pressors, IV dextrose.

- Wt is 100 kg.

- Taking Methylprednisolone 500 mg today x1 dose with scheduled taper.
Example #1 Cont.

- Weight: 100 kg
- Basal Dose: 30 un basal daily or 15 un BID. Give first dose at least 2 hours prior to stopping drip.
- Bolus Dose: 20 un rapid or short acting insulin with meals. May want to hold this order until pt is eating at least 50% of meal trays consistently.
- Sliding Scale: Standard dosing requirements with no complicating factors: 2 or 3 un/50>150 ACHS
- ACHS BG checks
- Diabetic Diet as tolerated.
Insulin Drip

- **IV insulin infusion** is ideal (IV insulin half-life=5-9 min.) following standard, validated protocol for at least first 24 hrs.

- **BG monitoring q1-2h** is imperative to avoiding hypoglycemia while on drip. Check more frequently with change in IV meds or nutrition.

- As status improves, **transition to subcutaneous** insulin based on most recent IV insulin infusion rate while pt is fasting. Use rates that have maintained euglycemia only.

- Be sure to **overlap IV and subcutaneous insulin** by at least 2 hrs to avoid rebound hyperglycemia after stopping insulin drip.

- Type 2 DM with <2un/h IV insulin requirement may do well on a **non-intensive subcutaneous regimen** or scheduled insulin. Can try sliding scale only at first.

Transitioning from Drip to SQ Insulin

• Patients without a history of DM
  – If <1 unit/hour: may not require scheduled insulin
    • Treat with scheduled insulin to determine if scheduled insulin is required

• All patients with T1DM and most with T2DM
  – Require SQ long- and short-acting insulin
  – Give basal insulin 1-2 hours before discontinuation of IV insulin
Transitioning from Drip to SQ Insulin

• Extrapolate insulin requirement over preceding 6 to 8 hours to a 24-hour period
• Various approaches:
  – Surgical patients not eating:
    • 60-80% of the TDD as basal demonstrated to be safe and effective in surgical patients (Clement 2004, Schmeltz 2006)
  – Medical patients:
    • 75-80% of TDD divided between basal and bolus (Schmeltz 2006, Yeldandi 2006, Bode 2004)
Example #2:

- Sneezy Dwarf is a 50 yo M who presents following liver transplant, now POD 4.
- Euglycemia is maintained with insulin drip with rates of 2.5 un/hr on average.
- No complicating factors such as pressors or IV dextrose.
- Diet: Clear liquids. PO intake is poor.
- No current steroids.
- Wt: 100 kg

<table>
<thead>
<tr>
<th>BG in mg/dL</th>
<th>Drip Rate in un/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>1.5</td>
</tr>
<tr>
<td>110</td>
<td>2.5</td>
</tr>
<tr>
<td>100</td>
<td>2.0</td>
</tr>
<tr>
<td>140</td>
<td>3.0</td>
</tr>
<tr>
<td>150</td>
<td>3.5</td>
</tr>
<tr>
<td>120</td>
<td>2.5</td>
</tr>
<tr>
<td>200</td>
<td>5.0</td>
</tr>
</tbody>
</table>
Example #2 Cont:

- Take average drip rate of 2.5 un/hr and multiply by 24 hrs.
  - 2.5 x 24 = 60
- Reduce by 20%.
  - 60 x 0.8 = 50
- Use this dose to calculate TDD.
  - 50 un TDD
    - 25 un for basal coverage
    - 25 un for bolus coverage
    - Moderate insulin requirements ss: 2/50>150 ACHS
Impact of Nutrition

- **No Food Intake:**
  - Give continuous insulin infusion via IV (insulin drip)
  - Alternatively give basal insulin + sliding scale
  - Give basal coverage twice/day if requirements >60 un/day or pt is highly insulin sensitive.

- **Continuous Enteral Feeding:** Basal insulin + TF coverage + correction dose q4h or q6h.
  - *If feeding interrupted, give IV glucose to prevent hypoglycemia.*

- **Total Parenteral Nutrition:** Add regular insulin to IV bag and titrate dose in increments of 5-10un/liter.

- Reassess insulin requirement with any change in nutritional status.

Confounding Variables

- Changes in caloric or carbohydrate intake
- Change in clinical status or medications (corticosteroids, vasopressors)
- Make adjustments based on daily BG patterns
- Poor coordination of BG testing and administration of insulin with meals
- Errors during patient transfer
- Renal or liver insufficiency
Adjusting Goal Targets

- Consider elevating goal target in the following situations:
  - Elderly >60 yo
  - ESRD, liver disease, partial or total pancreatectomy
  - CAD, CVA
  - Reduced hypoglycemic awareness
  - Recurrent hypoglycemia

- Watch for IV fluids with Dextrose, vasopressors, edema, snacking which can falsely increase your daily dosing.

- Be more aggressive with insulin dosing when pt has elevated TDD or BMI >35 kg/m2.
When to Involve Endocrine

- U500 insulin or High Dose Requirements
- Low Dose Requirements
- Erratic Inpatient or Outpatient Control
- Insulin Pump
- Anytime!
Watch Out!

• Common Med Errors with Insulin:
  – Insulin to Carb mismatch: Providing meal or TF insulin without meal/TF
  – Holding SS or Long-acting insulin for NPO
  – Using meal coverage when pt isn’t eating to bring down a high BG
  – “Pt refused” when it seems like too much or too little.
  – Poor communication between teams and nurses
  – Overtreating Hypoglycemia. Remember Rule of 15.
Diabetes in the Transplant Patient

- Risk Factors, Screening, Diagnosis
- Inpatient Management
- Outpatient Management
Diabetes in the Transplant Patient

- Risk Factors, Screening, Diagnosis
- Inpatient Management
- Outpatient Management:
  - Assessment
  - Lifestyle Modification
  - Oral Agents
  - Non-Insulin SQ Agents
  - Insulin
  - Hypoglycemia
# ADA Goals of Care

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>HbA1c</td>
<td>4-6%</td>
<td>&lt;7% *</td>
</tr>
<tr>
<td>Pre-prandial Blood Sugar</td>
<td>70-100 mg/dl</td>
<td>90-130 mg/dl (70-120)</td>
</tr>
<tr>
<td>Post-prandial Blood sugar</td>
<td>&lt;140 mg/dl</td>
<td>&lt;180 mg/dl (&lt;160)</td>
</tr>
</tbody>
</table>

**ADA Recommendation:** Check A1c at least 2 x/yr if in target and stable; q 3 months if therapy has changed or not meeting goals. *Diabetes Care 29:S4-S42, 2006*
Assessment of Glycemic Control

HbA1c%

Average Blood Glucose (Sugar) mg/dL

How to Interpret GlucoProtein Test Results

* Comprised from data obtained from literature and not from LXN clinical studies.
Blood Glucose Monitoring

• Provides vital data for clinical decision making
• Provides patient with accountability and feedback about his/her behavior
• Advise patient about:
  - Appropriate meter
  - When to test
  - How to record results
  - How to interpret and respond to results
  - Insurance/financial issues, prescription required for reimbursement
# Record Keeping

## Vanderbilt Diabetes Program Blood Glucose Record

**Patient Name:** [Redacted]  
**Patient Phone Number:** (____)  
**Email Address:** ________  
**Week of:** [Redacted]  
**Deliver this Fax to:** Kathleen Wolff  
**Fax Number:** 343-4953

<table>
<thead>
<tr>
<th>Day/Date</th>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Bedtime</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>1/31</td>
<td>131</td>
<td>206</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/16</td>
<td>116</td>
<td>121</td>
<td>193</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/10</td>
<td>76</td>
<td></td>
<td>97</td>
<td>261</td>
<td></td>
</tr>
<tr>
<td>1/6</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/3</td>
<td>123</td>
<td>197</td>
<td></td>
<td></td>
<td>164</td>
</tr>
<tr>
<td>1/2</td>
<td>82</td>
<td>125</td>
<td>203</td>
<td>116</td>
<td>189</td>
</tr>
</tbody>
</table>

**Average Blood Sugar**

*Notes: Record Illness, Low Blood Sugar, Exercise, Large Meal, Emotional Stress, etc.*

- Target pre-meal BS: 70 - 120
- Target post meal BS: < 180
- Target HbA1c: 6% - 7%
Diet: The Plate Method
Resources

• App and Websites
  – My Fitness Pal
  – Calorie King (Also available in a book)
  – Live Strong
  – Spark People (Look for Meal Plan, Grocery List)
Physical Activity

- Set small, reasonable goals: *Something is better than nothing!*
- Aim for **30 minutes** of moderate-to-vigorous intensity aerobic exercise **at least 5 days a week** or a total of **150 minutes per week**.

“What fits your busy schedule better, exercising one hour a day or being dead 24 hours a day?”
Chronic Effects of Diabetes

- Macrovascular
- Microvascular
- Consider short-term risks in the post-op setting

# Oral Diabetes Meds

<table>
<thead>
<tr>
<th>Drug Class</th>
<th>Action</th>
<th>Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin Secretagogues</td>
<td>Increase Glucose Secretion</td>
<td><strong>Sulfonylureas</strong>: Glipizide, Glyburide, Glimepiride (Amaryl®) <strong>Meglitinides</strong>: Nateglinide (Starlix®) Repaglinide (Prandin®)</td>
</tr>
<tr>
<td>Biguanides</td>
<td>Increase insulin sensitivity, decrease hepatic glucose output</td>
<td>Metformin (Glucophag®)</td>
</tr>
<tr>
<td>Alphaglucosidase Inhibitors (AGI’s)</td>
<td>Inhibit absorption of glucose from the gut</td>
<td>Acarbose (Precose®) Miglitol (Glyset®)</td>
</tr>
<tr>
<td>Thiazoladindiones (TZD’s)</td>
<td>Increase insulin sensitivity</td>
<td>Rosiglitazone (Actos®) Pioglitazone (Avandia®)</td>
</tr>
<tr>
<td>DPP-4 Inhibitors</td>
<td>Increase insulin secretion, decrease glucagon secretion</td>
<td>Sitagliptin (Januvia®) Saxagliptin (Onglyza®)</td>
</tr>
<tr>
<td>SGLT2 Inhibitors <em>NEW CLASS!</em></td>
<td>Increase glucose reabsorption in kidney</td>
<td>Canagliflozin (Invokana®) Dapagliflozin (Farxiga®) Empagliflozin (Jardiance®)</td>
</tr>
<tr>
<td>Bile Acid Resins</td>
<td>Cholesterol-lowering med that also reduces BG by binding bile acids in the digestive tract</td>
<td>Colesevelam (Welchol®)</td>
</tr>
</tbody>
</table>
## Non-Insulin Injectables

<table>
<thead>
<tr>
<th>Drug Class</th>
<th>Action</th>
<th>Names</th>
</tr>
</thead>
</table>
| GLP-1 Receptor Agonists     | stimulate insulin production while suppressing the liver’s glucose output, slows gastric emptying | - Albiglutide (Tanzeum) weekly  
- Dulaglutide (Trulicity) daily  
- Exenatide (Byetta) twice daily  
- Exenatide Extended Release (Bydureon) weekly  
- Liraglutide (Victoza) daily |
<p>| Amylin Analogue             | slows food from moving too quickly through the stomach and helps keep after-meal glucose levels from going too high, also reduces glucose production from liver. | Pramlintide (Symlin) |</p>
<table>
<thead>
<tr>
<th>Agent</th>
<th>Safety or Efficacy Studies in Transplant Patients</th>
<th>Potential Considerations in Organ Transplant Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metformin</td>
<td>Effective in stable KTX patients but contraindicated for many other TX groups, including during acute hospitalizations (177, 214)</td>
<td>Should not be used during acute hospitalization, with ↓ GFR, ↑ LFTs, CHF, or active, significant infection; and should be held for planned iv contrast procedure</td>
</tr>
<tr>
<td>Sulfonylureas</td>
<td>Efficacy is not well documented in transplant patients. Did not alter cyclosporine pharmacokinetics in a small study of KTX recipients with PTDM (215–218)</td>
<td>Increased risk of more frequent and more prolonged hypoglycemia with ↓ GFR</td>
</tr>
<tr>
<td>Repaglinide</td>
<td>Effective and safe with no interaction with CNIs in a small study of KTX recipients with PTDM (180)</td>
<td>Less risk of hypoglycemia with ↓ GFR than sulfonylureas</td>
</tr>
<tr>
<td>Thiazolidinediones (eg, pioglitazone)</td>
<td>Effective and safe in small studies of KTX recipients (177, 180, 183, 219, 220)</td>
<td>Known risk for weight gain, edema, heart failure, and reduced bone mass, contraindicated with known elevated liver function tests with the exception for known fatty liver disease including after liver transplant; contraindicated with known heart failure; unknown impact on risk for heart failure risk after transplant</td>
</tr>
</tbody>
</table>

Table 4. Non-Insulin Diabetes Treatments: Potential Considerations for Use in the Solid Organ Transplant Patient

<table>
<thead>
<tr>
<th>Agent</th>
<th>Safety or Efficacy Studies in Transplant Patients</th>
<th>Potential Considerations in Organ Transplant Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>α-Glucosidase inhibitors</td>
<td>No studies of safety or efficacy to date in organ transplant populations.</td>
<td>Avoid with ↓ GFR; unlikely to be an effective single agent.</td>
</tr>
<tr>
<td>GLP-1 agonists (exenatide, liraglutide, lixisenatide)</td>
<td>Liraglutide did not affect tacrolimus concentration in a very small study of KTX recipients (185).</td>
<td>Decreases bowel motility, which may impact absorption of immune suppression agents and has not yet been studied; should not use if GFR &lt; 40 ml/min.</td>
</tr>
<tr>
<td>DPP-4 inhibitors (sitagliptin, vildagliptin, saxagliptin, linagliptin, allogliptin)</td>
<td>Retrospective and small random controlled trials of KTX recipients show safety of several DPP-4 inhibitors (8, 181–184).</td>
<td>Reduce dose of all but linagliptin with ↓ GFR.</td>
</tr>
<tr>
<td>SGLT-2 inhibitors (dapagliflozin, canagliflozin, empagliflozin)</td>
<td>Known to increase risk of genitourinary infections in those with previous history, which is a concern in immunocompromised transplant patients, known to cause volume dehydration and hypotension, which may also be a concern in these patients as well as recent reports of diabetic ketoacidosis raise concerns of safety for most transplant populations (186, 187).</td>
<td>Avoid until safety studies are performed.</td>
</tr>
</tbody>
</table>

Insulin

- Maintenance Insulin (Basal) – NPH, Levemir, Lantus
  - 50% of daily needs
  - Suppresses glucose production while fasting
- Prandial and SS Coverage (Bolus)
  - Limits hyperglycemia after meals
  - Immediate risk and sharp peak at 1-2 hrs
  - 10-20% of total daily insulin requirement at each meal
Normal Endogenous Insulin Secretion

• Guidelines just a starting point.

• When correction is required before most meals, ↑ basal

• When BG remains consistently elevated at one time point, ↑ preceding bolus

• Fasting BG also a good measure of basal insulin dose but be wary of the bedtime snack!

Modified from J Clin Endocrinol Metab, January 2012, 97(1):16 –38
Volume 29, Number 1, 2011 • Clinical Diabetes
## Insulin Types

<table>
<thead>
<tr>
<th>Type</th>
<th>Generic/ Brand Name</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAPID ACTING</td>
<td>Glulisine/Apidra</td>
<td>5-15 Min.</td>
<td>1-2 Hours</td>
<td>3-4 Hours</td>
</tr>
<tr>
<td></td>
<td>Lispro/Humalog</td>
<td>5-15 Min.</td>
<td>1-2 Hours</td>
<td>4 Hours</td>
</tr>
<tr>
<td></td>
<td>Aspart/Novolog</td>
<td>5-15 Min.</td>
<td>1-2 Hours</td>
<td>4-6 Hours</td>
</tr>
<tr>
<td>Short Acting</td>
<td>Regular/Humulin R,</td>
<td>½-1 hour</td>
<td>2-3 hours</td>
<td>4-8 hours</td>
</tr>
<tr>
<td></td>
<td>Novolin R</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Insulin Types Continued

<table>
<thead>
<tr>
<th>Type</th>
<th>Generic/ Brand Name</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediate Acting</td>
<td>NPH/ Humulin N</td>
<td>1-1.5 Hours</td>
<td>4-12 Hours</td>
<td>18-25 Hours</td>
</tr>
<tr>
<td></td>
<td>Novolin N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reli-on N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Acting</td>
<td>Glargine/Lantus</td>
<td>4-6 Hours</td>
<td>4-12 Hours</td>
<td>24+ Hours</td>
</tr>
<tr>
<td></td>
<td>Detemir/Levemir</td>
<td>1-2 Hours</td>
<td>1-7 Hours</td>
<td>6-23 Hours</td>
</tr>
</tbody>
</table>
Insulin Duration Of Action

![Graph showing plasma insulin levels over time for different types of insulin: Regular, NPH, Detemir, Glargine.](image)
Inhaled Insulin

- Inhaled insulin begins working within 12 to 15 minutes, peaks by 30 minutes, and is out of your system in 180 minutes.
- Types: Technosphere insulin-inhalation system (Afrezza® Human Insulin)
  - Rapid acting human insulin
  - Take prior to your meals
  - Each puff is approximately 4 un, 8 un, or 12 un. Depending on dose prescribed.
  - Similar dosing, although slightly more effective than SQ insulin.
Pre-Mixed Insulins

- Protamine + Short or Rapid-Acting Insulin
  - Novolin 70/30® = 70% NPH + 30% Regular
  - Humulin 70/30®, Humulin 50/50®
  - Humalog 75/25® = 75% NPL + 25% Lispro
  - Novolog 70/30® = 70% NPH + 30% Aspart

- Onset: 0.5-2.5 hours
- Time to Peak: 4-8 hours
- Duration: 17-25 hours
- Clinical Use: Elderly, cognitive or psych. impairment, multiple co-morbid illnesses, low cost, poor compliance
Insulin Sensitivity for Sliding Scale

• DM2: Rule of “1800” for Humalog, Novolog, or Apidra pre-meals
  – 1800/total daily insulin dosage = expected BG lowering (mg/dL) of 1 unit of rapid-acting analog.

• Example:
  – Breakfast 9 u, Lunch 9 u, Supper 9 u, Bedtime 9 u Lantus = 36 units total
  – 1800 ÷ 36 = 50

• DM1: Rule of “1500”.
Insulin Sensitivity for Sliding Scale

- DM2: Rule of “1800” for Humalog, Novolog, or Apidra pre-meals
  - 1800/total daily insulin dosage = expected BG lowering (mg/dL) of 1 unit of rapid-acting analog.
- Example:
  - Breakfast 9 u, Lunch 9 u, Supper 9 u, Bedtime 9 u Lantus = 36 units total
  - 1800 ÷ 36 = 50
- DM1: Rule of “1500”.

1 unit of insulin should decrease BG approximately 50 mg/dL
<table>
<thead>
<tr>
<th>Glucose</th>
<th>Insulin Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;70 mg/dL</td>
<td>Hold meal coverage</td>
</tr>
<tr>
<td>80 - 150 mg/dL</td>
<td>Usual dose</td>
</tr>
<tr>
<td>151 - 200 mg/dL</td>
<td>Add 1 unit</td>
</tr>
<tr>
<td>201 - 250 mg/dL</td>
<td>Add 2 units</td>
</tr>
<tr>
<td>251 - 300 mg/dL</td>
<td>Add 3 units</td>
</tr>
<tr>
<td>301 - 350 mg/dL</td>
<td>Add 4 units</td>
</tr>
</tbody>
</table>
Cost Of Diabetes Medications

- Cost Effective Insulin Regimens
  - Over-the-counter insulin
  - Glucometer, Strips
- May also consider use of SFU if appropriate.
  - Other generic, low-cost oral agents include Metformin, TZD (Actos), etc although these may not typically be correct for the post-transplant setting.
Pen Delivery

- Improves Accuracy, especially with low dosing
- More Convenient
- Insulin Requires Priming and SQ Hold
Pumps
Continuous Glucose Monitoring Sensor

- Measures interstitial fluid
- Gives trends
- Alerts
- Poor Accuracy
- Medtronic, Dexcom
Hypoglycemia

- Below 70: **Rule of 15**
- Causes
  - Severe Hypoglycemia
  - Hypoglycemia Unawareness
Take Home Points

- How to Screen For and Diagnosis Diabetes in the Post-Transplant Setting
- Weight-Based Dosing
- Transitioning Off An Insulin Drip
- Management Options for Outpatient

<table>
<thead>
<tr>
<th>Test/Exam</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wgt.</td>
<td>Each visit</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>Each visit</td>
</tr>
<tr>
<td>HbA1c</td>
<td>Every 3 months</td>
</tr>
<tr>
<td>Dilated eye exam</td>
<td>Yearly if no DR</td>
</tr>
<tr>
<td>Lipid Panel</td>
<td>Yearly if low risk</td>
</tr>
<tr>
<td>Foot exam</td>
<td>Yearly if low risk</td>
</tr>
<tr>
<td>Microalbumin</td>
<td>Yearly</td>
</tr>
</tbody>
</table>
Thank You!

Ann Hackett, APRN-BC, MSN, CDE