Insulin Basics

***Onset**, **peak** and **duration** of action are important when choosing an insulin regimen.*

Rapid-acting insulins

	Insulin lispro (Humalog®)[1]	Insulin aspart (Novolog®)[2]	Insulin glulisine(Apidra®)[3]
Onset	15 to 30 minutes	10 to 20 minutes	10 to 15 minutes
Peak	30 minutes to 2.5 hours	40 to 50 minutes	1 to 1.5 hours
Duration	3 to 6.5 hours	3 to 5 hours	3 to 5 hours
Meal timing	Give within 15 minutes before or immediately after meals. Give pump bolus immediately before meal.	Give 5 to 10 minutes before meals. Give pump bolus immediately before meal.	Give within 15 minutes before or within 20 minutes after starting a meal.

Short-acting insulins

	Regular human insulin (Humulin R®, Novolin R®)[4,5]
Onset	30 to 60 minutes
Peak	1 to 5 hours
Duration	6 to 10 hours
Meal timing	Give approximately 30 minutes before meals. Give pump bolus 20 to 30 minutes before a meal.

Intermediate-acting insulins

	NPH insulin (Humulin N®, Novolin N®)[6,7]
Onset	1 to 2 hours
Peak	6 to 14 hours
Duration	16 to 24+ hours
Meal timing	NPH can be given separately from rapid- or short-acting insulin. In these cases, it does not have to be given with meals; it can be given in the morning and/or at bedtime.

Long-acting insulins

	Insulin glargine (Lantus®)[8]	Insulin detemir (Levemir®)[9]
Onset	1.1 hours	0.8 to 2 hours (dose-dependent)
Peak	No significant peak	Relatively flat; 4 to 14 hours
Duration	24 hours	Dose-dependent: 12 hours for 0.2 units/kg, 20 hours for 0.4 units/kg, up to 24 hours. Binds to albumin.
Meal timing	Not applicable	Evening dose can be given at dinner or bedtime. In twice-daily regimens, it can also be given 12 hours after the morning dose.

Insulin premixtures

	70% NPH/30% regular[10,11]		50% NPH/50% regular[12]	75% insulin lispro protamine/25% insulin lispro[13]	70% insulin aspart protamine/30% insulin aspart[14]
	Humulin® brand	*Novolin®* brand			
Onset	30 to 60 minutes			Faster than 30 minutes	
Peak (mean)	4.4 hours	2 to 12 hours	3.3 hours	2.6 hours	2.4 hours
Peak (range)	1.5 to 16 hours		2 to 5.5 hours	1 to 6.5 hours	1 to 4 hours
Duration (effective)	10 to 16 hours			Up to 24 hours	15 to 18 hours
Duration (maximum)	18 to 24 hours				Up to 24 hours
Meal timing	Give approximately 30 minutes before meals. Individualize based on blood glucose.			Give within 15 minutes of a meal. Individualize based on blood glucose.	

Insulin Initiation and Titration

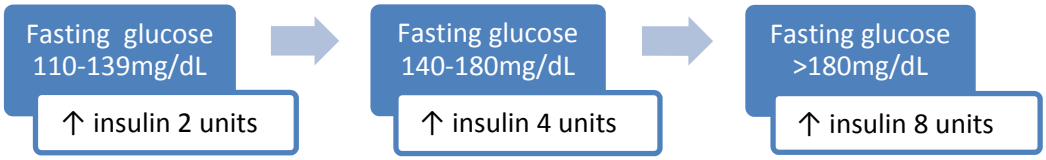
Patients initiated on basal (long-acting) insulin should be given long-acting insulin doses based on their individual hemoglobin A1c level. The American Association of Clinical Endocrinologists (AACE) recommends that **if a patient's A1c is less than 8% the total daily doses (TDD) of basal insulin should be 0.1-0.2units/kg, and if the A1c is greater than 8% the TDD should be 0.2-0.3 units/kg**.[16]

Basal Insulin Initiation[16]

A1c < 8%	A1c > 8%
TDD 0.1-0.2 units/kg	TDD 0.2-0.3 units/kg

Dose adjustments should be made weekly according to patients' average fasting blood glucose. For most patients with type 2 diabetes, HbA1c < 7% is an appropriate glycemic goal. The chart below reflects targeting to HbA1c goal of 7%.

Basal Insulin Titration[16,18]



**Titration should stop if blood glucose drops below 70 mg/dL during the night.*

- Consider dividing basal insulin into two equal doses given every 12 hours subcutaneously when the total dose of basal insulin reaches 60 units.
- **If hypoglycemia occurs**, or the fasting glucose is <70mg/dL, reduce bedtime doses by 4 units or 10%, whichever is greater.
- **If patient's blood glucose remains uncontrolled**, adjust insulin doses according to when hyperglycemia or hypoglycemia occurs. Remember, no two patients will be managed the same.

Adding Prandial Insulin:

- If after 3 months of basal insulin therapy patient is still not at goal, consider adding bolus insulin if fasting blood glucose > 140mg/dL and/or basal insulin TDD exceeds 60 units/day.
    - **Note: Patients requiring intensive therapy with both basal and postprandial insulin should be referred to a certified diabetes educator (CDE)**.
- Can initiate bolus insulin at **0.1units/kg/meal** in a type 2 diabetic patient and titrate based on self-monitoring blood glucose levels.
- **If postprandial insulin is required**, **use rapid-acting insulin**. The AACE states NPH, regular, or premixed insulin are less advantageous.
    - Rapid-acting insulin has less variability in absorption, provides better postprandial glucose control, and is associated with less nocturnal hypoglycemia than regular insulin.

Insulin Management Tools:

- Important to ask patients at visits where they are injecting their insulin, what time(s) they are doing it, and which insulin they are using to clarify any confusion the patient may have.
- Lifestyle management including diet and exercise enhances the efficacy of insulin therapy.[19] **Studies have shown Medical Nutritional Therapy (MNT) can decrease HbA1c up to 1-2%**.
- Re-evaluate insulin regimen routinely, insulin therapy may need to be changed due to different causes: progression of diabetes, change in stress level, presence of other comorbidities, hypoglycemia, weight gain and cost[19].

References:
1: Humalog® (insulin lispro [rDNA origin] injection) Prescribing Information. *Eli Lilly and Company*;2010. 2: NovoLog® (insulin aspart [rDNA origin] injection) Prescribing Information. *Novo Nordisk Inc*;2010. 3: Apidra® (insulin glulisine [rDNA origin] injection) Prescribing Information. *sanofi aventis U.S. LLC*;2010. 4: Humulin R® (human insulin [rDNA origin] injection) Prescribing Information. *Eli Lilly and Company*;2010. 5: Novolin R® (human insulin [rDNA origin] injection) Prescribing Information. *Novo Nordisk Inc*;2010. 6: Humulin N® (human insulin [rDNA origin] isophane suspension) Prescribing Information. *Eli Lilly and Company*;2010. 7: Novolin N® (human insulin [rDNA origin] isophane suspension) Prescribing Information. *Novo Nordisk Inc*;2010. 8: Lantus® (insulin glargine [rDNA origin] injection) Prescribing Information. *sanofi aventis U.S. LLC*; 2010. 9: Levemir® (insulin detemir [rDNA origin] injection) Prescribing Information. *Novo Nordisk Inc*;2010. 10: Humulin 70/30® (70% human insulin isophane suspension and 30% human insulin [rDNA origin] injection) Prescribing Information. *Eli Lilly and Company*; 2010. 11: Novolin 70/30® (70% human insulin isophane suspension and 30% human insulin [rDNA origin] injection) Prescribing Information. *Novo Nordisk Inc*;2010. 12: Humulin 50/50® (50% human insulin isophane suspension and 50% human insulin [rDNA origin] injection) Prescribing Information. *Eli Lilly and Company*;2010. 13: Humalog Mix 75/25® (75% insulin lispro protamine suspension and 25% insulin lispro [rDNA origin] injection) Prescribing Information. *Eli Lilly and Company*;2010. 14: NovoLog Mix 70/30® (70% insulin aspart protamine suspension and 30% insulin aspart [rDNA origin] injection) Prescribing Information. *Novo Nordisk Inc*;2010. 15: SUNY, NYSDOH. Treating type 2 diabetes mellitus: a New York State Medicaid clinical guidance document. 2011. Available online at nypep.nysdoh.suny.edu. Accessed 10/18/2011. 16: AACE Comprehensive Diabetes Management Algorithm, Endocr Pract. 2013; 19(No. 2). 17:*ACP Diabetes Care Guide: A Team-Based Practice Manual and Self-Assessment Program*: American College of Physicians; 2007. Available at: http://diabetes.acponline.org. Accessed 10/13/2011. 18:Nathan DM, Buse JB, Davidson MB, et al. Medical management of hyperglycemia in type 2 diabetes: a consensus algorithm for the initiation and adjustment of therapy: a consensus statement of the American Diabetes Association and the European Association for the Study of Diabetes. *Diabetes Care*. Jan 2009;32(1):193-203. 19: Hamaty M, Insulin treatment for type 2 diabetes: When to start, which to use. Cleaveland clinic Journal of Medicine. May 2011;78(5) 332-42.