Diabetes at Camp: All About Insulin

Module 2 of 12

Special thanks to the team below and everyone who contributed to this work.

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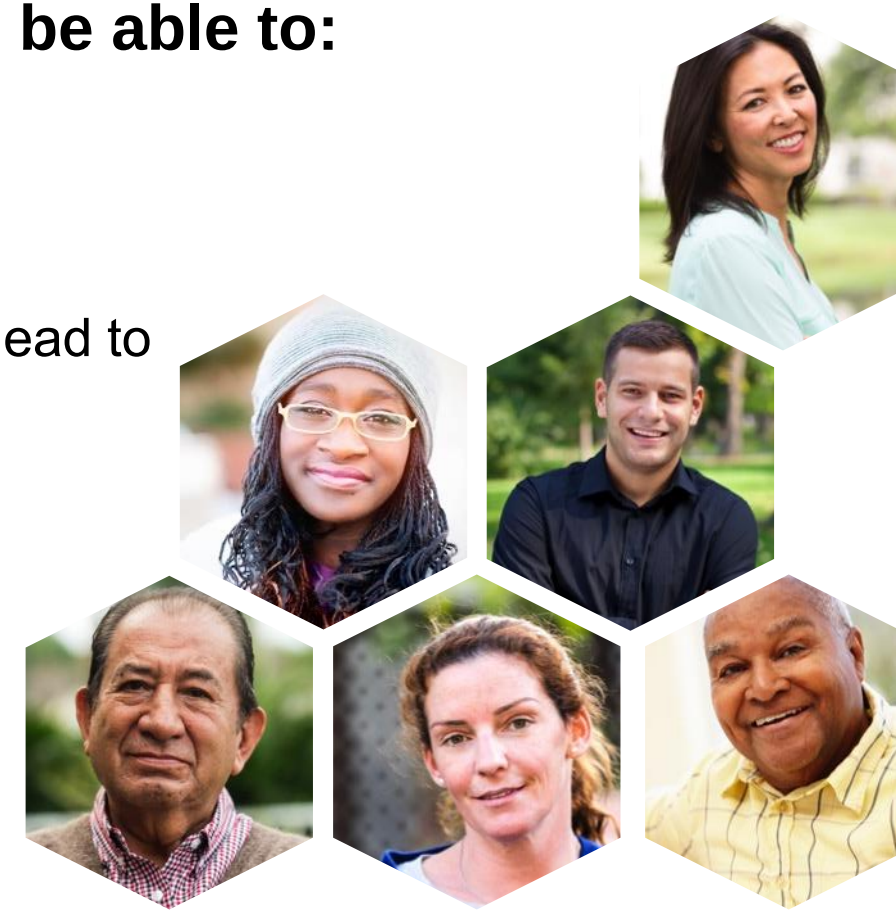
Objectives

At the end of this module, the participant should be able to:

- Identify how insulin works
- State how basal-bolus insulin regimens work
- Identify how “stacking” insulin doses occurs, and how it can lead to hypoglycemia
- State proper temperature for insulin storage



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Topics

- How insulin works
- Types of insulin
- Basal-bolus regimens
- Timing of doses
- Temperature sensitivity of insulin

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How we get insulin into the blood

If you don't have diabetes:

- Rising blood glucose causes beta cells in pancreas to release insulin
- Insulin goes into blood and works right away
- Since the body is able to regulate blood glucose levels there is no risk of blood glucose going too high or too low

If you take insulin:

- Insulin can be injected or infused under the skin or taken through inhaler
- Insulin absorbs into the bloodstream at variable rates depending on the type of insulin, then starts working

Retrieved from

https://professional.diabetes.org/sites/professional.diabetes.org/files/pel/source/medications.pdf

INSULIN TYPE
Rapid-Acting Onset: about 15 minutes Peak: about 1 or 2 hours after injection Duration: last between 2-4 hours
Regular or Short-Acting Onset: about 30 minutes Peak: about 2 to 3 hours after injection Duration: last between 3-6 hours
Intermediate-Acting Onset: about 2-4 hours Peak: 4-12 hours later Duration: it is effective for abut 12-18 hours
Long-Acting or Basal Insulin Analogs Onset: between 2-4 hours Peak: continuous, "peakless" action that acts the way your body normally releases insulin Duration: lasts 24 hours or longer
Ultra Long-Acting Onset: 6 hours Peak: No peak Duration: 36 hours
Inhaled Insulin (FDA approved > 18 years; clinical trials for < 18 years) Onset: Within 12-15 minutes Peak: 30 minutes Duration: Out of your system in 180 minutes Note: Must be used with injectable long-acting insulin in patients with type 1 diabetes and in type 2 diabetes patients who use long-acting insulin.

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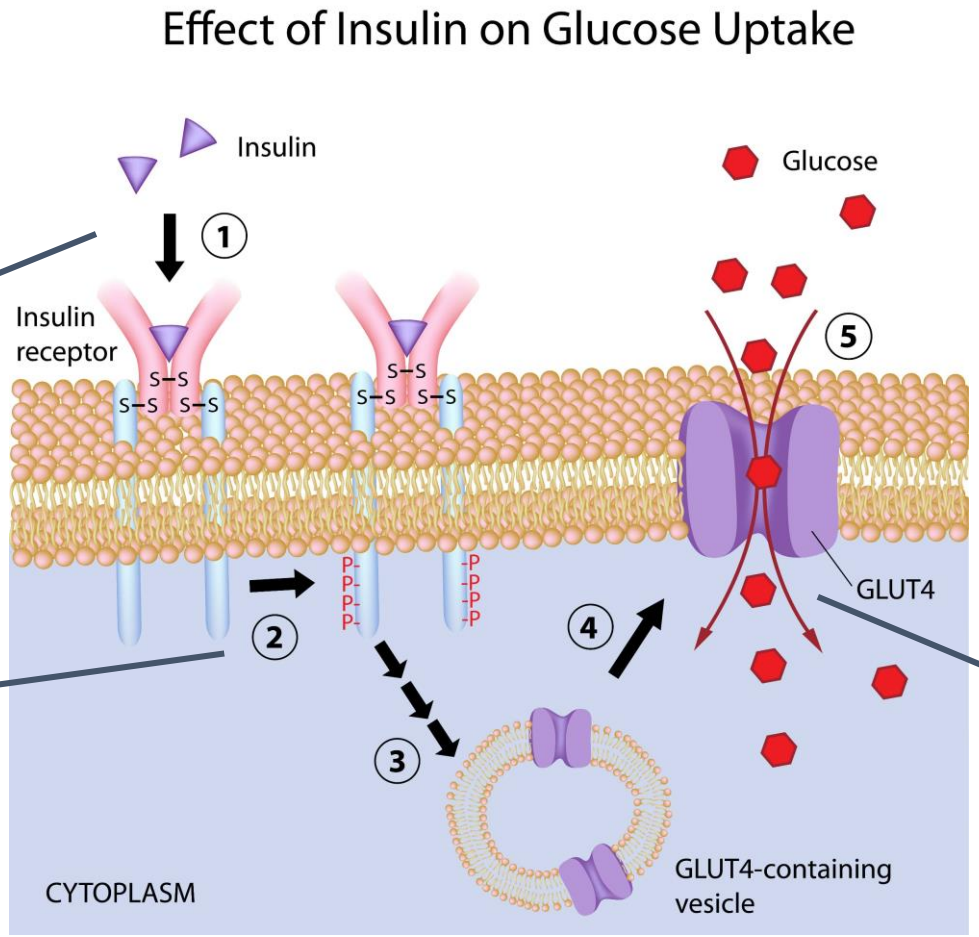
Once insulin is in the blood, what does it do?



1. Insulin binds to receptor

2. Signals cause glucose transporter to move to cell membrane

- Circulating insulin binds to receptors on cells
- When receptor is occupied, glucose transporters move to cell membrane and facilitate movement of glucose into cell

4. Glucose transporter moves glucose into cell

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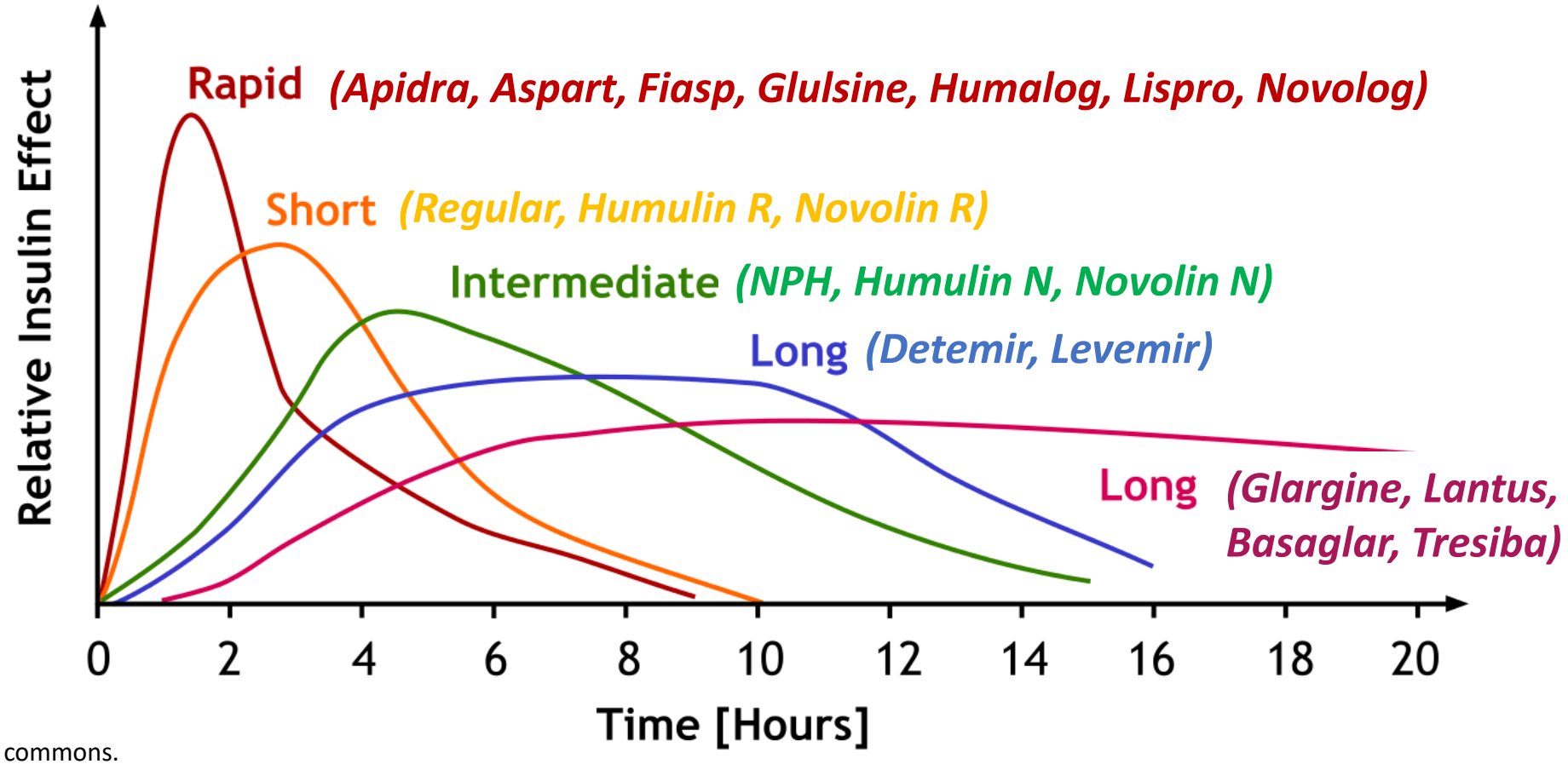
Action profiles of insulin



Adapted from commons.
Wikimedia Foundation. (2010). Insulin short-intermediate-long acting. Retrieved from wikimedia.org/wiki/File:Insulin_short-intermediate-long_acting.svg.

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Rationale for insulin regimens

Blood glucose peaks about an hour after eating

- Insulin that begins working and peaks shortly after taking it avoids high glucose after eating

The liver produces glucose and puts it in the bloodstream 24 hours per day (hepatic glucose output)

- Insulin that works aggressively over long periods of time allows this glucose to be utilized

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Basal-bolus regimens

Basal insulin

- Covers background need for insulin
- Patients on injections use long-acting insulin for this
- Patients on pump use short-acting insulin infusing at a basal (low) rate for this

Bolus insulin

- Covers blood glucose rise from eating meals or snacks
- Can be used to correct high blood glucose level
- All patients use rapid- or short-acting insulin for this type of dose

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Basal insulins-insulin analogs

INSULIN TYPE	GENERIC NAME	BRAND NAME
Long-Acting or Basal Insulin Analogs Onset: between 2-4 hours Peak: continuous, “peakless” action that acts the way your body normally releases insulin Duration: lasts 24 hours or longer	degludec	Tresiba
	detemir	Levemir
	glargine	Basaglar
		Lantus

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Basal insulin-protein bound

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	glargine	Basaglar
		Lantus

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Basal insulin-protein bound

NPH (Humulin N, Novolin N, ReliOn)

- Recombinant human insulin is complexed with proteins called protamine
- Complex crystalizes so suspension is cloudy
- Needs to be gently mixed before each dose
- Peaks 4-8 hours after injection, so it is not a great basal insulin
- Campers taking NPH are at risk for hypoglycemia during peaks and may need extra snacks
- Premixed insulins (70/30, 75/25) are infrequently used, contain 70 or 75% NPH and 30 or 25% short-acting insulin

Bolus insulins

INSULIN TYPE	GENERIC NAME	BRAND NAME
Rapid-Acting Onset: about 15 minutes Peak: about 1 or 2 hours after injection Duration: last between 2-4 hours	aspart	Fiasp
		NovoLog
	glulisine	Apidra
	lispro	Admelog
		Humalog
Regular or Short-Acting Onset: about 30 minutes Peak: about 2 to 3 hours after injection Duration: last between 3-6 hours	human regular	Humulin R
		Novolin R
		ReliOn

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Typical regimens

Injections

- Lantus/Basaglar daily, Humalog/Novolog with meals
- Levemir once or twice daily, Humalog/Novolog with meals
- Previously popular: human nph and human regular, Humalog, or Novolog at breakfast and supper
- Less common: premixed (70/30, 75/25) human nph with or without short-acting at breakfast and supper

Pumps

- Could use human regular but almost all patients use Humalog, Novolog, Apidra, Admelog (Fiasp)
- Total daily basal and total daily bolus are often near equal (each is near 50% of total daily insulin) but lots of individual variability
- Basal rates per day is variable
- Parameters for meal doses usually programmed into bolus advisor

Meal bolus dosing part 1: carb coverage

Carb based dosing

- Requires counting grams of carbohydrate
- Expressed as ratio (also called i:c ratio or insulin-to-carb)
  - Example: 1 unit per 10 grams carbohydrate
  - Small kids may take small doses, like 1 unit per 20 or 30 grams carb
  - Adolescents may take big does, like 1 unit per 3 or 5 grams carb

Fixed dosing

- Patients unable to carb count may take a certain number of units per meal for carbohydrate

Meal bolus dosing part 2: correction

Correction

- Additional insulin added when blood glucose is above patient's target
- Expressed as "sensitivity factor" (how much one unit of insulin is expected to lower the blood glucose) and "target" (blood glucose at which correction insulin is given)
- Also referred to as "sliding scale"
- (Current blood glucose – target) ÷ sensitivity factor = correction
- **Correction is added to carb based dose to get the total meal dose**

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Give it a try!

Camper Caitlyn uses an insulin pump. At lunch, she plans to eat **85** grams of carbohydrate and her pre-lunch blood glucose is **230.** Her insulin:carb ratio is 10, her sensitivity factor is 50, and her target is 130.

Carb coverage: 85 ÷ 10 = **8.5**

Correction: [Current glucose (230) - target (130)] ÷ sensitivity factor (50) = **2**

Total bolus: 8.5 + 2 = 10.5 units

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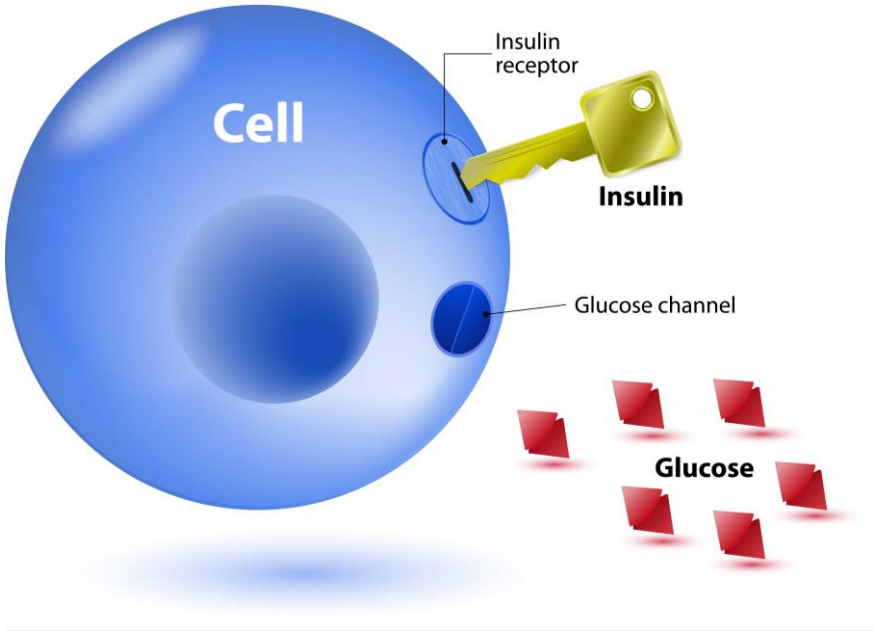
What happens if you take short-acting insulin while the last dose is still active?

Kids often think that insulin is “used up” by the carb it covers.



In reality, insulin works more like a lock and key. It unlocks the receptor, followed by changes in the cell that allow glucose to enter.

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Insulin doses too often = insulin stacking

Taking short-acting insulin while the last dose is still active

will result in additive insulin action (last dose activity + new dose activity).

This can easily lead to low blood glucose.

Short-acting doses given less than 2-3 hours apart

need CAREFUL BLOOD GLUCOSE MONITORING!

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To dose or not to dose

Camper Chris started feeling “bad” during cabin clean up after breakfast, so he came to the health lodge. His blood glucose **before breakfast was 205** and he took **14 units of Humalog**. His **glucose now**, 40 minutes after breakfast, is **266**. He indicates that he “might” have eaten an extra waffle beyond the carb grams he calculated for his insulin dose. His cabin will be playing soccer after clean up.

What to do?

Consider: Humalog dose is just **getting to peak**, and camper will be doing **vigorous activity**. An additional Humalog dose now will peak while prior dose is still active (**stacked insulin action**).

Recommend: good hydration with water, no additional insulin, and gentle reminder to talk to nurse if still hungry after eating calculated carbs. Recheck blood glucose in one hour to ensure that glucose is decreasing as expected.

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Insulin does not like to be too hot or too cold

- Insulin will lose activity if exposed to heat above 86˚F
- Insulin will lose activity if frozen
- Unopened insulin should be refrigerated
- Open insulin can be kept at room temperature (under 80˚F)
- Open insulin should be discarded after 30 days, even if it is refrigerated after opening
- Ideal temperature range is 36˚F - 80˚F

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Summary

- Insulin permits movement of glucose from the circulation into cells.
- Bolus insulin doses are calculated using an insulin-to-carb ratio for food, and a target and sensitivity factor to correct for pre-meal blood glucose that is above target.
- Short-acting insulin given while prior dose is still active will have action additive to the activity of the prior dose.
- Insulin will lose activity if exposed to heat over 86˚F.

Assessment

1. Lantus insulin should be given

A. at night

B. In the morning

C. with a meal

D. every 24 hours

2. Insulin that is taken to cover carbohydrate intake should be

A. cloudy

B. clear

C. rapid-acting

D. long-acting

3. A camper with diabetes takes Humalog insulin with a cabin treat at 4:30pm. The camper takes Humalog insulin with dinner at 5:30pm.

The camper is most at risk for a low blood glucose:

A. between dinner and bedtime

B. in the middle of the night

C. the next day

4. A camper with diabetes is scheduled for a hike and a picnic lunch a day when the expected high temperature will be about 95˚F. The insulin pen to be used at lunch

A. should be packed in ice

B. should be kept cool but not frozen

C. can be kept in a backpack as long as it is not in direct sunlight

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