

CHAPTER 16

INSULIN

"How did she get the nickname of 'Sweet Pea'?"

"When her class mates discovered the Greek and Latin roots for diabetes mellitus they thought it would be a good pet name for her as a diabetic."

--A discussion between two instructors.

Ideally, the human body will effectively create its own insulin and make proper utilization of it in order to regulate its blood glucose level. When the human body fails to regulate it effectively a patient may end up receiving some form of insulin therapy from a pharmacy.

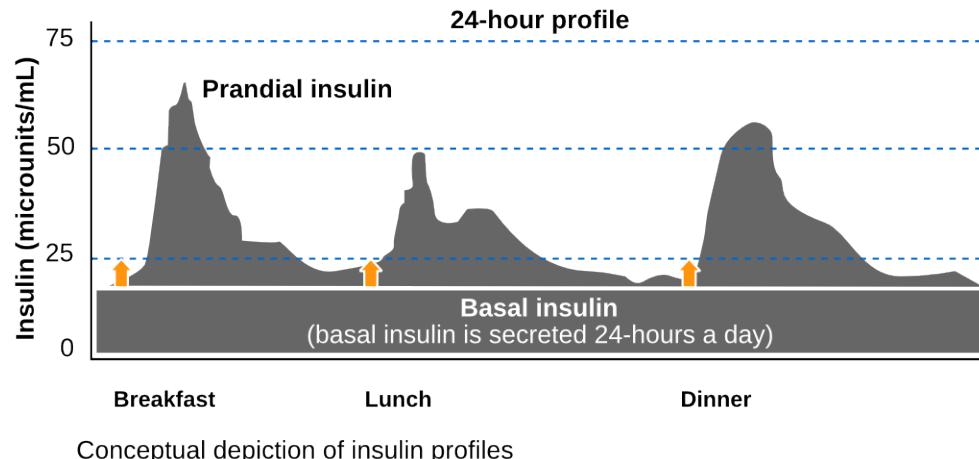
In this chapter we will look at the following concepts with respect to insulin therapy:

- Categories of patients receiving insulin therapy,
- Definitions,
- Dosing and types of insulins,
- Insulin syringes, and
- Mixing insulins.

Categories of patients receiving insulin therapy

Insulin therapy is required in type 1 diabetes (insulin dependent diabetes mellitus, IDDM), and may be necessary in some individuals with type 2 diabetes (non-insulin dependent diabetes mellitus). The general objective of insulin replacement therapy is to approximate the physiological pattern

Endogenous insulin secretion



of insulin secretion. This requires a basal insulin throughout the day, supplemented by prandial insulin at mealtime. Insulin injections are intended to mimic the natural process shown in the image above:

Definitions

Insulin is a hormone central to regulating carbohydrate and fat metabolism in the body. Insulin

causes cells in the liver, muscle, and fat tissue to take up glucose from the blood, storing it as glycogen in the liver and muscle. Ideally it will be created endogenously in the pancreas and effectively used by the body's cells, but when either one or both of those situations are not occurring an exogenous source of insulin may be required.

Basal insulin may also sometimes be called "background" insulin, that is, the insulin working behind the scenes. Basal insulin may be covered with a long-acting insulin like glargine insulin, or an intermediate-acting insulin like isophane (NPH) insulin.

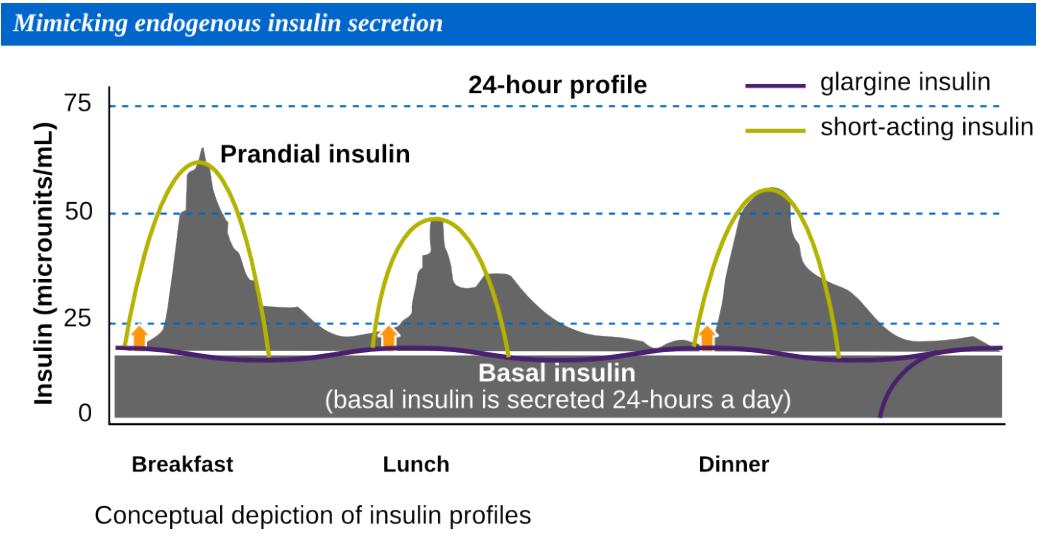
Prandial insulin, also known as nutritional insulin, is the insulin used to cover the spike in blood sugar from consuming food. Prandial insulin may be covered with regular insulin (a short-acting insulin), or a rapid-acting insulin like lispro insulin.

Dosing and types of insulin

Although some patients may receive a continuous infusion of insulin in an institutional setting, multiple daily doses guided by blood glucose monitoring are the standard of diabetes care. Combinations of insulins are commonly used. The number and size of daily doses, time of administration, and diet and exercise require continuous medical supervision. In addition, specific formulations may require distinct administration procedures/timing.

There is solid scientific documentation of the benefit of tight glucose control, either by insulin pump or multiple daily injections (4-6 times daily). However, the benefits must be balanced against the risk of hypoglycemia, the patient's ability to adhere to the regimen, and other issues regarding the complexity of management. Diabetic education and nutritional counseling are essential to maximize the effectiveness of therapy. Patients should also be instructed in administration techniques, timing of administration, and sick day management.

Type 1 diabetics (IDDM) will traditionally use either a rapid or short-acting insulin prior to each meal simulating prandial insulin and they will often take an intermediate or long-acting insulin either once or twice a day simulating basal insulin. The image to the right demonstrates this concept.



The chart on the following page lists the onset, peak, and duration of various insulin products. Combination products include either rapid or short-acting insulin in combination with an intermediate-acting insulin.

<i>Types of Insulin</i>	<i>Onset (h)</i>	<i>Peak (h)</i>	<i>Duration (h)</i>
Rapid-acting			
lispro insulin - Humalog	0.2-0.5	0.5-1.5	3-4
aspart insulin - NovoLog	0.2-0.5	1-3	3-5
glulisine insulin - Apidra	0.2-0.5	0.5-1.5	3-4
Short-acting			
regular insulin (clear) - Humulin R, NovolinR	0.5-1	2-4	6-8
Intermediate-acting			
isophane (NPH) insulin (cloudy) - Humulin N, Novolin N	1-2	6-12	18-24
Intermediate to long-acting			
detemir insulin - Levemir	3-4	6-8	6-23
Long-acting			
glargine insulin - Lantus	3-4	*	24
Combinations			
70% isophane (NPH) insulin & 30% regular insulin - Humulin 70/30, Novolin 70/30	0.5	2-12	18-24
aspart protamine insuline & aspart insulin - Humalog Mix 50/50, Humalog Mix 75/25	0.2-0.5	1-4	18-24
lispro protamine insulin & lispro insulin - NovoLog Mix 70/30	0.2-0.5	2-12	18-24

* glargine insulin has no pronounced peak

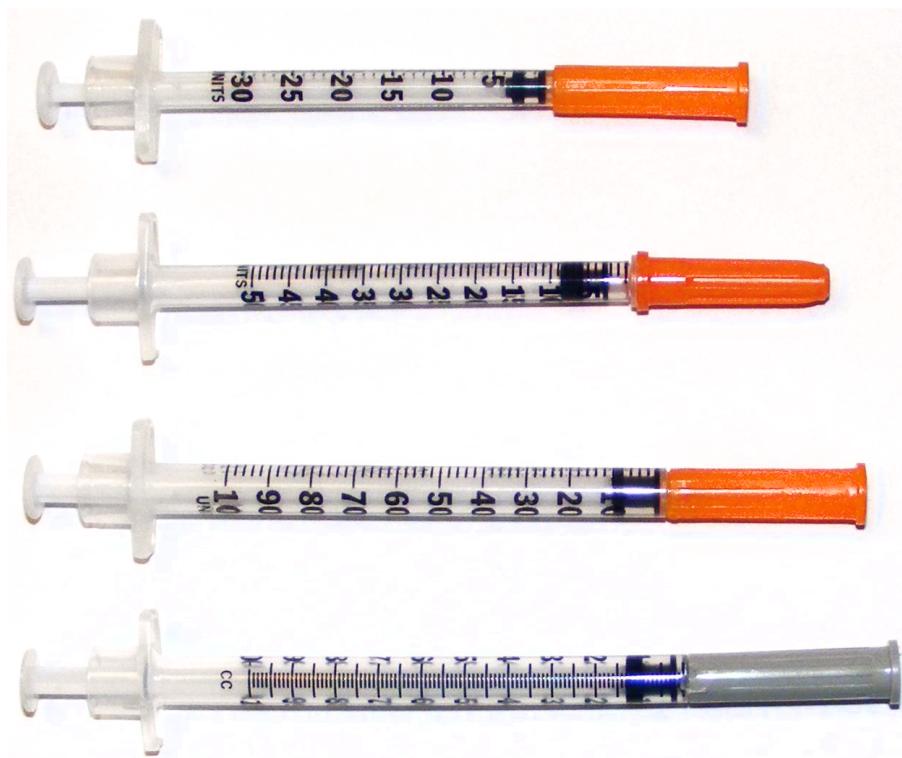
Insulin syringes

Insulin dosing is very customized for various patients and therefore flexible delivery systems allowing for a wide range of required doses make it common place for the use of insulin syringes and vials. Insulin vials are marked with their concentration in two ways 100 units per mL and U-100. Most insulins have this same concentration but occasionally pharmacies need to carry a concentration of 500 units per mL / U-500 regular insulin for patients that need very high doses of insulin. Pictured below are both concentrations.



Insulin syringes (easily identifiable by their orange caps) are intended for the much more common dosing of U-100 insulins. Note, insulin syringes should only be used for insulins with a concentration of U-100 as the higher concentration of U-500 insulin will lead to a medication error. The following

are images providing examples of various insulin syringes and a 1 cc syringe for dosing a U-500 insulin.



When selecting a syringe choose the one that will most closely compliment the dose being given to the patient.

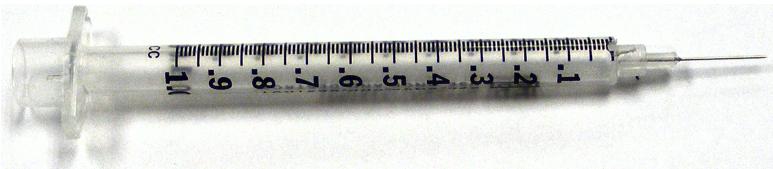
Practice Problems

Mark on the syringes near each problem how many units or mL you should draw up for each scenario.

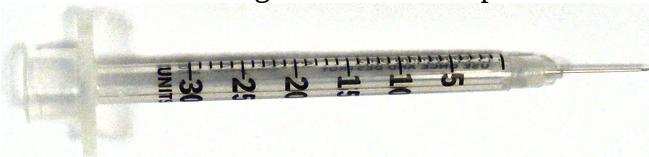
- 1) 66 units of Novolin N is ordered for a patient.



- 2) 150 units of U-500 concentrated Humulin R is ordered for a patient.



- 3) 8 units of Humalog is ordered for a patient.



- 3) The syringe should be marked at 8 units
2) The syringe should be marked at 0.3 cc
1) The syringe should be marked at 66 units

Mixing insulins

As previously mentioned, a physician will often order two kinds of insulin. In order to decrease the number of injections a patient might need to take in a day a physician may order a combination vial such as Novolin 70/30 or Humalog Mix 75/25 in order to allow a patient to receive both kinds at the same time. If a patient's needs can not be met that way with premixed combination vials some solutions can be mixed together by the patient immediately before administration and injected. Isophane (NPH) insulin may be mixed with the following insulins: regular insulin, lispro insulin, aspart insulin, or glulisine insulin. Below is a list explaining the procedure for drawing up two different insulins into the same syringe.

- 1) Calculate the total dose of both insulins combined.
- 2) Draw up a volume of air equivalent to the volume of isophane (NPH) insulin desired and inject the air into the isophane (NPH) insulin vial, but do not draw up the dose. Withdraw the needle from the vial.
- 3) Draw up a volume of air equivalent to the volume of the rapid or short-acting insulin and inject it into the rapid or short-acting insulin vial. Draw up the appropriate quantity of this insulin.
- 4) Carefully insert the needle through the stopper of the isophane (NPH) insulin vial. Invert the vial without injecting any of the rapid or short-acting insulin into the vial.
- 5) Slowly draw up the isophane (NPH) insulin until the syringe reaches the appropriate dose for both insulins combined.

A good memory trick to help with memorization of this pattern is '*clear before cloudy*' as the clear rapid or short-acting insulin is actually drawn into the syringe prior to adding the cloudy isophane (NPH) insulin.

Example

A patient requires 42 units of Humulin N and 10 units of Humulin R to be given at the same time. To minimize the number of needle sticks the patient needs to endure they should be drawn up at the same time.

First, calculate the total dose.

$$42 \text{ U} + 10 \text{ U} = 52 \text{ units}$$

Then draw up 42 units of air and inject it into the Humulin N vial, but do not draw up any solution yet. Withdraw the needle from the vial.

Next, draw up 10 units of air, inject it into the Humulin R, and draw 10 units of regular insulin.

Next, insert the needle into the Humulin N vial and carefully invert the vial without injecting any solution into the Humulin N.

Lastly, slowly withdraw insulin from the Humulin N vial until the vial contains a total of 52 units of insulin.

Practice Problem

Using the above example as a guide, explain how to prepare an insulin syringe with 43 units of Novolin N and 22 units of NovoLog.

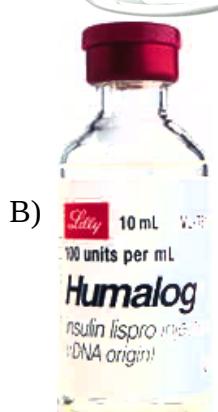
First, calculate the total dose. $(43 \text{ units} + 22 \text{ units} = 65 \text{ units})$ Then draw up 43 units of air and inject it into the Novolin N vial, but do not draw up any solution yet. Withdraw the needle from the vial. Next, draw up 22 units of air, inject it into the NovoLog, and draw 22 units of aspart insulin. Next, insert the needle into the Novolin N vial and carefully invert the vial without injecting any solution into the isophane (NPH) insulin. Lastly, slowly withdraw insulin from the Novolin N vial until the vial contains a total of 65 units of insulin.

Worksheet 16-1

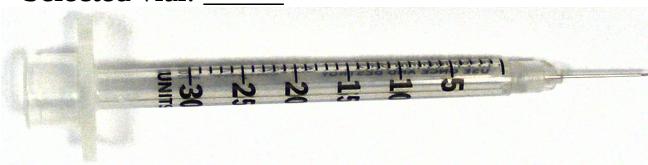
Name:

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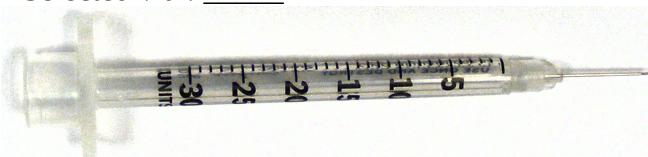
Select the vial or box that corresponds with each order in problems 1-14 and 16-17. Also mark the syringes pictured in problems 1-14 with the correct volume for the ordered dose.



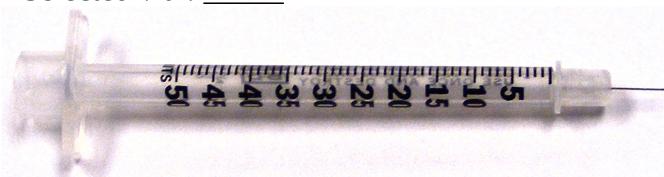
- 1) A patient is ordered 12 units of Humulin R SQ before breakfast.
Selected vial: _____



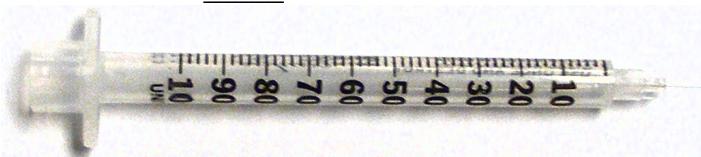
- 2) A patient is ordered 5 units of Humalog SQ 15 minutes before lunch.
Selected vial: _____



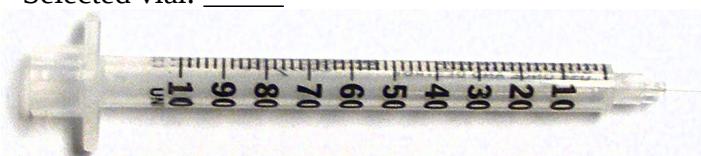
- 3) A patient is ordered 35 units of Novolin N SQ every morning.
Selected vial: _____



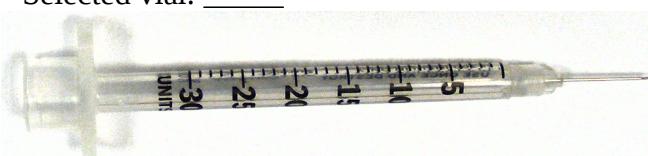
- 4) A patient is ordered 72 units of Lantus SQ every evening.
Selected vial: _____



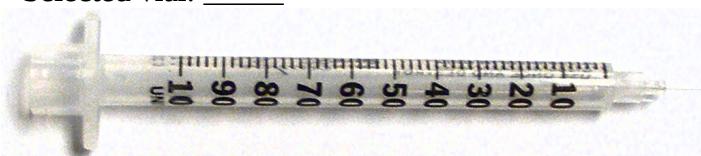
- 5) A patient is ordered 55 units of Humulin N SQ every evening.
Selected vial: _____



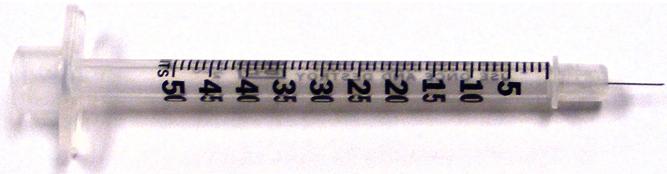
- 6) A patient is ordered 22 units of Levemir SQ every morning.
Selected vial: _____



- 7) A patient is ordered 80 units of Humulin 70/30 SQ every morning.
Selected vial: _____



- 8) A patient is ordered 45 units of Humalog Mix 75/25 SQ every evening.
Selected vial: _____



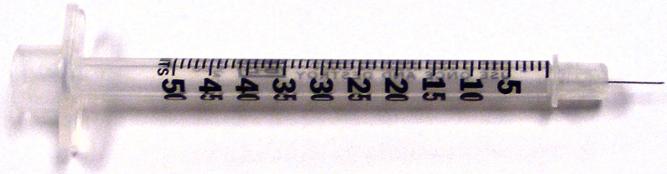
- 9) A patient is ordered 25 units of Humalog SQ daily before lunch.
Selected vial: _____



- 10) A patient is ordered 170 units of U-500 Humulin R every morning.
Selected vial: _____



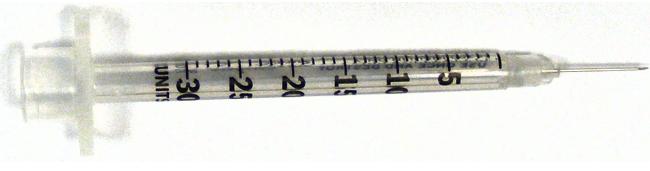
- 11) A patient is ordered 40 units of Novolin N SQ every evening.
Selected vial: _____



- 12) A patient is ordered 77 units of Humulin 70/30 SQ every morning 30 minutes before breakfast.
Selected vial: _____

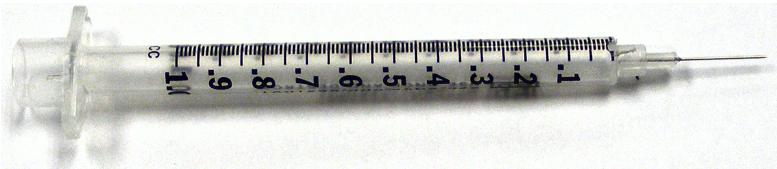


- 13) A patient is ordered 21 units of Lantus SQ every evening.
Selected vial: _____



- 14) A patient is ordered 50 units of Humulin R in a 50 mL bag of normal saline. Use sliding scale to maintain appropriate blood glucose levels. *Note: It's easier to use a 1 cc syringe than an insulin syringe for this as you need a needle long enough to pierce the injection port on an IV bag.*

Selected vial: _____



- 15) When mixing insulins explain what the phrase 'clear before cloudy' means.

- 16) A patient is to receive 15 units of Humulin R and 30 units of Humulin N. Explain how the two insulins can be drawn up at the same time.

Selected vials: _____ & _____

- 17) A patient is to receive 20 units of Humalog and 45 units of Humulin N. Explain how the two insulins can be drawn up and injected at the same time.

Selected vials: _____ & _____