

# The 4-1-1 on I-O-B

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It goes by different names depending on who you're talking to and whose pump you use: IOB (Insulin On Board), BOB (Bolus On Board), Active Insulin, Insulin Remaining, and so on. Regardless of what you call it, it just may be the best thing to happen to pump therapy since the disconnectable infusion set.

For those of you unfamiliar with the concept of IOB (let's just call it IOB since it saves me a few keystrokes), it refers to the amount of bolus insulin that was previously delivered but is still active (working) in the body. This is important to know because it prevents "stacking" of insulin when bolusing for high blood sugars within a few hours of a previous bolus. For instance, I (like many of you, I'm sure) don't like the feeling of being in the 200s. I used to check my blood sugar a few hours after eating, and if it was elevated, I would apply my usual "correction" bolus formula. And sure as sugar, I'd wind up low a few hours later. Now that the pumps deduct IOB, that rarely happens.

IOB is what puts the "smart" in today's "smart pumps". By taking IOB into account when calculating boluses, pumps make it safe to correct high readings at almost any time. However, different pumps have different ways of calculating IOB as well as applying it to bolus calculations. Should you trust the pump's IOB estimate? Will using it improve or hinder your control? Understanding how your pump handles IOB will help you to answer these questions.

**Deltec Cozmo** is probably the simplest to start with. Deltec considers all boluses (meal and correction/high-blood-sugar boluses) when figuring IOB, and deducts the total IOB from every subsequent bolus. The only "oddity" about Deltec is that it calculates IOB in a linear

fashion, assuming that the insulin works in a steady constant manner until it stops working. We all know that insulin starts slowly, picks up speed during hours 1-2, then gradually wears off. "Linear" calculations mean that IOB is slightly underestimated during the first hour, and slightly overestimated during the last couple of hours of insulin activity.

For example, if you set the "duration of insulin action" for 4 hours, Cozmo will figure that 25% of the bolus is "used up" each hour. A 4-unit bolus given at 6pm means that the IOB will be 3 units at 7pm, 2 units at 8pm, 1 unit at 9pm, and 0 units at 10pm. The full amount of IOB will be deducted from any bolus given between 6pm and 10pm.

**Medtronic** (and all other pumps that we will discuss) calculates IOB using an algorithmic equation so as to match the normal ebb and flow to insulin's activity. Only a small amount of insulin is used up during the first 30 minutes, a great deal is used up during the next couple of hours, and only a small amount is used towards the end of the insulin's action curve.

With the Medtronic Paradigm pumps, all boluses (meal and correction) are taken into account when IOB is calculated. However, IOB is only deducted from *correction* boluses, so the full amount of IOB is not always deducted. For example, if the correction bolus is 3 units and there are 2 units of IOB, the full 2 units are deducted. But if the correction bolus is 1 unit, only 1 of the 2 units of IOB will be deducted. If the blood sugar is below target, no IOB will be deducted. In other words, IOB is never deducted from meal boluses, only correction boluses.

**Animas** is a hybrid of Deltec and Medtronic in terms of how it handles IOB. IOB is calculated in an algorithmic fashion (similar to Medtronic), taking all previous meal and correction boluses into account. But when you look at how IOB is used, things get a bit strange. If the blood sugar is *above* target, Animas acts like Medtronic: IOB is only deducted from correction bolus amounts. But when blood sugar is below target, it acts like Deltec: the full amount of IOB is deducted from the total bolus (including the food portion). Thus, a small difference in blood sugar (just above vs. just below the target BG) can result in radically different bolus calculations.

For example, let's say your target BG is 120, your current reading is 180, and your total bolus (5 for the meal + 2 for correction) is 7 units. Without any IOB, you would receive the full 7 units. But if you have 4 units of IOB, the correction bolus is reduced to zero, and the recommended dose would be just the 5 units for the meal.

However, if your blood sugar is 90, and the usual dose is 4 units (5 for the food, -1 for the blood sugar), the 4 units of IOB would be deducted from the 4 unit total, resulting in a recommended dose of zero.

Both **OmniPod's PDM** and the **Pocket Compass Software** that works with **AccuChek Spirit** take a very different approach to IOB calculations. Both of these systems only consider boluses that were given to correct high blood sugars when figuring IOB. For example, if you gave 6 units for a meal and 2 to cover an above-target reading, the 6 units is essentially ignored in all IOB calculations. Only the 2-unit correction portion is taken into account. This leads to much lower IOB calculations than we see in other pumps, and hence less bolus reduction and more aggressive insulin dosing.

There are some who agree with this approach, believing that any insulin left from a meal bolus

is still covering what is still digesting from that meal. However, most experts agree that this can set people up for hypoglycemia, since the pump deducts far less IOB than what is actually present in the body.

For those who use the OmniPod and prefer the more traditional approach, whereby all boluses are taken into account for IOB calculations, there is another way. Simply have the PDM calculate your boluses as usual, then back up and deliver that full amount as a correction bolus. Confused? Don't worry. Here are the steps:

1. Enter blood sugar (or use the built-in meter) and carbs as usual. Note the suggested bolus amount, but do not press enter or confirm to initiate delivery.
2. Press the "back" button twice. When the PDM asks "Are you going to eat now?" answer "No".
3. Enter the full amount that was calculated by the PDM in step 1 above.
4. Press "enter", then press "confirm" to initiate delivery.

Essentially, you have entered your entire meal bolus (along with the correction dose component) as a correction bolus. The PDM will now calculate IOB based on all bolus insulin that was given rather than just correction portion. For all future boluses, the IOB will be calculated and deducted appropriately, and your chances for hypoglycemia will be reduced.

*Editor's note: Gary Scheiner MS, CDE is Owner and Clinical Director of Integrated Diabetes Services, a private consulting practice based near Philadelphia offering diabetes self-management education and coaching on blood sugar regulation via phone and the internet. He is the author of several books, including Think Like A Pancreas: A Practical Guide to Managing Diabetes With Insulin. Gary (and most of his staff) have type-1 diabetes and are proponents of pump therapy and CGM technology. For more information, visit [www.integrateddiabetes.com](http://www.integrateddiabetes.com), or call 877-735-3648.*