IOB APP {Insulin On Board}

Ashley Mosley

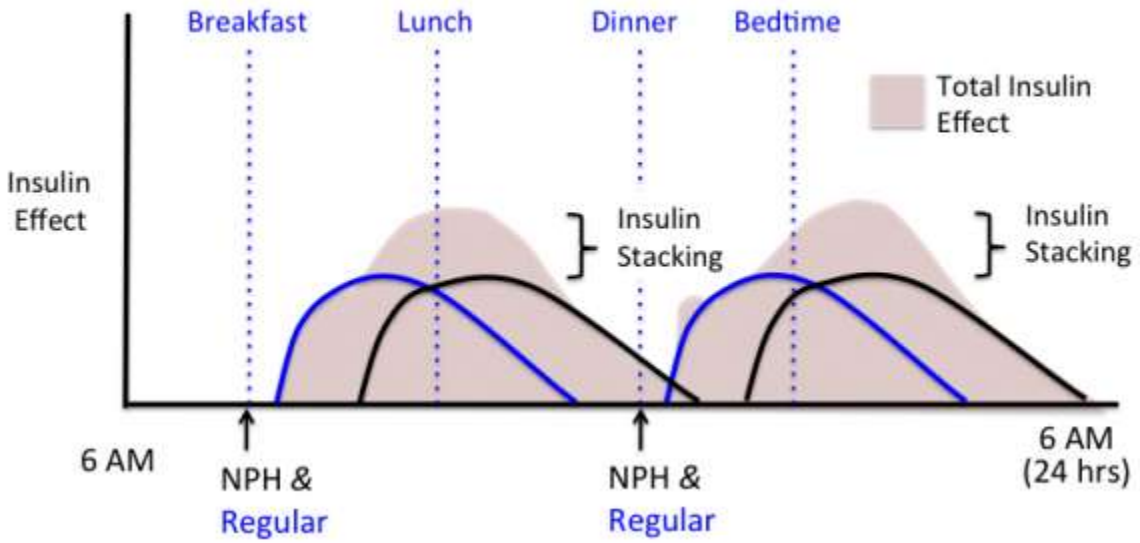
Introduction:

What's type 1 diabetes, insulin stacking, and active insulin even mean? Type 1 diabetes is an autoimmune disease where the body's defense cells attack healthy insulin producing cells in the pancreas. This leaves the person with type 1 diabetes unable to produce any insulin at all and therefore in need of daily injections. Most type 1 diabetics use newer technologies like an insulin pump that slowly releases insulin throughout the day and night. While others unable to have access to a pump for various reasons, and take two insulins: one being a basal insulin (long-acting insulin that gives a slower steady release to keep sugars stable throughout the day) and a bolus insulin (also known as a rapid acting insulin to cover meal times, and corrections).

For insulin pump users, the technology is great, you can put into your pump how many carbs you're eating, with your current blood sugar, and then it does an algorithmic calculation for you to see how much active insulin you have in your system from the time you took your last bolus (the insulin taken to cover a meal/snack). It then takes that amount of active insulin and subtracts it for you and tells you how much insulin you should actually be taking for this new bolus you're about to take. Active insulin is the amount of insulin that is still active in your system from a previous bolus. It's important to know how much insulin is active in your system from your last bolus because of insulin stacking. The result of insulin stacking is severe low blood sugars. Low blood sugars can cause fainting, hyperventilation, hallucinations, shaking, sweating, and even seizures. If a low blood sugar goes untreated (no sugar gets into the body) for a long enough time, the person will pass away.

How insulin stacking occurs is based on a person's sensitivity to the rapid acting insulin they are taking and the peak time (reaction rate time) of the insulin. The sensitivity rate is something that is calculated by the physician and programmed into a pump. For those not on a pump they instead remember their carb to insulin ratio rates for different times of the day. For example, a diabetic less sensitive to rapid acting insulin in the morning might have a sensitivity ratio of 60% which means during their insulin's peak time 60% of the insulin would be absorbed and the rest would still be in their system (this diabetic may have a 1 unit:10 carb ratio in the morning). At night this diabetic may be more sensitive to their insulin, meaning they absorb faster, so at their insulin's peak time they may absorb 70% of their insulin (they may have a 1 unit: 20 carb ratio for example). Knowing this if a diabetic with less sensitivity in the morning at breakfast bolused and then very shortly after took another bolus, for an apple, then they would run a higher chance of causing a low blood sugar because 40% of that insulin from the first bolus was still in their system. That is how insulin stacks, when you are bolusing back to back full carb:insulin ratio boluses during the time frame the insulin is still active in the body, without accounting for it.

Example of insulin stacking:



Pictured here is a rapid acting insulin NPH-R being bolused throughout the day. The pink is where the stacked insulin is being highlighted, which would be the times where you may see a low blood sugar occurring because the active insulin that was still in the body from the previous bolus was not accounted for when taking the next bolus.

Purpose of IOB:

With everything else a type 1 diabetic has to keep track of--like knowing their insulin to carb ratios, having to count up their carbs and decide how much insulin they should take, they shouldn't also have to worry about a severe low blood sugar due to insulin stacking. One way this can be accomplished is through the IOB App. This app would do the calculation that an insulin pump would do before a bolus. It would ask what's the current blood sugar, how many carbs they are bolusing for, and then it would take into account the previous amount bolused to make sure there is no active insulin on board that would cause a low blood sugar. If there was still active insulin on board, it would take that amount subtract it from the total bolus amount about to be taken, and give a new bolus amount that should be taken. This app would have a section where the person using the app could change their settings, an area that keeps a log of their boluses, and then of course the main portion that is doing the calculating.

Deployment:

The benefits from this app would out weigh the cost of creation and deployment. This is meant to be a free software for those in need of it. It would be taking the already FDA approved

algorithmic math that is used in an insulin pump and putting it into an app, so it may be utilized the same way for those not on an insulin pump.

Stretch Features: After deployment a feature to be added to the IOB app would be a carb counter. What this feature would do is total up the number of carbohydrates a person inputs for a meal or snack, along with the current information needed to be entered in the IOB app like previous bolus amount, and then the two features interact together to give the adjusted bolus amount not only based on IOB (insulin on board) but also taking into consideration the amount of carbs being consumed at that time.

User Interactions:

Let's use the example of Sam & Joe, who are sending their little type 1 diabetic girl off to school at the sweet age of 5. Since she is not on an insulin pump she has been taught to count carbs and she knows how much to inject for those carbs; however, she does not know how to do complex mathematic problems, like figuring out how much insulin is still active in her body before her next bolus, as she is only 5 years old! While she is fully prepared to treat herself for any spontaneous low blood sugars by carrying with her glucose shots, and glucose tabs, her parents would like to send her off to school with some extra assurance of avoiding a low blood sugar at all cost. Here is where the IOB app would come in. The app could be utilized with her settings across multiple devices for care takes at her school to manage. This way before giving injections she could take the accurate amount of insulin (accounting for the active insulin on board). She would be less likely to suffer from a severe low blood sugar due to insulin stacking.

We could also use the example of Cody's case, a type 1 diabetic who is in between health insurances and low on finances, so he is unable to utilize his pump at this time. He's in his early 20's and after using the pump he had became accustomed to using the bolus features that came with it. Now after going on to shots for his meals and snacks he has been having more low blood sugars due to insulin stacking. He lives a very active lifestyle, so he has just been treating his low blood sugars with glucose gel shots, rather than taking the extra time needed to try to remember and calculate the amount of insulin that is still active in his body from his last bolus. That is where the IOB app comes in, for him having this app means he's able to stop treating for lows, snack as often as he needs, and without having to do all of the daunting calculations his pump was once doing for him. Now he has an app that's able to do just that!

Nasar was not quite ready yet to go off of shots and jump on board with newer technology like an insulin pump. While he is still on shots, he could use the IOB app for calculating how much active insulin is still on board to give him adjusted bolus amounts. Not only that, with the new feature of carb counting in conjunction to the active insulin on board, he now has a complete total care interactive experience with the IOB app that mimics most features of an insulin pump. Now if he were to switch to an insulin pump the transition would go a lot smoother as he would

be already familiar with how all the features of an insulin pump would work, by having used the IOB app.

And let's not forget Klaus, the 86 year old who's memory is not quiet what it use to be. As a long-time type 1 diabetic on shots, he decided to keep up with that routine but he has a hard time remembering when his last bolus was and for how much. That is how IOB could be utilized for him. He can use it for the active insulin on board calculations but it would also be logging his past boluses so he's not having to try and remember all the time.

Conclusion:

The IOB app would be utilized by type 1 diabetics to help them calculate the active insulin they still have in their system before giving their next bolus. When taking their next bolus, it would calculate the amount needed to be taken off based on their sensitivity factors, how long ago their last bolus was, and the duration of the rapid acting insulin in their body. The IOB app would be using FDA approved algorithmic functions that are already being utilized by diabetics on insulins pumps. Now these features that are loved so much by insulin pump users can be utilized for free by those who are not on insulin pumps. This is to help gain better glycemic control safety by reducing the amount of low blood sugar episodes due to insulin stacking.