

Bionic Pancreas

Patil Darshan Rajkumar

¹Vellore Institute of Technology, School of Computer Science and Engineering, Vellore, Tamilnadu, India
patildarshan.rajkumar2019[at]vitstudent.ac.in

Abstract: Artificial Pancreas (AP) or Bionic Pancreas are the different name for the same technology. Looping is shorthand name for Closed Looping. But the FDA likes to call this technology as Bionic Pancreas (AID) systems. Using Bionic Pancreas, there is no need to bolus, no need to count carbs and no hypoglycemia. Regardless of whether we're talking about Bionic Pancreas or commercial systems, hybrid or fully automated systems, they all basically work the equivalent in terms of their most essential usefulness. This type of technology makes small adjustments every few minutes to provide more or less insulin with the goal of keeping Blood Glucose levels in a predefined target range. It does so with the following components: an insulin pump, a Continuous Glucose Monitor (CGM) and a controller. Bionic Pancreas works with older established Medtronic pump models and can be utilized with any CGM. It utilizes a different microcontroller "rig" and can be used with either Android Mobile phones or iPhones. Loop has an unexpected algorithm in comparison to Bionic Pancreas, moreover works with older Medtronic pump models and can be used with most of the CGMs. It utilizes a different radio gadget (called a RileyLink) to connect correspondence to an IOS gadget and also it uses an IOS gadget (typically an iPhone) as its controller. Android Artificial Pancreas Systems utilizes the OpenAPS algorithm and works with DANA*R(S) or Roche Combo or Insight pumps, works with most CGMs and doesn't need a different radio gadget or controller on the grounds that the controller is an Android phone.

Keywords: Hypoglycemia, insulin, Continuous Glucose Monitor, diabetes

1. Introduction

In Bionic Pancreas, a computer functions as the regulator in the system. It reads from the pump and CGM, does estimations dependent on your settings, makes forecasts about what may occur and changes insulin dosing so as to change the anticipated results to your blood glucose levels.

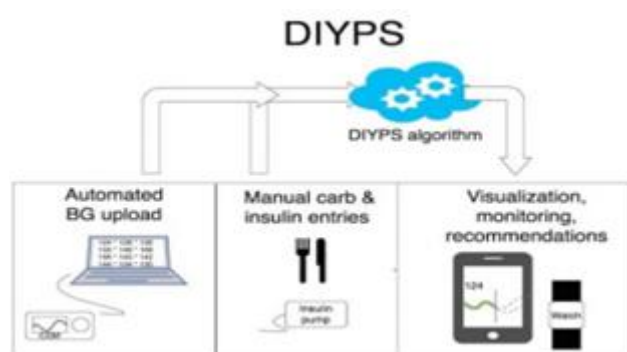


Figure 1: Working of Bionic Pancreas

A computerized system is greatly fit to be the "regulator" than we people. We people have day to day routines to experience, occupations to work, the need to rest, and so forth. Subsequently, even the most mindful human will now and then enjoy a reprieve or accomplish something different and not have the option to continually track Blood Glucose levels. A computer can be advised to look for each new approaching Blood Glucose information point, at regular interval and recalculate and re-change as needs be.

Another reason a computer works so well in Bionic Pancreas is that diabetes is confounded and has various inestimable elements that we need to react to - yet can't generally check or track. For instance, stress and adrenaline and excitement may impact your Blood Glucose levels, as does action and exercise. Be that as it may, here and there they may make your Blood Glucose rise and different occasions your Blood

Glucose will drop. In some cases it's momentary and now and then it might happen hours after the fact. It tends to be difficult to anticipate and modify for physically. So it's smarter to sit back and watches what occurs, and make steady changes, however we people don't have the opportunity or persistence for that.

Furthermore, insulin isn't instantaneous. Current "rapid" acting insulin top around 60-90 minutes and have a tail that still impacts your body 6 to 8 hours. That can be difficult to follow along of. Present day pumps' bolus wizards attempt to help with that, yet they try not to consider brief basal rates that may have balanced your insulin delivery or time spent suspended. Preparing the regulator to follow the insulin movement bends and both the negative and positive effect of more or less insulin conveyed contrasted with your body's typical is a great deal easier than us people carrying out the responsibility continually!

In other words, diabetes is hard. It's steady. It's constant. A computer will observe cautiously, continually and be capable to react more rapidly than a human does much of the time to fluctuating blood glucose levels. Also, if it cannot react enough in an extraordinary circumstance, it tends to be intended to make you aware of the requirement for more insulin or sugar consumption.

Different closed loop systems will require various degrees of co-operations from you as a human. Contingent upon your objectives and inclinations, that may impact both your decision of what type and brand of system to utilize, and it likewise may impact your decisions in how you cooperate with that framework after some time. (Steil, 2006) [1]

2. Reason to use Bionic Pancreas

There are numerous reasons why people may choose Bionic Pancreas. The primary motivation for most people using Bionic Pancreas is to improve glycaemia control, and

sometimes the improvements can be dramatic. Some people choose it because they want to sleep safely with peace of mind. There is nothing better than a long night of sleep with blood glucose levels staying within target range all night long. Some people have been able to achieve this on Metered Dose Inhaler or standalone pumping but some people will never be able to do this consistently due to their changing activity patterns. One should also appreciate the security of having the system, day or night, responding to any fluctuations in Blood Glucose levels for whatever reasons.

That's not the only reason people choose Bionic Pancreas technology. Some people choose it because they can achieve the same goals with much less work.

It may not make any difference what others' reasons are. Everybody is extraordinary: our diabetes may be unique. Our ways of life may be unique. Our objectives, decisions and inclinations are unique. So at the end of the day, it's an individual choice about whether you'd prefer to utilize Bionic Pancreas and which Bionic Pancreas you'll decide to utilize.

3. Getting started with Bionic Pancreas

It's very common to feel overwhelmed when considering or trying out new technology. It will require some time to adjust to the learning curve to absorb information of your new APS. If you were on a pump previously, you may recollect the change from Metered Dose Inhaler to pump. It was difficult or wasn't perfect right away. It required some time to adjust your settings. It required some time to make sense of the apparent multitude of highlights you could utilize. A similar will be valid with your Bionic Pancreas. You'll begin with the fundamentals. You'll probably need to adjust your settings with the new system. It will take some experimentation and getting utilized to the system assisting with revising for highs and lows. In certainty, you may wind up asking why it gave more or less insulin... and afterward acknowledge later why it did as such. This learning period includes figuring out how to trust the system and likewise understanding its restrictions. You will probably likewise learn from asking others about how or for what reason the Bionic Pancreas made the dosing choice that it chose was required. (Mark Christiansen, 2020)[2]

At the end of the day, even with Bionic Pancreas, you're in control. On the off chance that something doesn't feel right, you can always stop (or delay) and switch back to manual mode. You should at present be set up to manage, and treat hypoglycemia. It will even now occur. You may discover after some time, however, that you can treat low blood sugars with less carbs than before, if the automated system has been reducing your insulin delivery as your Blood Glucose dropped after some time. Thus, you may at present need to sometimes physically treat for hyperglycemia, yet not as much as you would have previously. Also, consistently, before taking manual rectification, make sure you realize how much insulin on board you have!

An artificial pancreas in any type of automated insulin conveyance isn't a fix. You actually have diabetes. You actually need to change your pump site. You actually may need to adjust your CGM sensor. You will even now need to

change your CGM sensor intermittently. It's very like "autopilot" for planes - particularly on the grounds that they actually have a pilot. With Bionic Pancreas, you're still near and guiding, regardless of whether you have automated assistance from the innovation. You're still responsible for flying the plane. You can consider one CGM sensor meeting like a "flight". You don't loop when you're most certainly not wearing CGM or when you're not getting sensor information, so inserting your CGM sensor resembles preparing in the "pre-flight" stage. Once you have CGM information going, you can "take off" and the system can begin computing and making alterations. However, in the event that your CGM tears out or on the other hand the meeting closes as arranged, you'll be back in manual mode until another CGM meeting is begun.

One of the most frequent things individuals need to do when beginning a closed loop system is modify their settings. Numerous individuals are utilizing settings that reflect the 10-years-back truth of their body's insulin needs. Others have changed things after some time, and their settings are in reality wrong in numerous ways, however by one way or another they're getting alright results. It's hard - for the two individuals with diabetes and medical services suppliers - to modify pump settings.

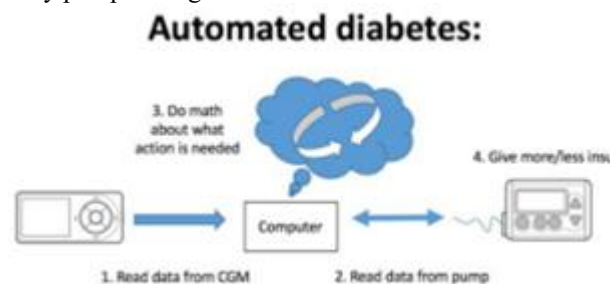


Figure 2: Automated Diabetes

Historically, the vast majority have speculated basal rates, ISF, and carb proportions. Over time, individuals need to physically change these fundamental basals and proportions so as to best carry on with existence with type 1 diabetes. It's difficult to do this physically, and difficult to know whether you're overcompensating with feast boluses (otherwise known as an off base carb proportion) for basal, or over-basaling to make up for feast times or an erroneous ISF.

However, this can be the distinction somewhere in the range of 70% and 90% time in go, and up to a rate point distinction in A1c. All things considered, a mechanized insulin conveyance framework utilizes your settings as a beginning point for its figurings. For somebody with sensibly tuned basals also, proportions, that works extraordinary. In any case, for somebody with values that are way off, it implies the framework can't enable them to change as much as somebody with all around tuned esteems. It'll actually help, however it'll be a part as ground-breaking as it could be for that individual. We adapted a considerable amount about this in the beginning of OpenAPS. We planned OpenAPS to fall back to whatever qualities individuals had in their pumps, since that is the thing that the individual/their specialist had chosen was ideal. Nonetheless, we know a few people's settings aren't unreasonably incredible, for an assortment of reasons. One of the most regularly posed inquiries was - and still is - about how to accomplish better results after the

underlying upgrades from shut circling. Also, likely 90% of the time it comes down to altering the standard settings.

4. Manually adjusting settings

In the event that you can't, or don't have any desire to utilize Autotune, there are still different approaches to assess your settings. One of the most well-known issues is that individuals have their basal rates set excessively high, and afterward a low carb proportion or ISF to redress. In case you're shut circling and seeing heaps of insulin decrease for the time being, odds are your default basal rates might be excessively high. Correspondingly, around supper time, if the system needs to include a ton of insulin, your carb proportion might be excessively "powerless", and those basal rates excessively high. In some cases individuals watch "exciting rides" in their Blood Glucose chart. Recall this is all family member - to various individuals, Blood Glucose rising furthermore, falling by 20 could conceivably be a major deal. First, you ought to dispense with human practices that cause these. Ordinarily, it's things like giving a customary portion of "quick carbs" that is more than required for a low or a forthcoming low, except if you have critical levels of insulin ready. Recollect the system is decreasing insulin, and so you regularly need way less carbs to manage a low, so you may rise a short time later in the event that you do excessively enormous of a carb remedy. Overcorrections like that for the most part can't be fixed by evolving settings: you need to likewise change practices. Likewise for human-driven drops, for example by rage bolusing or in any case bolusing an excessive amount of when Blood Glucose is high. It can be difficult to conform to that your settings should be changed. There can be some enthusiastic ties or difficulties with how much insulin you have been, or should be taking. You may likewise have been advised to have a specific level of basal contrasted with bolus insulin. In any case, huge numbers of the old standards and proposals were created many years back, and are not, at this point significant rules for enhancing settings. Most importantly in case you're utilizing an APS, hope to require to change your settings contrasted with what you were utilizing previously.

5. Choosing Bionic Pancreas

The most significant interesting point is the thing that issues most to you. You may have solid inclinations about the manufacturer, sort of pumps, kind of CGM or even the size, shape and shades of systems. Different decisions can incorporate a portion of the accompanying.

Physical Components:

- **CGM**

A few systems will have just a single CGM decision: choose the system and it accompanies the true CGM. Others will have choices for CGM. In the long run, and preferably, most systems will accompany a decision of CGM.

- **Pump body**

You may strongly incline towards the appearance of one pump over the other. You may need a tubeless choice, a little pump, or a pump with an enormous store. You may need a waterproof pump. You may need a choice that is more averse

to alert experiencing metal locators. You may think about how the pump is charged or what batteries it employs. You may mind about which destinations work with the pumps.

- **Controller**

The controller might be incorporated into the pump body. Or then again, it might be a different gadget - this could be an independent, secured controller that can't be used for anything else. Or on the other hand, it could be something that can be introduced on an Android or iOS mobile phone. You may feel strongly about having to carry "one more thing". Or then again, you may not trust the security or dependability of your existing cell phone (or the Bluetooth network) to go about as the controller for your APS. You may want to power and charge the regulator independently or you may discover you are better ready to keep it running if it's on your essential mobile phone.

- **Algorithms, features, and flexibility**

The vast majority of the primary general commercial systems will focus on the above segments. In any case, the calculation and its capacities, in addition to the serious highlights and other adaptability of convenience decisions may impact your decision of systems.

- **Algorithm:**

You may feel strongly about utilizing a specific algorithm, which you may have utilized before from a clinical preliminary, perused concentrates about or utilized in an alternate system. A few algorithm may have unexpected highlights in comparison to other people. You ought to likewise assess the algorithm's capacity to arrive at blood glucose targets, time in go targets, and so forth.

- **Targets**

By default, standard targets and temporary targets may matter to you. The customary or default target can make a major contrast. The first economically affirmed APS directed 120 mg/dL and the main option was a temporary activity target of 150 mg/dL. That might be alright with you, or you may need various targets and adaptability.

In the AID group, all systems have adaptable targets. We utilize temporary focuses to modify insulin conveyance driving into also, during/after physical movement. We likewise use lower than common focuses as an approach to alter insulin conveyance before a supper time. Adaptability in targets is exceptionally valuable for killing some consistently spikes and drops, even with a second-generation-skilled APS.

- **Data passage**

If you dislike taking care of your pump or have circumstances for work or in any case where you should be circumspect, consider whether you need to enter carbs and change targets on the pumps. Or on the other hand would you be able to utilize the secondary mobile phone, or on the other hand your own cell phone? This could mean your versatile mobile phone (Android or iOS) or a smartwatch.

- **Remote checking or secondary displays**

Remote monitoring can be valuable for some reasons. Will your arrangement of decision have distant checking abilities

built-in? If not, accomplishes it work with one of the DIY remote monitoring abilities?

Remote monitoring can likewise empower your own "glanceable" displays on your telephone or smartwatch of choice. Think about gadgets for your mobile phone or your computer, your watch and different gadgets, for example, your vehicle. Will you be capable to get to your information continuously and get it to the gadget you need? What's more, what information will it show? Is it just CGM information? What about knowing whether your closed loop is as of now robotized furthermore, functioning true to form? Shouldn't something be said about expectations and cautions? Shouldn't something be said about your net IOB?

• Calibration

You may likewise need to get some answers concerning the administration of your APS as it identifies with your CGM. For instance, does the system prevent you from looping in the event that you don't align your CGM per the suggested plan? How can it caution or alarm you to the need to adjust, or the finish of your CGM sensor? (Boris Kovatchev, 2017)[3]

6. Real-life Diabetes

The equipment (or physical) parts are frequently the most straightforward to investigate. In any case, genuine diabetes can at times cause issues, as well. For instance, what happens when your insulin pump site gets pulled out by a door handle? What happens when you have been running safe, understand your pump site is "somewhat old" and choose to transform it - how does your APS realize that your feasible reason of opposition is no more? Moreover, how does the APS think about - what's more, manage - you taking extra insulin, either as an infusion or through another component, for example, inhalable insulin? What occurs if you've bolused, and hurl because of food contamination? Also, what happens when you travel, concerning time regions and stream slack and the changing insulin requests that it causes? You might not have all the appropriate responses, or experience all of these situations, when you initially begin with an APS. However, they unquestionably occur! So it merits examining and investigating how your system can conceivably manage these situations.

It's likewise imperative to ensure that you realize how to switch between closed loop, and open loop, modes. There might be times where you have a situation like running a long distance race under control, and would want to be in manual mode rather than computerized mode. Realizing how to do that in advance will diminish a great deal of pressure and vulnerability when it really is the ideal opportunity for you to switch between modes.

7. Conclusion

Artificial pancreas innovation is here, and it's setting down deep roots. We have to make it accessible, open, and reasonable to each individual with diabetes who needs it. We need to ensure that this tech is adaptable enough for individuals to use in reality and to accomplish the most ideal results. There are tradeoffs that people ought to have the

option to make, picking between their practices and the number and type of connections they have with such a system. Also, we ought to have interoperability, so somebody can pick the best calculation, CGM, pump body and controller type for them. We likewise ought to recollect that not every person will need, or pick this kind of innovation. In any case, there are things we have learned in our quest for improving and creating APS that can apply to help improve advances accessible to individuals without APS. There are the board strategies and stunts that can improve life for anybody with diabetes, regardless of whether they're not utilizing a CGM.

APS innovation has amazing advantages for an individual with diabetes, their friends and family and companions, and even their HCP. However, it requires change. Change for the individual overseeing diabetes, to figure out how they may need to do things another way, and how to investigate new innovation. (Bailey, 2015)[4]

References

- [1] Steil, "Bionic Pancreas for type-1 diabetes," Current Opinion in Endocrinology & Diabetes, April 2006 - Volume 13 - Issue 2 - p 205-211
- [2] Mark, "Performance of Bionic Pancreas system: Results of Early Phase Feasibility Studies" Diabetes Technology & Therapeutics, October 5, 2020
- [3] Boris Kovatchev, "Feasibility of Long-Term Closed-Loop Control: A Multicenter 6-month Trial of 24/7 Bionic Pancreas," Diabetes Technology & Therapeutics, January 1, 2020
- [4] T. Davis, "Automated insulin pump suspension for hypoglycaemia mitigation: development, implementation and implications," Diabetes, Obesity and Metabolism, July 16, 2015

Author Profile



Patil Darshan Rajkumar is pursuing Bachelor of Technology in Computer Science and Engineering with Specialization in Bioinformatics at Vellore Institute of Technology, Vellore. My field of interest is Bioinformatics and Genetic Engineering. I have already got a review paper titled "Protective Effect of Aspirin on COVID-19 Patients" published in International Journal.