

Security, safety, and extensibility in the MetabolicOS automated insulin delivery system

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Biohacker

/ˈbɪoʊˌhækər/

Noun

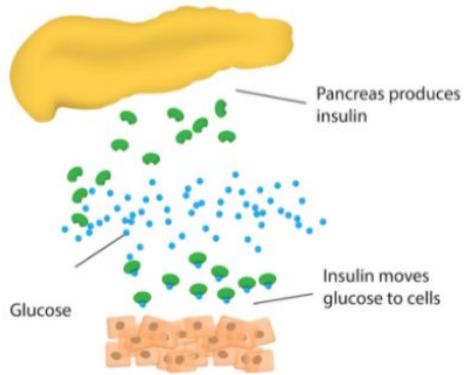
1. A person who manipulates their metabolic state using sensors, injected hormones, nutrients, physical activity, computer systems, and AI
2. An enthusiastic and curious person who learns about their own biology and metabolism through experimentation on themselves
3. A person who uses computers to gain access to someone's metabolic state

8.4 million people live with type 1 diabetes and they're all Biohackers

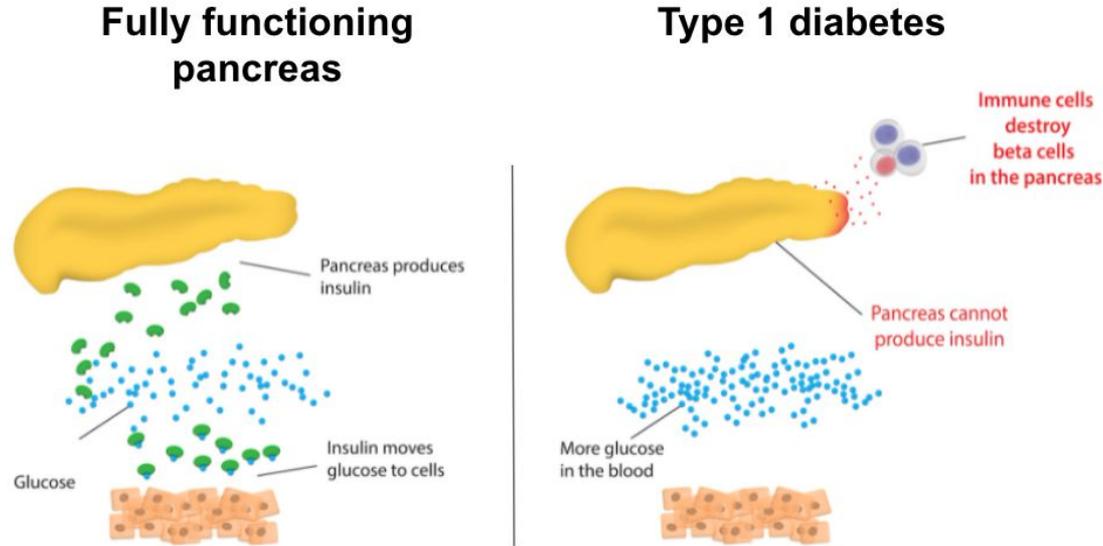
Core hypothesis: By using trustworthy computer systems we can turn a T1D diagnosis from a death sentence into an indicator of longevity

A 30 second overview of type 1 diabetes

Fully functioning pancreas

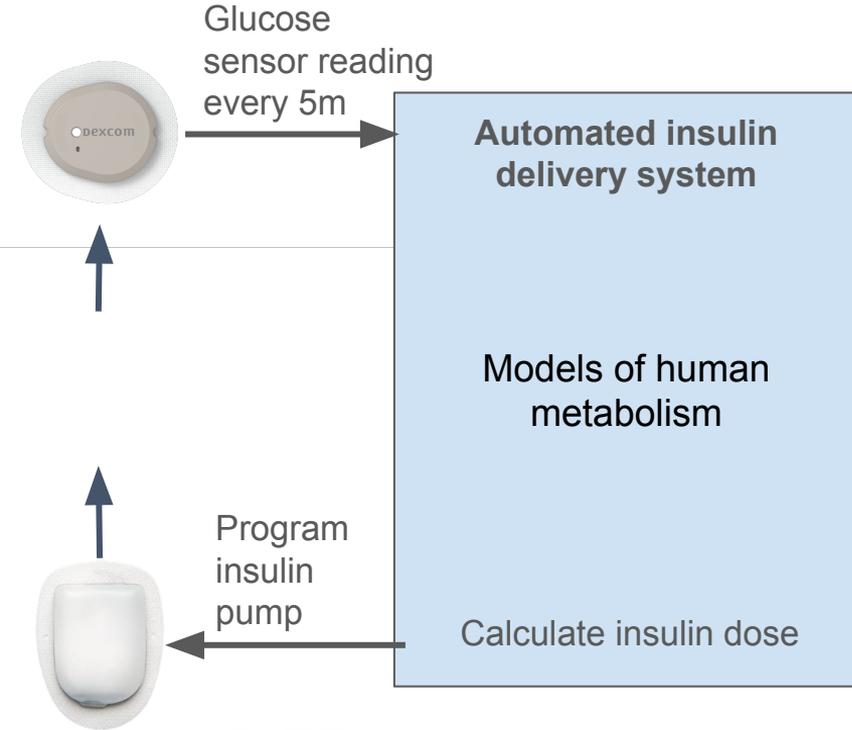


A 30 second overview of type 1 diabetes



- Individuals inject synthetic insulin to play the role of the pancreas

Automated insulin delivery systems inject insulin



A perfect fit for ML?

Google Scholar

AI type 1 diabetes

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Artificial intelligence in decision support systems for type 1 diabetes
[NS Tyler, PG Jacobs](#) - Sensors, 2020 - mdpi.com
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[HTML] **An artificial intelligence decision support system for the management of type 1 diabetes**
[NS Tyler, CM Mosquera-Lopez, LM Wilson...](#) - Nature ..., 2020 - nature.com
Type 1 diabetes (T1D) is characterized by pancreatic beta cell dysfunction and insulin depletion. Over 40% of people with T1D manage their glucose through multiple injections of long-...
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[HTML] **Insulin dose optimization using an automated artificial intelligence-based decision support system in youths with type 1 diabetes**
[R Nimri, T Battelino, LM Laffel, RH Slover, D Schatz...](#) - Nature medicine, 2020 - nature.com
... people with **type 1 diabetes** do not achieve their glycemic goals 1 **artificial intelligence**-based decision support system (**AI-DSS**... trial in 108 participants with **type 1 diabetes**, aged 10–21 ...
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None of the current automated insulin delivery systems that are available today use the most advanced ML, like deep neural networks

ML will always make mistakes in ways that are hard to anticipate and understand

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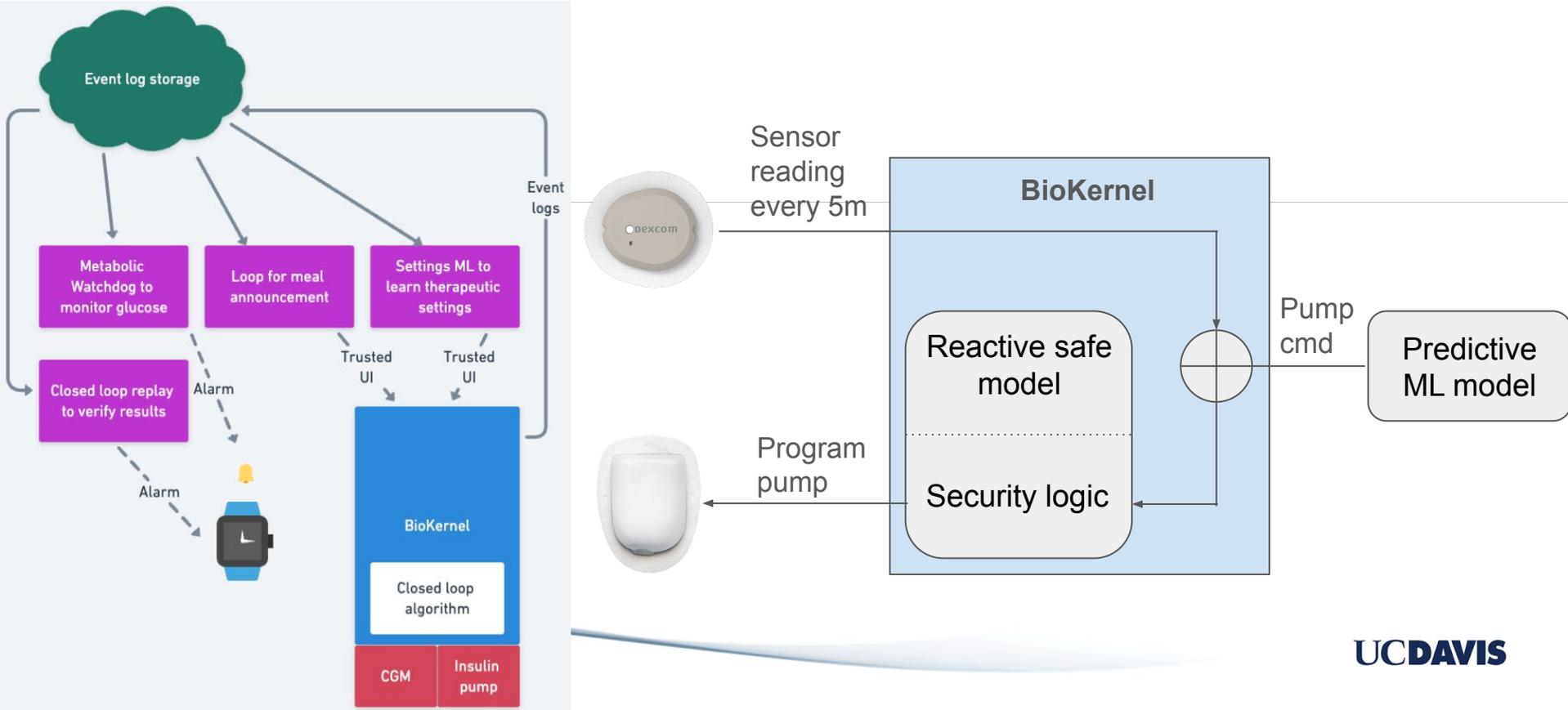
Insulin is an extremely dangerous hormone

Too much insulin can kill people in $O(\text{hours})$

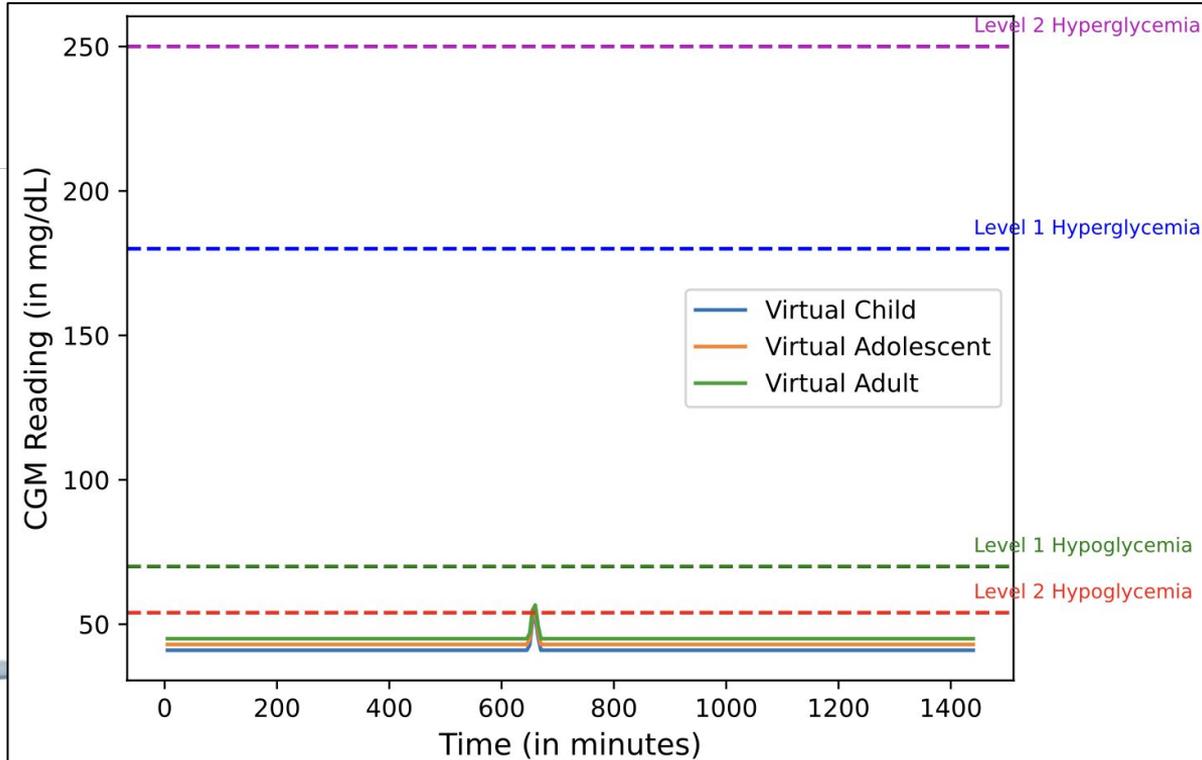
Too little insulin can kill people in $O(\text{days})$

Automated insulin delivery systems make decisions about how much insulin to inject 288 times per day

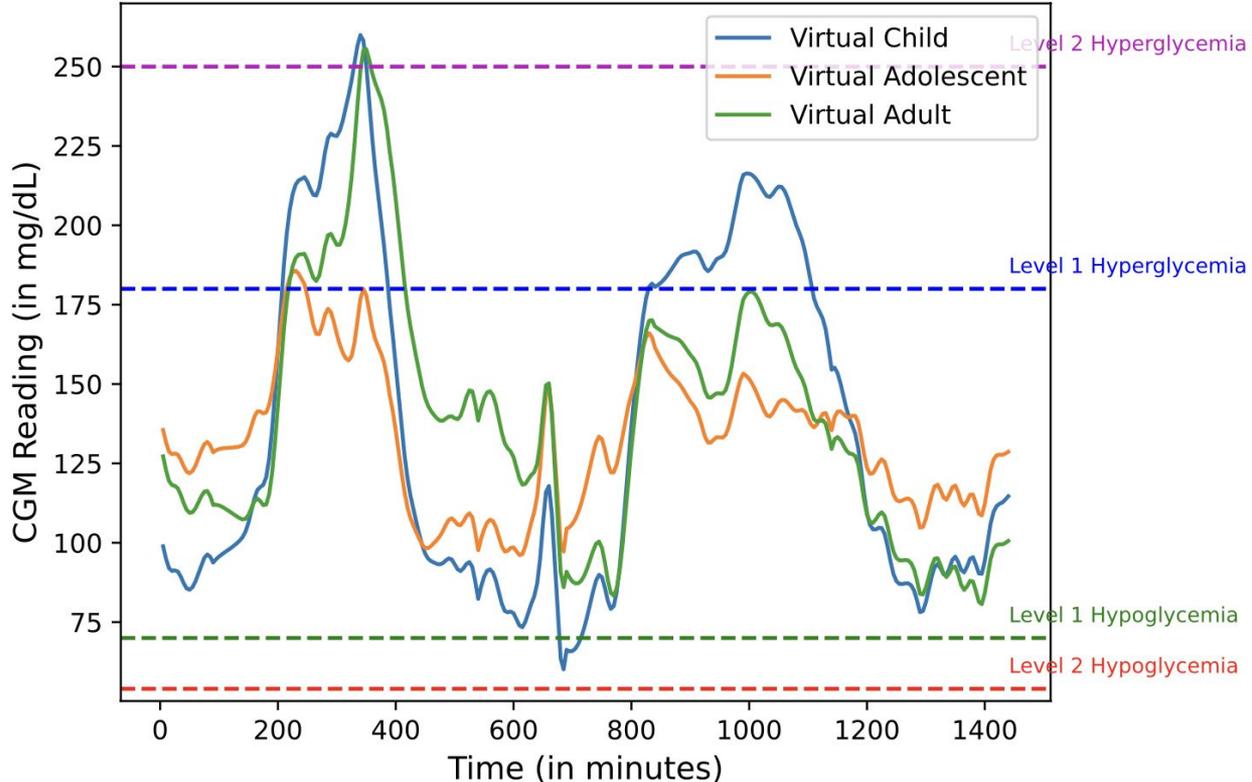
MetabolicOS: A system to run any ML in an automated insulin delivery system securely



Malicious model killed all of our virtual humans



Even with a fully malicious predictive model, MetabolicOS keeps individuals in range



Bob was able to maintain tight control using our system

- The week Bob used our ML was his tightest control ever
 - A1C was 5.8%, *almost* in the non-diabetic range (3.9% - 5.6%)
 - Full disclosure: Bob is a hard core biohacker, our system is just one tool that he uses to maintain tight control
- Significantly lower cognitive load
- The basketball anecdote...

Goal: Built the first **practical** automated insulin delivery system that uses **any ML** securely and safely



Questions?