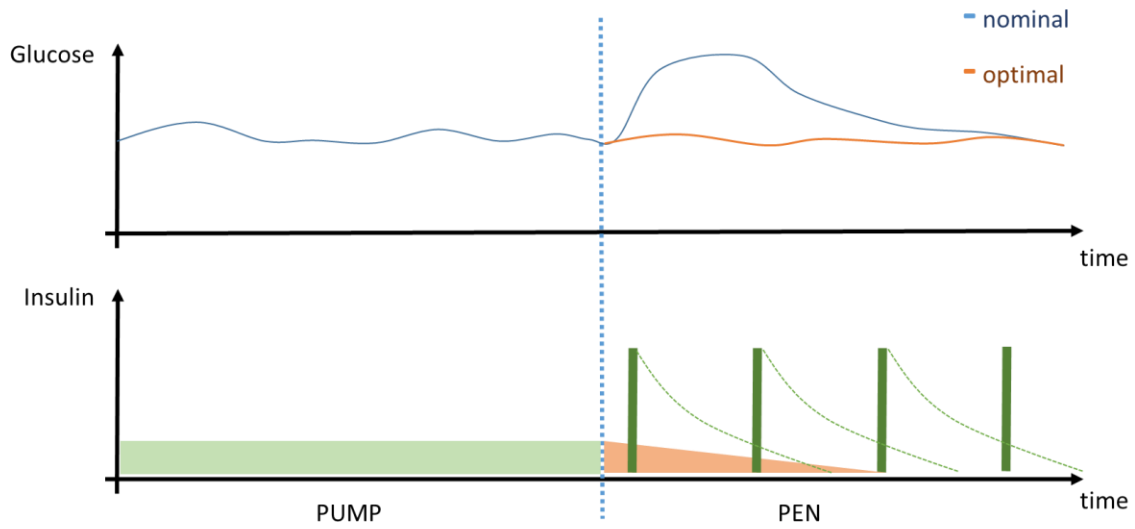
Going on a Pump-Holiday: How to switch from pump to pen, and back again

In recent years, insulin treatment with artificial pancreas (AP) systems have become commercially available for people living with diabetes. However, pump malfunctions, infusion set complications or allergic reactions to adhesives may force AP-users to switch to injection pen-based treatment for shorter periods. In this switch, continuous fast-acting insulin infusion from the pump is replaced by multiple daily injections of fast- and long-acting insulin to cover the glucose excursions after meals and the basal insulin need, respectively.

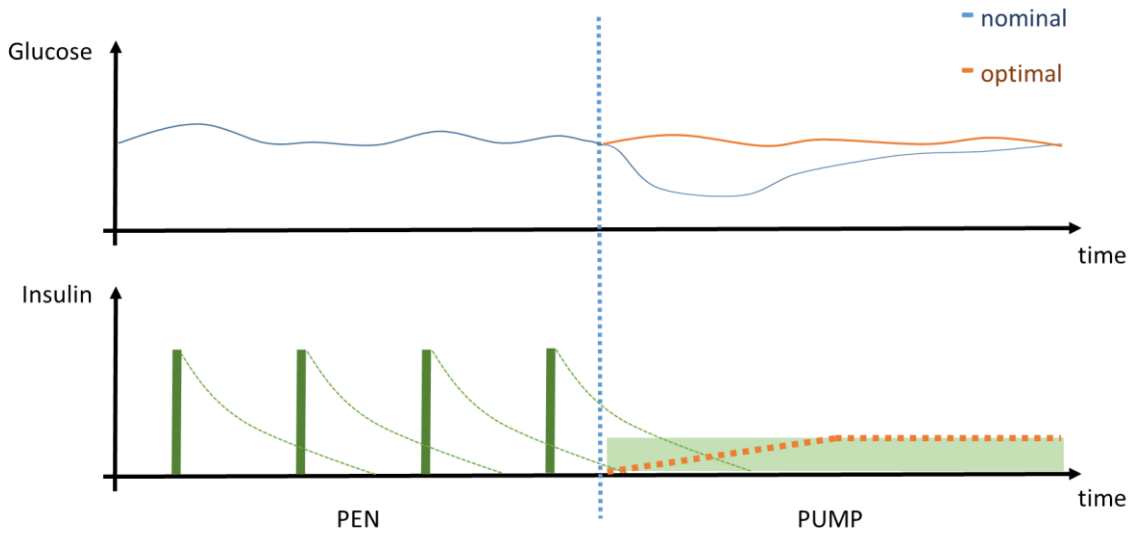
After a switch, insulin concentrations may be too high or too low resulting in suboptimal treatment. In this project, we investigate how to overlap pump and pen-based treatment to achieve the best control of fasting blood glucose.



1. Implement the MVP model with both fast- and long-acting insulin. (Ask Sarah for model equations and parameters)
2. Simulate a single patient on closed-loop treatment for 1 day. Be sure the patient's blood glucose is in steady state around 108 mg/dL.
3. Based on the steady state basal rate (uba [mU/min]), calculate the total daily dose [U/day].
4. Extend your initial simulation with 4 days of injection-pen based treatment. On the second day, stop the delivery of fast-acting insulin via the PID-controller at 7:00 AM. Use your calculated daily dose to simulate an injection of long-acting insulin at 7:00 AM. For the remaining days, give a daily injection at 7:00 AM each morning.
5. Investigate how to obtain the best treatment after the switch.
    - How should we continue the pump's infusion of fast-acting insulin after the first injection of long-acting insulin? Consider using a PID-controller.
    - How long do we have to wait before we turn off the pump?

- Consider other ways to achieve a good transition from pump- to pen-based treatment, e.g. could we change the size of the daily injections?

If time allows, investigate how to switch back from pen to pump. The effect of long-acting insulin "stacks" on top of previous injections until it reaches a steady state. Typically, the steady state occurs after 4 days. Hence, be sure to simulate 4 days of injection-based treatment with long-acting insulin, before switching to the pump.



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