Kapalı ve Yarı-kapalı İnsulin Pompa Sistemleri

6/2021

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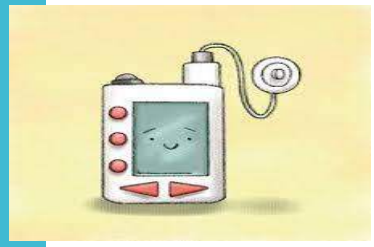
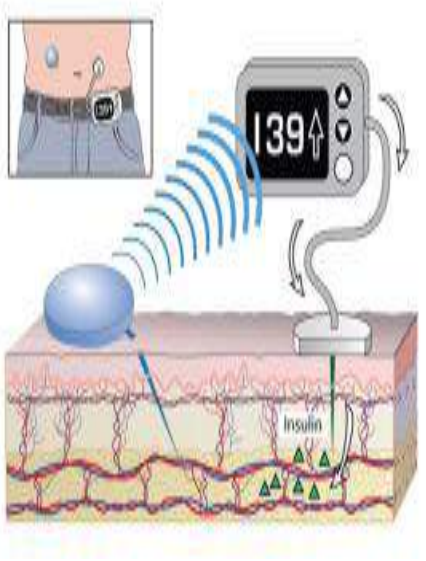
Genel Başliklar

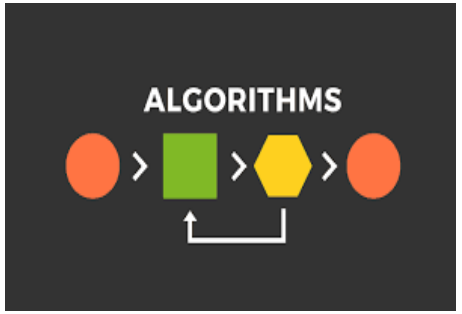
- Kapalı ve yarı kapalı Insulin Pompa Tedavisi nedir?
- Yeni Sistem İnsulin Pompalarının Özellikleri
- Geleceğin İnsulin Tedavi Sistemleri

Acik ve Kapalı İnsulin Pompa Tedavisi

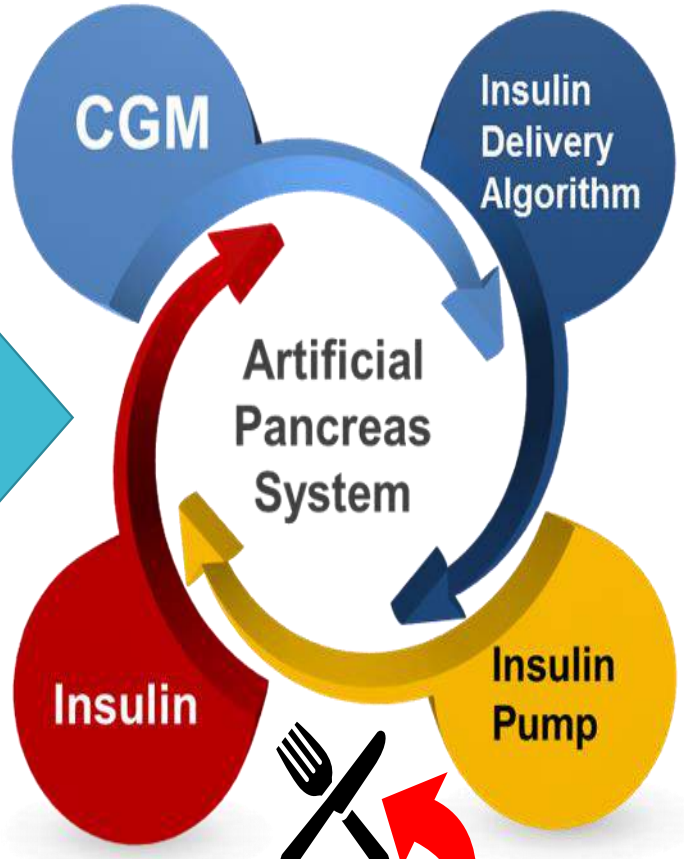
Acık Sistem (Open Loop)







Kapalı Sistem (Closed Loop)



Yarı-kapalı Sistem (hibrid)

Cengiz & Tamborlane, DTT 2009

Akıllı İnsulin Pompaları ve Teknolojik Interoperabilite

- ACE Pump
  - **“alternate controller-enabled”**
- iCGM
  - **“integrated continuous glucose monitor”**
- iAGC
  - **“interoperable automated glycemic controller”**

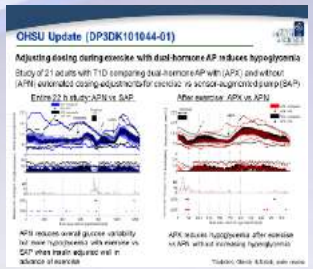
FDA’in Tandem Insulin Pompasi ile farkli sensorler arasinda iletisim izni ve onayini kabul etmesi ile gelisen diyabet teknolojisi.

Yapay Pankreas: Closed-loop Systems (Artificial Pancreas, Bionic Pancreas)

Medtronic 670G

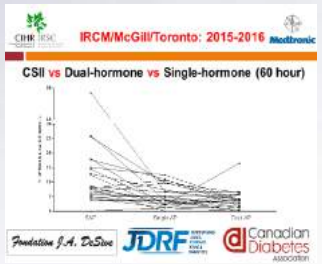
DiAs – Type Zero

iLet-
BetaBionics



OHSU

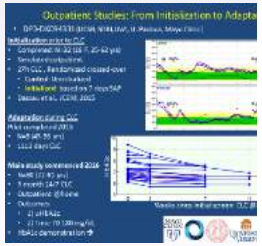
Diabeloop
(DBLG1)-France



CLASS

BCH/Harvard Med.

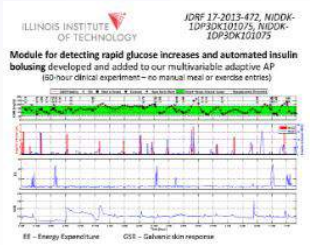
DSC



ZMPC

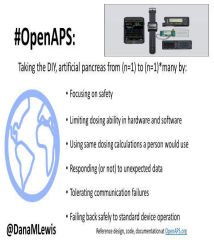
Camdiab FX

Medtronic 770G, 780G



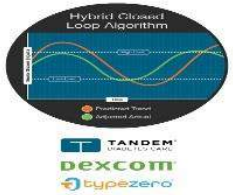
IMAPP

BigFoot



#OpenAPS

Omnipod 5



Tandem-Type
Zero

Lilly
Menarini
Roche

?

Kapalı, Yarı-Kapalı İnsulin Pompa Sistemleri

Medtronic Minimed

Tandem tSlim Control IQ

Omnipod 5

iLet Beta Bionics

Tidepool Loop

Lilly-Ypsomed

bigfoot™ BIOMEDICAL

MEDTRONIC MINIMED INSULIN POMPA SISTEMLERI

Akıllı İnsulin Pompa Donemine Geçiş

1st Sensor Augmented

MiniMed™ Paradigm™ REAL-Time Pump (2006)

1st Threshold Suspend

MiniMed™ Paradigm™ Veo™* Pump (2009)

1st Predictive Suspend

MiniMed™ 640G System* (2015)

1st Hybrid Closed Loop

MiniMed™ 670G System (2017)

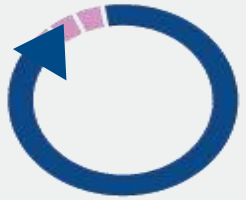
Bluetooth®-enabled pump

Peds (2-6 yr) indication

Advanced Hybrid Closed Loop **

Auto correction boluses

Personalized Closed Loop,^**



Automatic meal control

Reduced burden

İlk FDA Onayi Alan Yapay Pankreas Sistemi: Medtronic 670G Hybrid Closed-loop (HCL)

HCL System

Insulin only System

1st FDA Approved HCL for ≥14yo with T1D

Study Population

Pediatric & Adult

Study & Outcomes

-2 week run-in; 3 month, non-randomized study HCL vs. SAP

-One week hotel, rest of time AT HOME

-124 subjects, 10 centers

Bergenstal RM, et al. JAMA. Published online September 15, 2016 ; Garg SK, et al. DTT 2017

MODAL DAY SENSOR GLUCOSE TRACINGS

- *Adult Group:*

-Hypoglycemia reduction

Adolescent Group:

-Hyperglycemia reduction

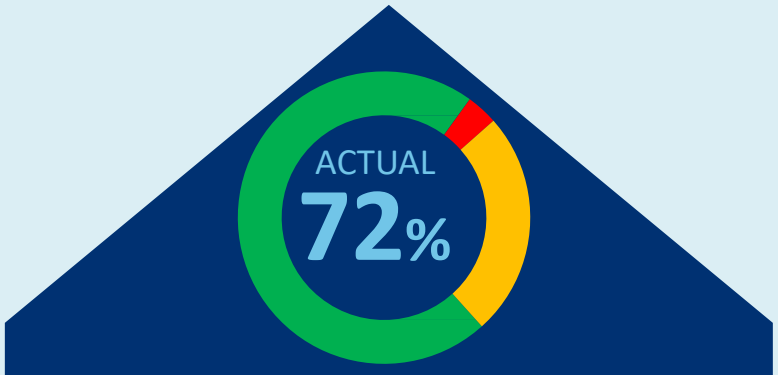
- **0.5% reduction in A1c, bringing subjects from a low initial A1c of 7.4% to 6.9%**

* System has CE Mark; System not approved in the US

** Investigational program not approved by the FDA; not commercially available

^ Breakthrough Devices Program. www.FDA.gov. Accessed April 23, 2019.

MOVING INTO THE FUTURE WITH ALGORITHMS AND SYSTEMS THAT MATTER



MINIMED™ 770G HYBRID CLOSED LOOP SYSTEM[1,2]

Designed to:

- Stay up to date with upgradable pump software
- Provide discretion with smartphone display

MINIMED™ 780G ADVANCED HYBRID CLOSED LOOP[3]

Designed to:

- Deliver 100% of correction to meet target
- Deliver a correction every 5 mins, as needed
- Allow setpoint of 100 or 120 mg/dL

PERSONALIZED CLOSED LOOP[4]

Designed to:

- Provide optional carb counting
- Adapt to behavior and physiology
- Improve connectivity through Smartphone control

Time above 180 mg/dL
Time in Range of 70-180 mg/dL
Time below 70 mg/dL

NEXT BIG STEP IN CLOSED LOOP

FDA BREAKTHROUGH DESIGNATION

[1] Time in Range of 72% obtained from Bergenstal RM, et al. *JAMA*. 2016;316(13):1407-1408.
[2] Investigational. Not approved by the FDA for any use and not commercially available in the US.
[3] Investigational. Not approved by the FDA for any use and not commercially available in the US. Data based on feasibility studies.
[4] In development. Not approved by the FDA for any use and not available for research or commercial use in the US. Data based on simulation modeling.

ADVANCED HYBRID CLOSED LOOP SYSTEM

GOAL: ACHIEVE MAXIMUM TIR WITH MINIMAL EFFORT

Currently in Pivotal Trial

Design Goals

- Control highs w/automated correction boluses
- Adjustable target glucose of as low as 100 mg/dL
- Fewer fingersticks with Day 1 calibrations only*
- Extended wear infusion set

MiniMed™ 780G System

Unsurpassed glycemic control:
TIR Goal >80%

Investigational program not approved by the FDA; not commercially available
*Day 1 calibrations only

PERSONALIZED CLOSED LOOP SYSTEM

SIMPLIFYING THERAPY MANAGEMENT

**With FDA Breakthrough Designation

Algorithm

Fizyolojiye adapte olarak calisan sistem

Otomatik yemek insulin dozu duzenlemesi
“Automated Meal Handling”
Reduced Carb counting

100% Auto Mode Capable
TIR goal of >85%

Design Goals

Comfort
Personalization
Meaningful outcomes

Sensor & Key Features

50% daha kucuk ve atilabilen sensor (CGM)

10 saniyede sensor takabilme ozelligi

Akilli telefon ile kontrol edilebilir

Development programs not approved by the FDA; not investigational nor commercially available

** Priority review and communication with FDA. Breakthrough Devices Program. www.FDA.gov. Accessed April 23, 2019.

Control IQ-Tandem Tslim

-Control-IQ kullanan cocuklar **67% time in range (TIR)**, SAP(kontrol) kullanan cocuklar 55%.

-**Gece kontrol IQ 80% TIR**, 54% (kontrol)

-**Control IQ ile 6 saat daha uzun sureli TIR**

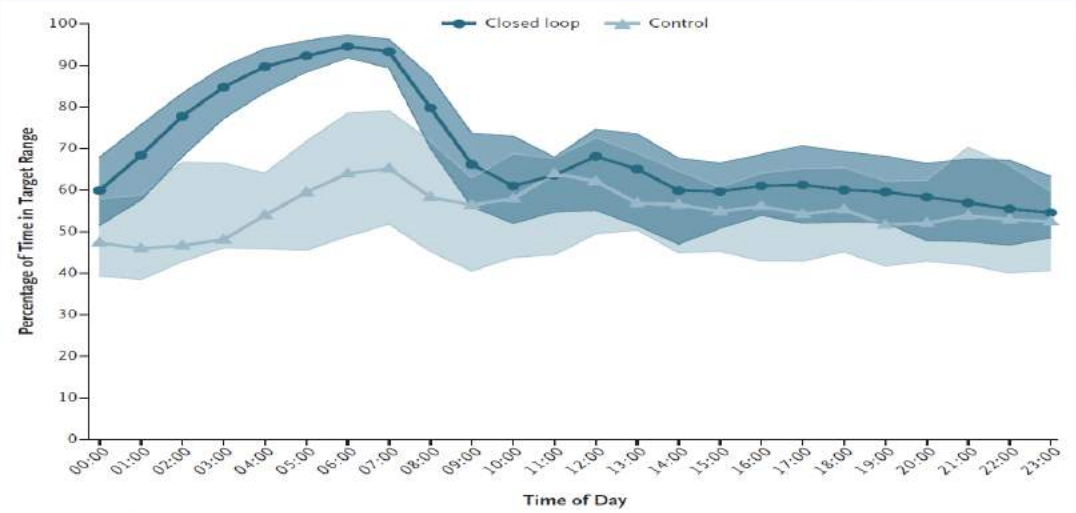
-Control IQ gercek hayat kullanim (n=1659):
Hb A1c 7.2% den 6.9% geriledi
Yapay pankreas kullanimi :96%

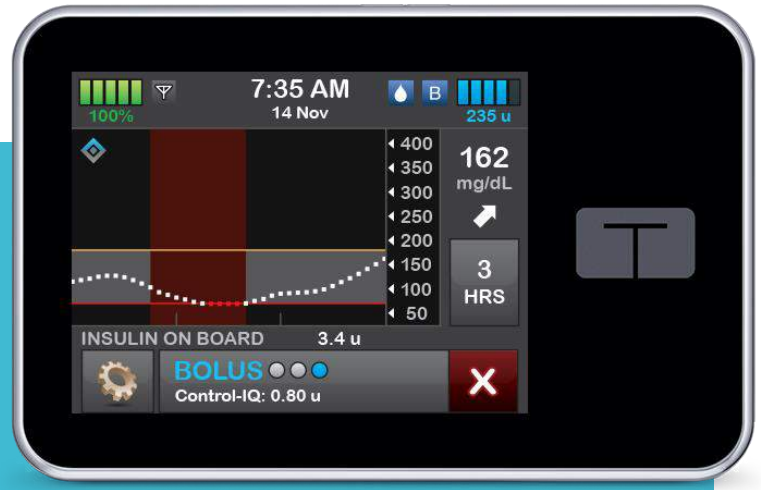
The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

A Randomized Trial of Closed-Loop Control in Children with Type 1 Diabetes

Marc D. Breton, Ph.D., Lauren G. Kanapka, M.Sc., Roy W. Beck, M.D., Ph.D., Laya Ekhlaspour, M.D., Gregory P. Forlenza, M.D., Eda Cengiz, M.D., Melissa Schoelwer, M.D., Katrina J. Ruedy, M.S.P.H., Emily Jost, M.P.H., R.D., C.D.E., Lori Carria, M.S., Emma Emory, R.N., Liana J. Hsu, B.S., Mary Oliveri, C.C.R.C., Craig C. Kollman, Ph.D., Betsy B. Dokken, Ph.D., Stuart A. Weinzimer, M.D., Mark D. DeBoer, M.D., Bruce A. Buckingham, M.D., Daniel Cherñavvsky, M.D., and R. Paul Wadwa, M.D., for the iDCL Trial Research Group*





Tandem tslim Control IQ

- Dokunmatik, renkli ekran
- Akilli telefon app, bilgisayar programi
- Upgrade internetten yapilabiliyor
- Pil sarj edilebilir

	Delivers	Delivers an automatic correction bolus if sensor glucose is predicted to be above 180 mg/dL
180		
	Increases	Increases basal insulin delivery if sensor glucose is predicted to be above 160 mg/dL
160		
	Maintains	Maintains active Personal Profile settings
112.5		
	Decreases	Decreases basal insulin delivery if sensor glucose is predicted to be below 112.5 mg/dL
70 mg/dL		
	Stops	Stops basal insulin delivery if sensor glucose is predicted to be below 70 mg/dL

Omnipod 5

-Patch pump

- Infuzyon seti olmadan direkt cilt altina insulin infuzyonu
- Insulin algoritmasi pompa (pod) icinde
- Android telefon app ile insulin dozu ayarlamak mumkun (telefon yakinda olmasa bile)
- -Hedef kan sekeri 110-150 arasi degistirebiliniyor

			 Control IQ	 Omnipod 5
Pompa	Minimed	Minimed	Tslim X2	Omnipod
CGM	Guardian 3	Guardian 3	Dexcom G6	Dexcom G6
Sistemi Baslatma	3-6 gun insulin data	3-6 gun insulin data	Diyabetli kisinin kilosu (kg)	Son pod degisimindeki total gunluk insulin dozu
Otomatik sistemden cikis	Safe basal: 1.max/min delivery 2.loss of CGM connection or system concerns regarding CGM accuracy	Time to exit (similar to safe basal) Lasts 4 hours before exit to manual mode Fingerstick BG to prevent exit to manual mode	Gecis donemi olmadan otodan manuel sisteme geciyor	Automated limited: static basal without SG dependent adjustment Activates AL if no CGM data >+20min Or Min/max delivery constraints

	 MiniMed® 670G MiniMed® 770G	 MiniMed® 780G		
Otomatik sistem cikis	90 dk safe basal sonrasi otomatik sistemden cikis	4 saat safe basal sonrası otomatik sistemden cıkış	CGM baglantisi yoksa 20dk sonra otomatik sistemden çikiyor	Sinirli otomatik sistemde bir kac saat kalıp manuele geciyor
Hedef CGM degeri	120	100 Ya da 120	112.5-160 Uyku: 112.5-120 Egzersiz: 140-160	110,120, 130,140,150mg/dl Hipoglisemi koruma: hedefi 150 ye değiştirip, insulini de azaltiyor (1-72hr)
Yuksek kan sekeri duzeltme Otomatik	150 _	120 KS>120	110 + Uyku modunda yok	
Insulin zamani	degistirilebilir	degistirilebilir	5saat (sabit)	degistirilebilir

open source do-it-yourself (DIY) Loop code base

Open APS -Kendi Yapay Pankreasini Kendin Yap Sistemi

#OpenAPS:

Taking the DIY, artificial pancreas from (n=1) to (n=1)*many by:

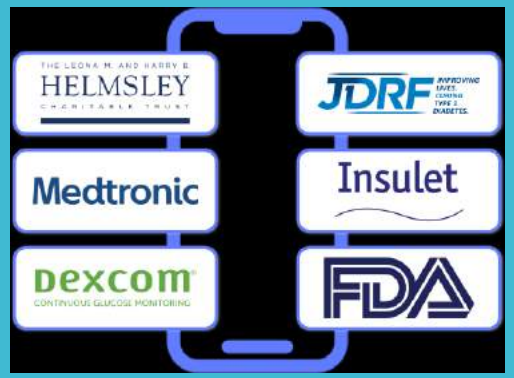
- Focusing on safety
- Limiting dosing ability in hardware and software
- Using same dosing calculations a person would use
- Responding (or not) to unexpected data
- Tolerating communication failures
- Failing back safely to standard device operation

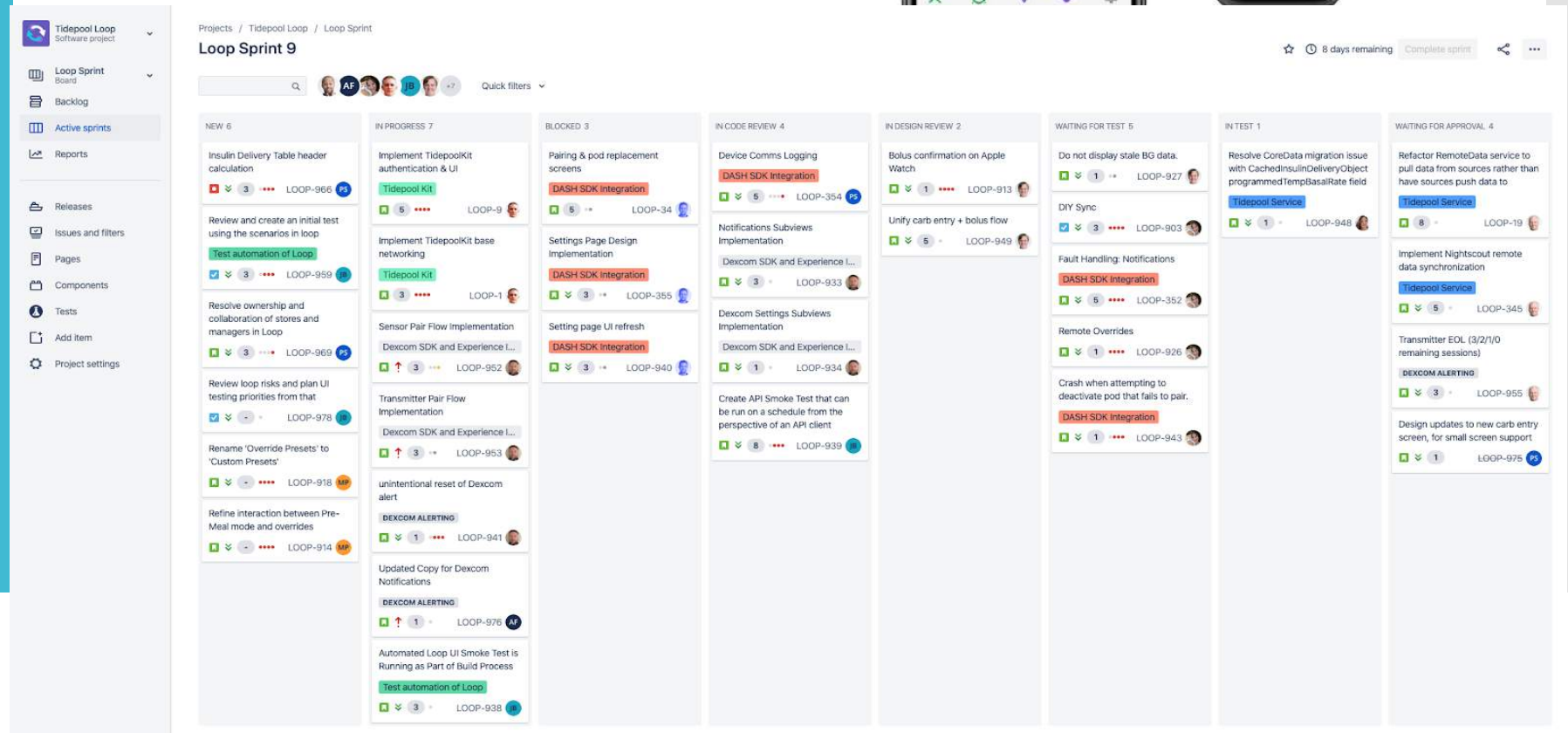
@DanaMLewis

Reference design, code, documentation at OpenAPS.org

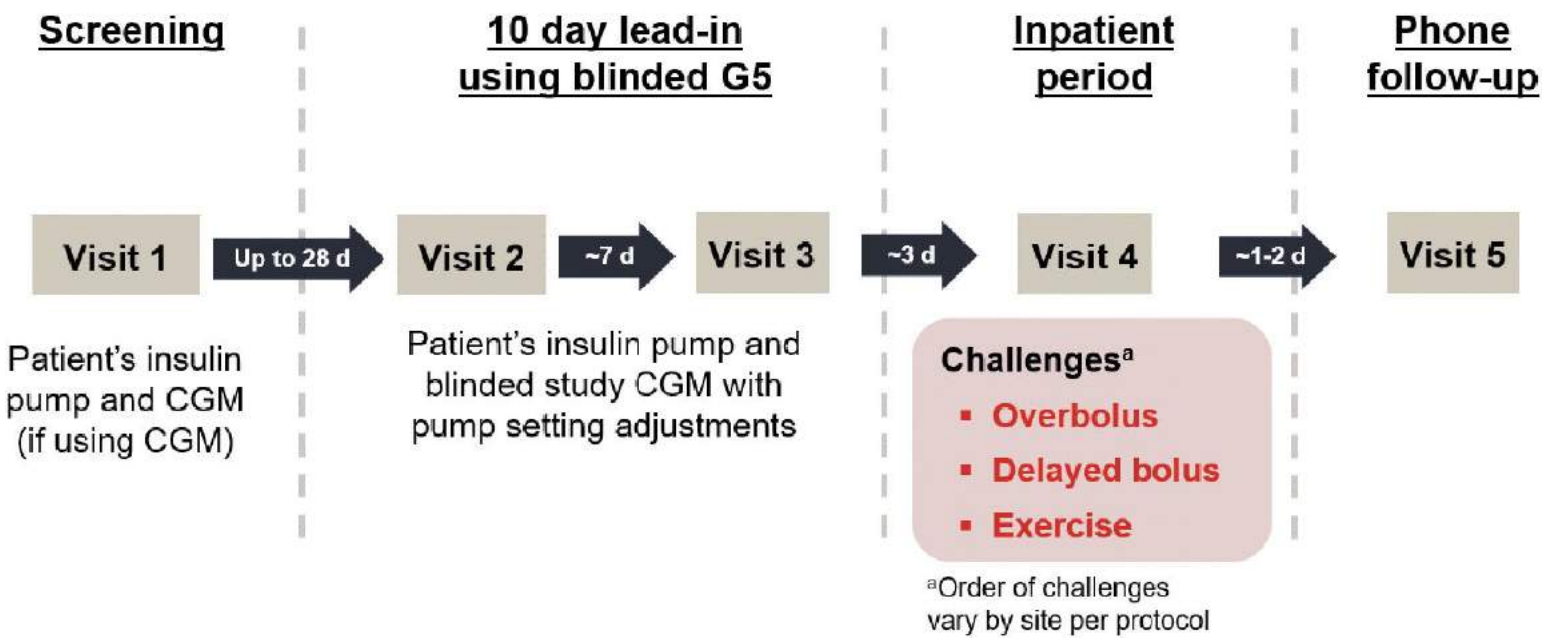
Tidepool-Loop

- ACE Pump
  - **“alternate controller-enabled”**
- iCGM
  - **“integrated continuous glucose monitor”**
- iAGC
  - **“interoperable automated glycemic controller”**
- #WeAreNotWaiting





Lilly - Ypsomed Loop System



Ypsomed insulin pompasi+Dexcom G5

iLet
Beta Bionics
-insulin
-insulin+glukagon

- Insulin ve coklu hormone sistem (insulin+glucagon)
- Insulin rezervuar yerine kartus sistemi

Bigfoot Unity
Bigfoot Loop

Pens or Pumps? YES.

Bigfoot Inject

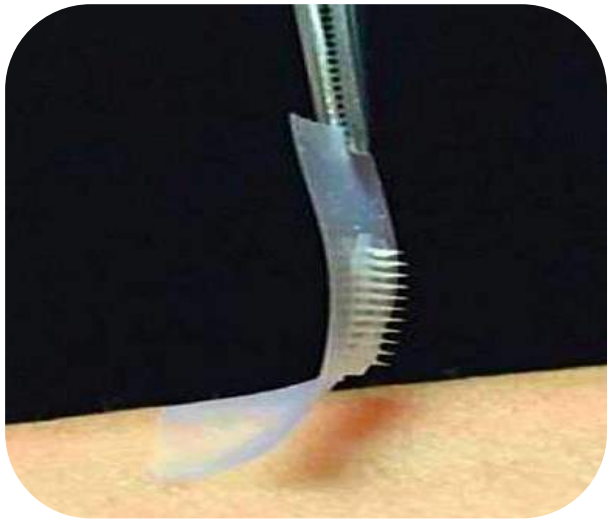
For individuals who wish to control insulin delivery through self-administration of insulin injections

Bigfoot Loop

For individuals who wish to automate management of diabetes through a fully integrated pump system

Gelecegin Kapali ve Yari kapali Sistemleri

- Insulin + hormon kombinasyonlar
- Yemek yendigini tahmin eden sensor, algoritmalar
- Nanoteknoloji patch pompalar ve CGM
- Akilli insulinler



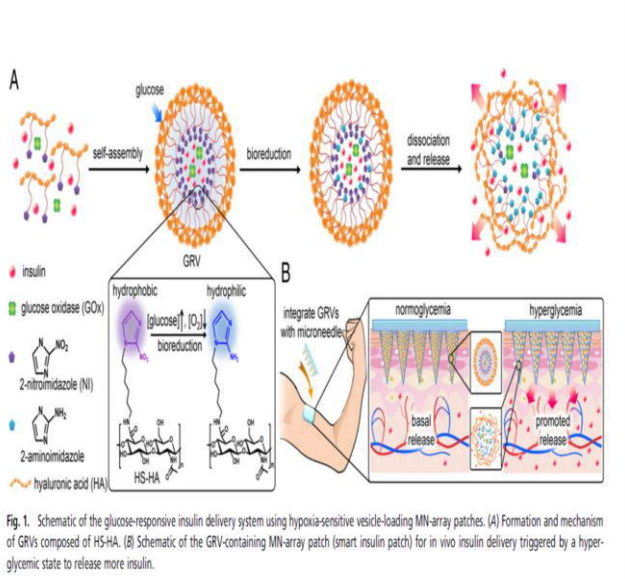


Fig. 1. Schematic of the glucose-responsive insulin delivery system using hypoxia-sensitive vesicle-loading MN-array patches. (A) Formation and mechanism of GRVs composed of HS-HA. (B) Schematic of the GRV-containing MN-array patch (smart insulin patch) for in vivo insulin delivery triggered by a hyperglycemic state to release more insulin.

1. Tai, Biomacromolecules 2014
2. Bakh et al., 2017 Nature Chemistry

Tesekkurler

JDRF IMPROVING LIVES. CURING TYPE 1 DIABETES.
Yale Center for Clinical Investigation
NIH National Institute of Diabetes and Digestive and Kidney Diseases
ISPAD International Society for Pediatric and Adolescent Diabetes
BAU Bahçeşehir University
UNIVERSITY OF VIRGINIA 1819
Robert E. Leet and Clara Guthrie Patterson Foundation
JCHR
MannKind Corporation