FOCUS ON TECHNOLOGY
METERS, PUMPS, CLOSED LOOP, CELL PHONES, INTERNET:
TOOLS FOR DIABETES

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Director, Kovler Diabetes Center

Diabetes Tech in 2016

- Scope of diabetes and obesity – worldwide, US, and Chicago

- Cell phone apps and the internet

- Social networking for diabetes

- Heart rate and activity monitors

- insulin pumps, glucose sensors, "artificial pancreas"

- Inhaled insulin

- New research and products not yet available

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More than
800,000
Illinois residents living with diabetes

About 8-10% live with type 1

Diabetes at Home

- 1 in 9 Chicagoans are living with diabetes

- In some neighborhoods as many as 1 in 4 suffer from the disease

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"Because of a growing, aging population, increasingly widespread obesity and, in part, to African-Americans' and Latinos' higher risk of diabetes, the CDC expects the 1.1 million diabetics in metropolitan Chicago to have increased by 500,000 to 1.6 million by 2025."

– Chicago Sun-Times, 2011

JDRF
typeone
nation

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What do we know about *preventing* type 1 diabetes?

- Type 1 Diabetes TrialNet Pathway to Prevention Study

Cell Phone Apps and the Internet

By Shantanu Nundy, Jonathan J. Dick, Chia-Hung Chou, Robert S. Nocon, Marshall H. Chin, and Monica E. Peek

Mobile Phone Diabetes Project Led To Improved Glycemic Control And Net Savings For Chicago Plan Participants

- Two-way texting to health plan participants for medication reminders, counseling on healthy eating, and help with keeping to their care plan
- Increased interaction between participants and nurses and doctors
- Result: better diabetes control with reduced costs

Diabetes Management Apps

Digital assistants will track your daily carb intake, weight, blood sugar, activity level, medicine intake, and more:

- Fooducate: healthy food helpers and nutrition tracker (iPhone and Android)

- Glooko: cable to 11 meters syncs meter data to app (iPhone)

- Glucose Buddy: logbook manager with syncing, blood pressure, and weight tracking (iPhone and Android)

- Diabetes App (formerly Diabetes Buddy): blood sugar control, glucose tracker and carb counter (iPhone)

- mySugr Jr: for kids, fun and games during the diabetes routine (iPhone and Android)

- iBGStar Diabetes Manager (iPhone)

- Diabetes Pilot (Apple and Windows)

Social Media

Twitter:

- #dsma

- @JDRFIllinois

- @AmDiabetesIL
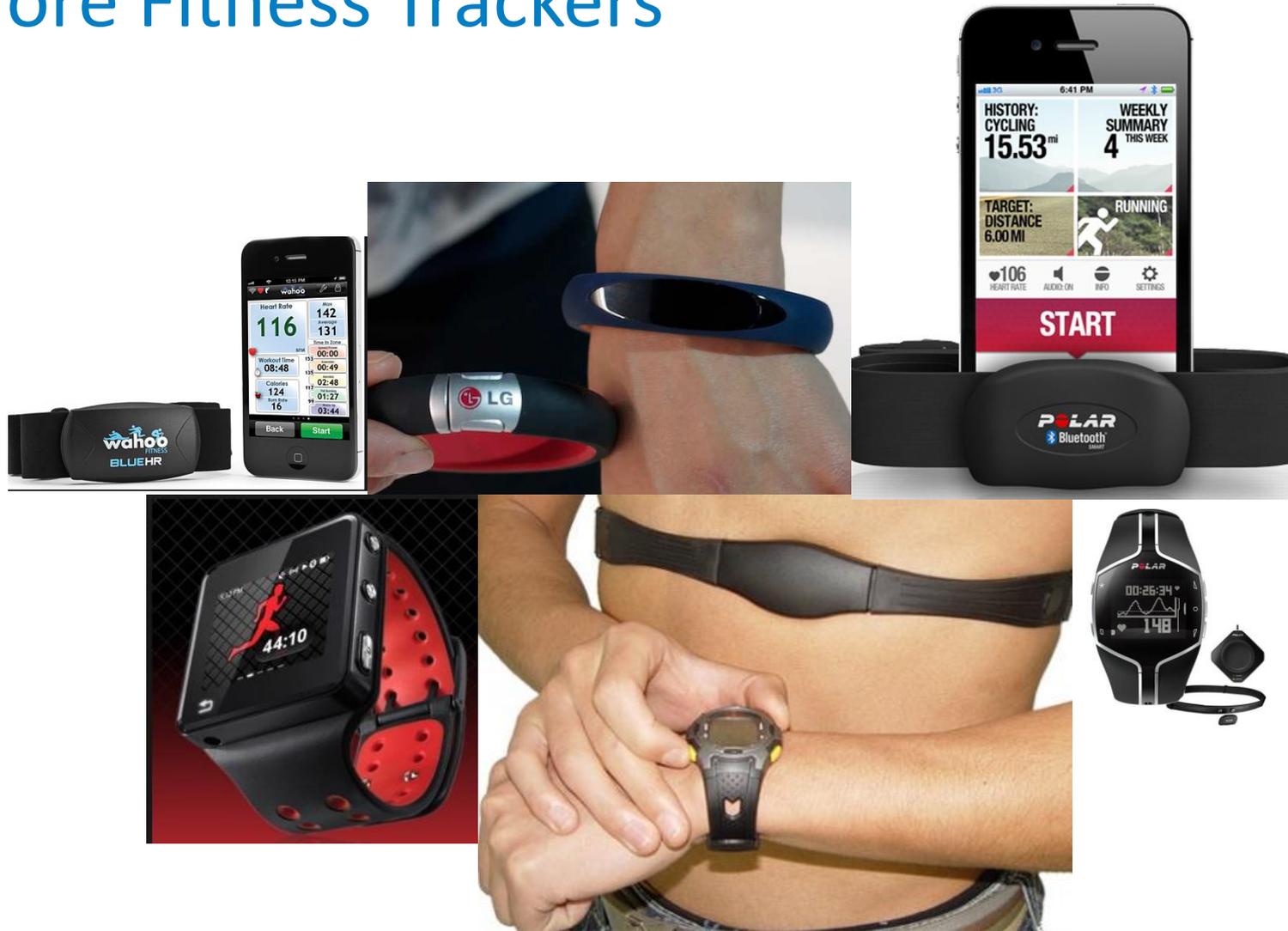
- @SSide_Diabetes

- @KovlerDiabetes

- @lphilipson

Facebook:

- JDRF Illinois

- American Diabetes Association (Chicago)

- Diabetes Mine

- Diabetes Hands Foundation

- Kovler Diabetes Center

- Diabetes TrialNet Chicagoland

Heart Rate and Activity Trackers

More Fitness Trackers
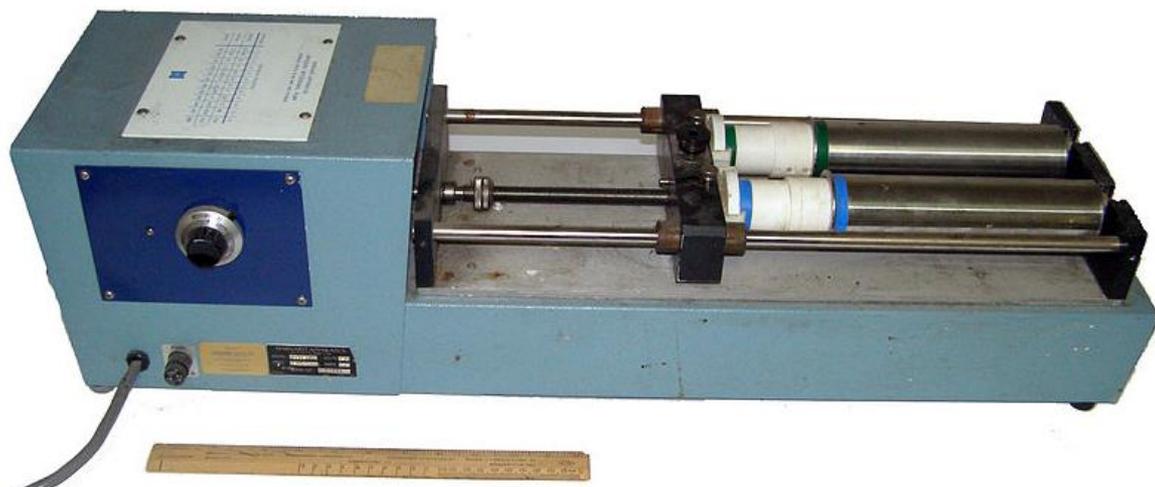
Blood Glucose Meters

Insulin Treatment

- Insulin Pens

- Insulin Pumps
  - Multiple options

- Continuous glucose sensors
  - Continuous Glucose Monitoring System (CGMS)
  - Can identify patterns of high and low blood sugars
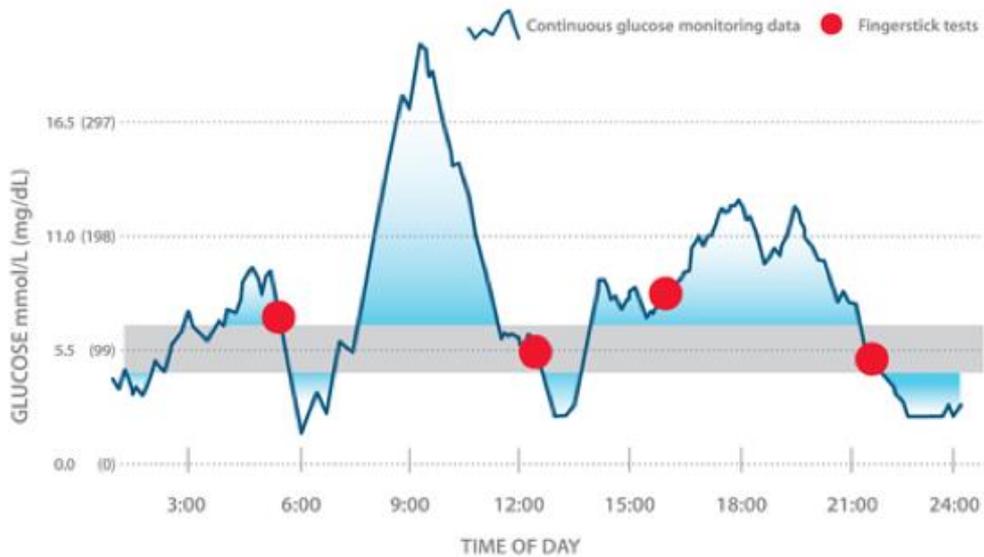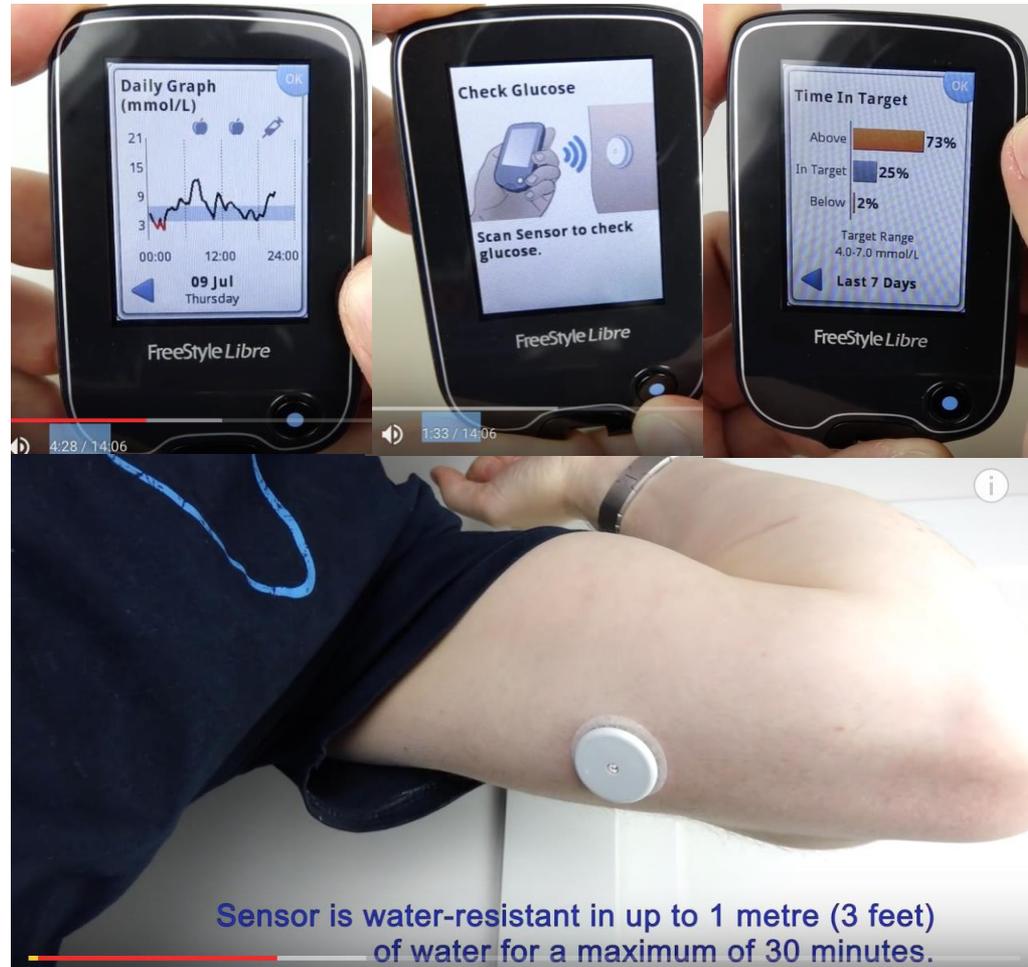
New Pumps and Sensor Technology

New Pumps and Sensor Technology

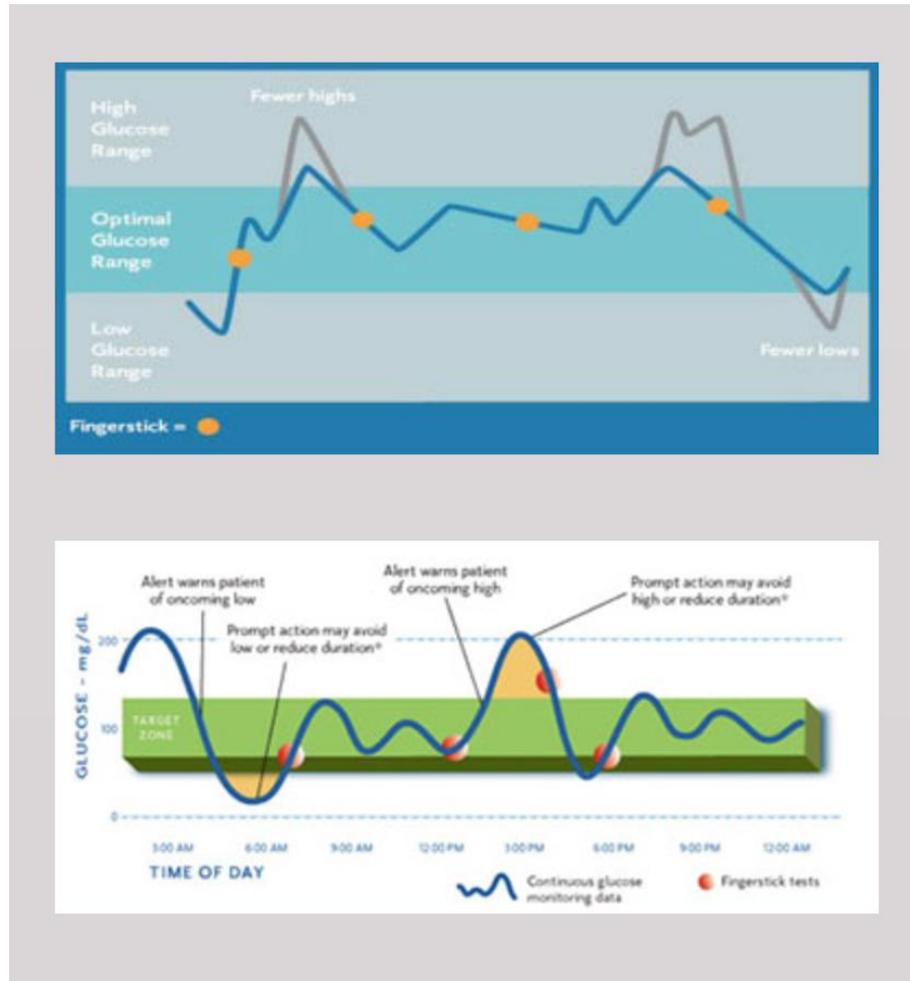# Glucose Sensors

Glucose Sensors

Sensor is water-resistant in up to 1 metre (3 feet) of water for a maximum of 30 minutes.

Continuous Glucose Monitoring

Continuous Glucose Monitoring

Continuous Glucose Monitoring

The Dexcom G4 PLATINUM System with *Share* and the
Dexcom Share2 and Follow apps are available in the US only

Continuous Glucose Monitoring

Continuous Glucose Monitoring

Commercial Diabetes Management

eoshealth®
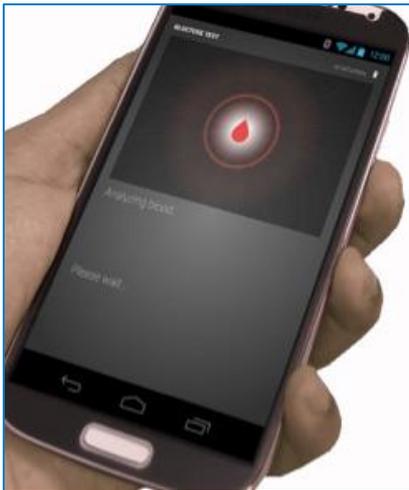
Diabetes program features

◀ Back

Personal Health Record
Record, transmit and maintain all your pe
directly from your phone, the web, or at a
personal information is secure and can b
anywhere via your Personal Health Portal
and program information at your fingertip
progress and share these with your healthcare

Blood pressure: Monitoring & Trends
Record and transmit your blood pressure
directly into your personal health record fo
When readings are received, you get immedia
and goals and on ways to improve your bloo
This program includes an exercise plan to imp
performance.

Weight and BMI
Record and transmit your daily weight d
phone. You will automatically receive feedbac
and goals in weight and in mass body ind
improvements.
This feature will enable you to keep track of y
while providing access to view your successes.

Jana Care

The Aina Device
A mobile diagnostic platform that measures the following parameters:

- · Blood Glucose
- · HbA1C
- · Lipids-HDL,LDL,TrG
- · Creatinine
- · Haemoglobin

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Diabetes Closed Loop Technology

Disclaimer:

The content in these slides may contain information that is investigational and/or not approved in all countries.

Artificial Pancreas?

B

Glucose level

Sensing (glucose sensor)

Delivery (insulin pump)

Modulation (control algorithm)
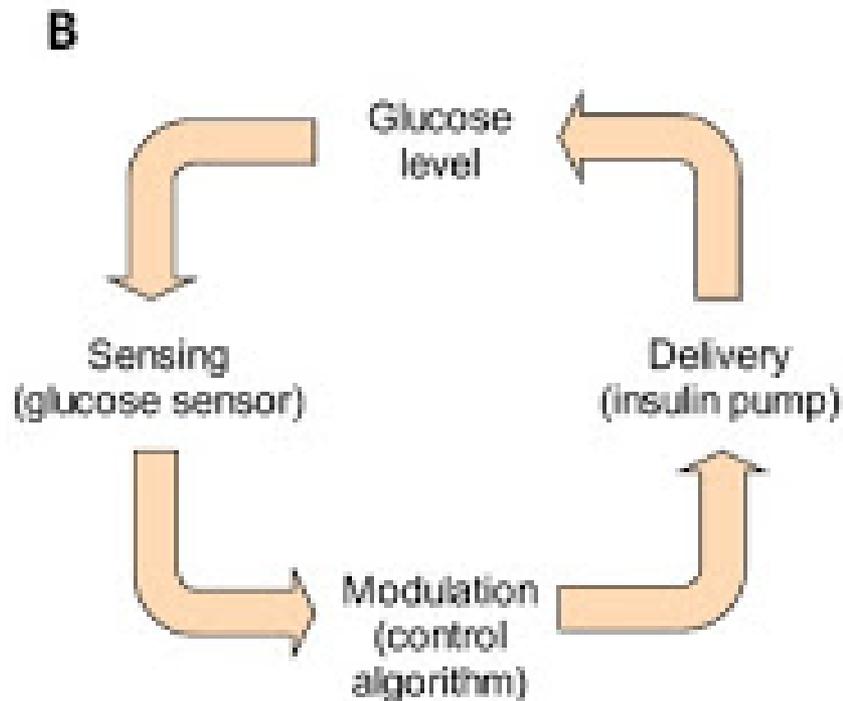
- Closed-loop insulin system

- How close is this to reality?
  - Recent study in adults compared closed-loop system to CGMS
  - More blood sugars in good range
  - FAR fewer low blood sugars

Augmented Closed Loop System

Armband

Feedback: Armband Sensors Signals

Insulin

Pump

Glucose Set point

Computer

Alarm

Food

CGM Reading

Sensor

Feedback: Glucose Sensor Signal
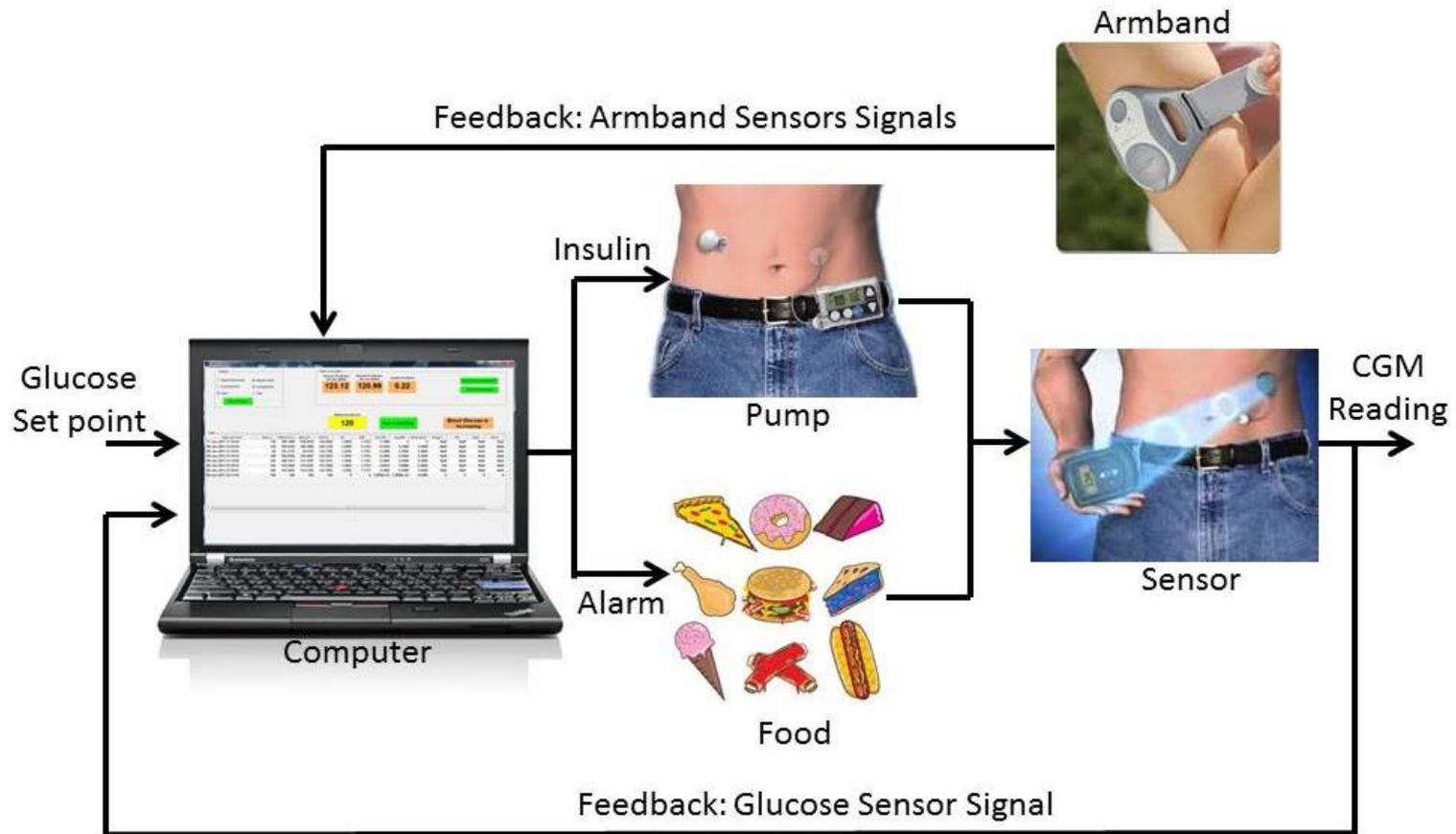
Defining the Future of Closed Loop

INFORM		SUSPEND		DELIVER		
Bolus Wizard ✓	Integrated System ✓	Threshold/Low Glucose Suspend (TS/LGS) ✓	Predictive Low Glucose Management (PLGM)* ✓	Overnight Closed Loop (OLS)*	Hybrid Closed Loop (HCL)*	Artificial Pancreas*
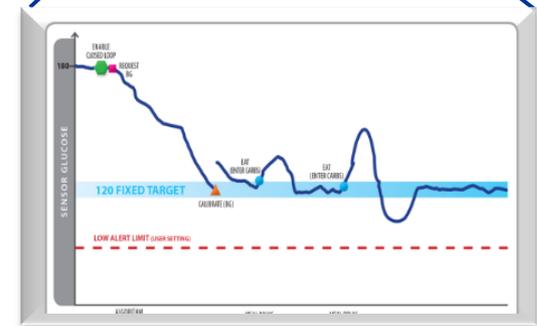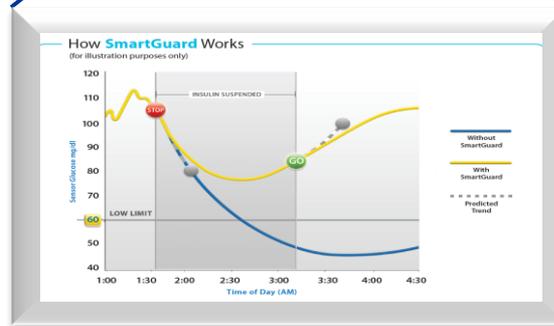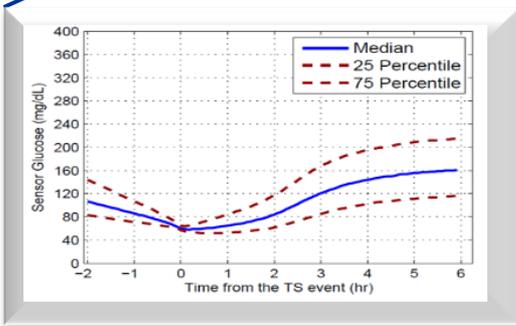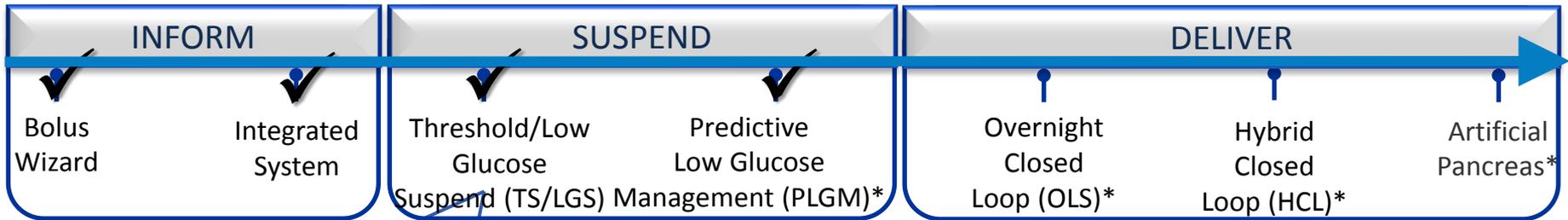
ASPIRE TRIALs - Low Glucose Suspend

CLINICAL EVIDENCE FOR LOW SUSPEND FEATURE:
ASPIRE IN-CLINIC
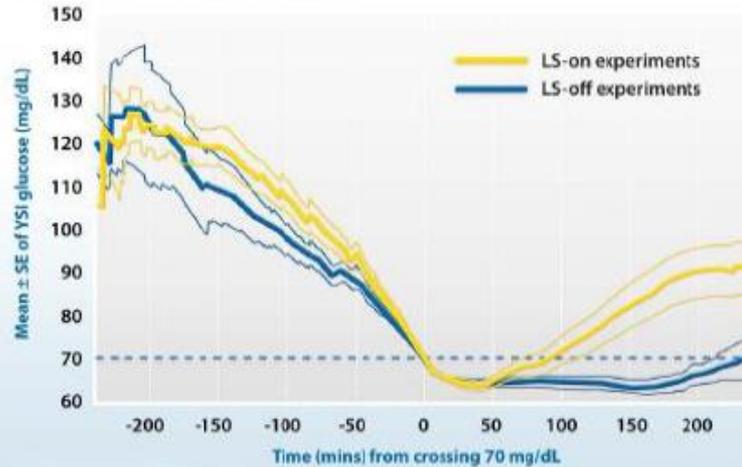
In the ASPIRE In-Clinic study, the low suspend feature showed a significant reduction in the duration and severity of induced hypoglycemia without rebound hyperglycemia in T1DM (n = 50, age 17-58 years)

Garg S, Brazg R, Bailey T, et al. Reduction in Duration of Hypoglycemia by Automatic Suspension of Insulin Delivery: The In-Clinic ASPIRE Study. *Diabetes Technol Ther.* 2012;14(3): 205-209.

	Duration of hypo, min	Nadir,(Severity) mg/dL	End-observation YSI value, mg/dL
LS ON	138.5 ± 76.68	59.6 ± 5.72	91.4 ± 41.84
LS OFF	170.7 ± 75.92	57.6 ± 5.69	66.2 ± 13.48
p VALUE	0.006	0.015	<0.001

Nadir mmol/L
3.3 ± 0.32

3.2 ± 0.32

End Observation mmol/L
5.1 ± 2.32

3.7 ± 0.74

Study conducted with Veo pump. Not FDA approved and not commercially available in the US.

Limitations to the ASPIRE Study

- Assessment of overall glucose control with threshold suspend
    - Duration of study was only 3 months, therefore assessment concerning long term effect of threshold suspend on glucose control is not possible
    - There was an increase in morning ketones and a slight increase in hyperglycemia AUC in threshold suspend group, however the significance is unknown with no episodes of DKA or change in 3 month A1C
    - Due to short duration of study, analysis on DKA and severe hyperglycemia rates difficult to interpret

- The main outcome measure was hypoglycemia AUC which alone may not demonstrate the superiority of the threshold suspend feature
    - This outcome measure may not be clinically justified
    - The evaluation was based on events lasting more than 20 minutes only

- "Low sensor glucose event" measured in the study is not necessarily equated with "hypoglycemia" described in the New England Journal of Medicine article
    - SG≠ BG
    - Analysis uses a biochemical (numerical) endpoint rather than a clinical measure

Bergestal R, et al. *N Engl J Med*. 2013;369:224-232.

PILGRIM Study

- Single-center observational study of 22 youths (14-20 years) where hypoglycemia was induced by exercise while using SmartGuard technology*. SmartGuard may further reduce the severity of hypoglycemia.

80% of hypoglycemic events were avoided by use of SmartGuard (defined as SG <70 mg/dL, 3.9mmol/L)
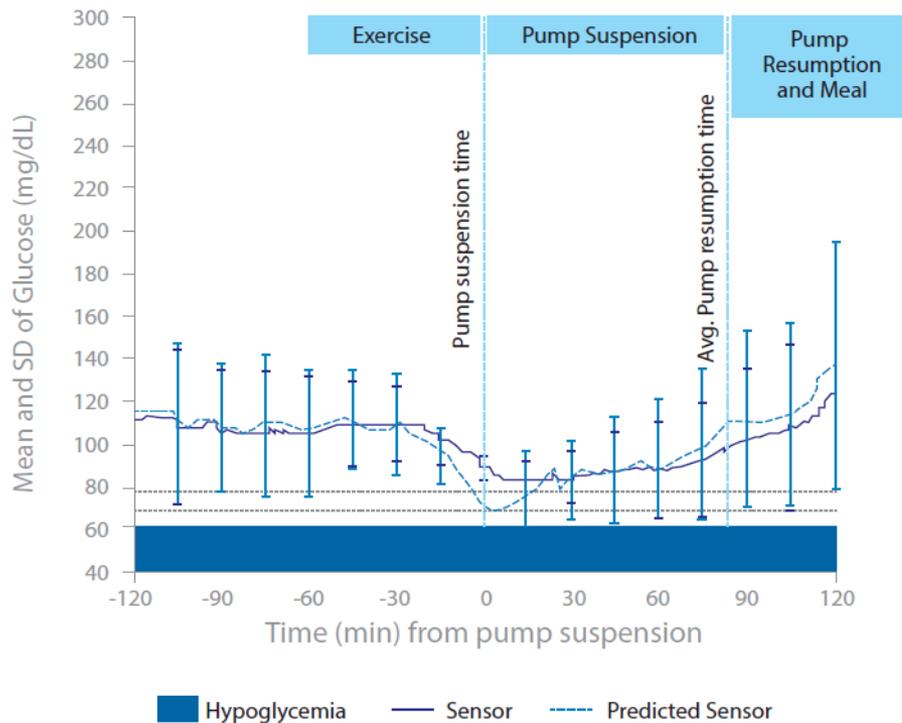
SmartGuard achieved **42% less time spent low** compared to Low Glucose Suspend
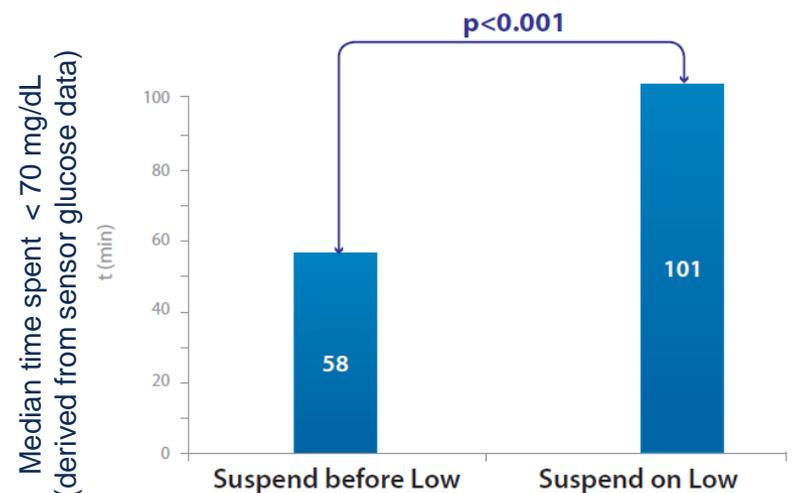
SmartGuard Performance	
Mean SG ± SD at Suspend	92 ± 7 mg/dL
Mean SG ± SD at Lowest value	77 ± 22 mg/dL
Mean Time of Suspend Duration	90 ± 35 min

1. Danne T, et al.. *Diabetes Technology & Therapeutics.* 2014; 16(6):338:347.
2. Investigational device and not commercially available in the US.

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The Next Step in Automation – Three Algorithms Used for Closed Loop

PID
**Proportional-integral-derivative**

- 90% of all closed loop systems

- Looks at present, past and predicted future errors (actual glucose vs. desired glucose)

- Attempts to minimize errors through delivery of insulin
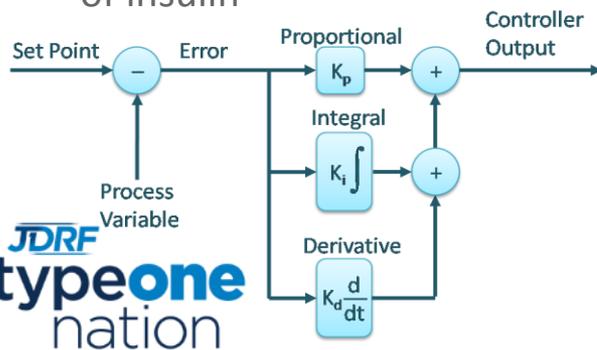
MPC
Model Predictive Controller

- Used mainly in chemical engineering
- Builds model of the process
- Iteratively looks to optimize process variables
- Sensitive to model quality and input quality
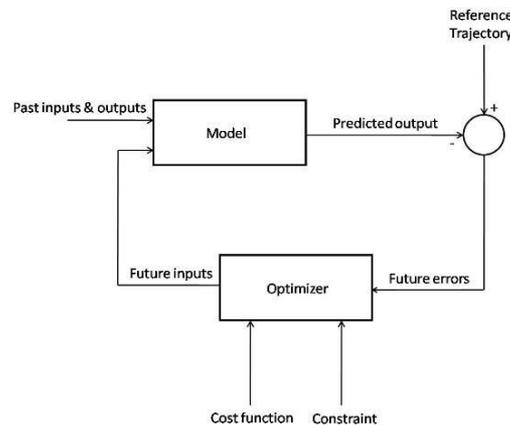
Fuzzy Logic
Based on If – Then

- However, if-then logic can accommodate partially true "ifs"
- Can only account for scenarios specifically defined
- Prone to gaps in scenarios

Structure of a neuro-fuzzy system
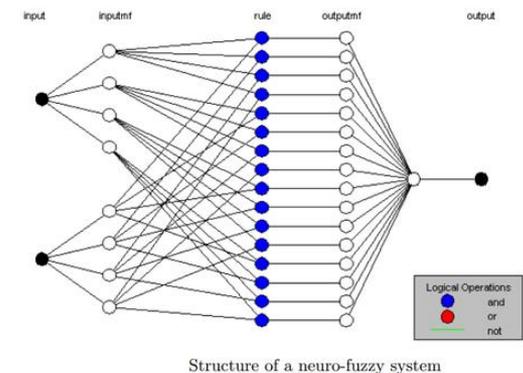
Overnight Closed Loop

- In-Clinic, In-Home, In-Clinic
- The Overnight Period is without disturbances of Food and Activity
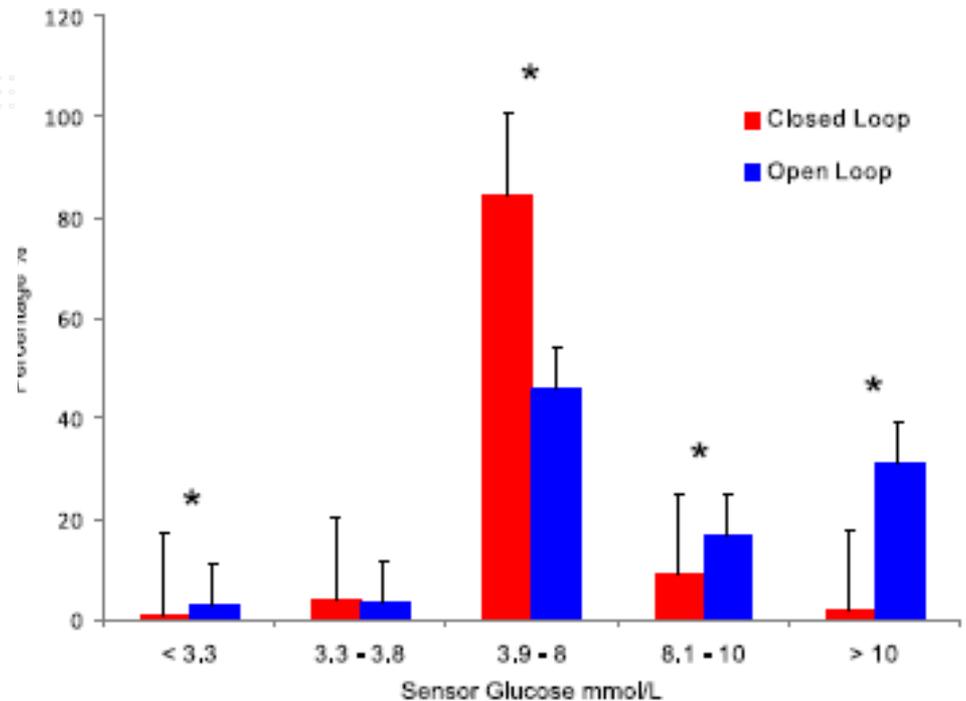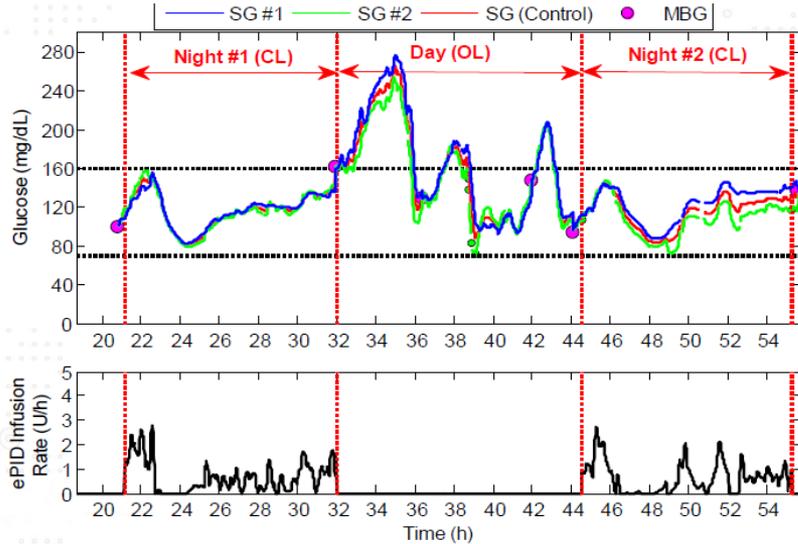- Over 80% of time in target 70-180 mg/dl (3.9-10.0 mmol/l)

Figure 3—Comparison of overnight closed-loop (red) with prestudy open-loop (blue) control. *P < 0.0001.

O'Grady M, et al. *Diabetes Care*. 2012;35:2182-2187. DOI:10.2337/dc12-0761 2012

The Dream Study

- Nocturnal Glucose Control at Diabetes Camp

Results: Glucose Control Over Time

MD-Logic Nights
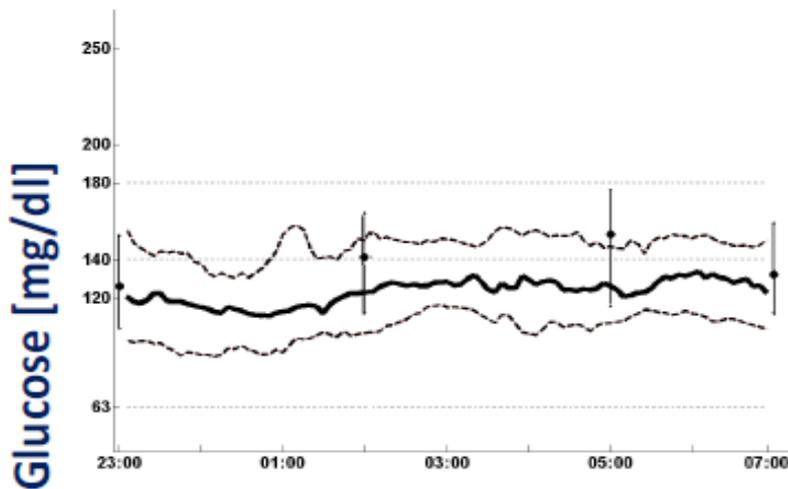
Control Nights

P<0.0001

Time [hh:mm]

Phillip M, et al. *N Engl J Med*. 2013;368:824-833.
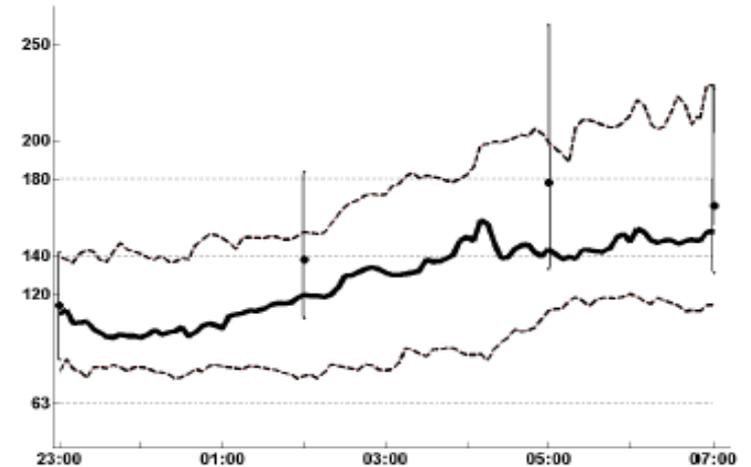
Comparing Pre-Bolusing for Meals vs. Full Automation

Automated Feedback-Controlled Insulin Delivery in Children with Type 1 Diabetes

Yale University School of Medicine

Weinzimer S, et al. *Diabetes Care*. 2008;31:934-939.
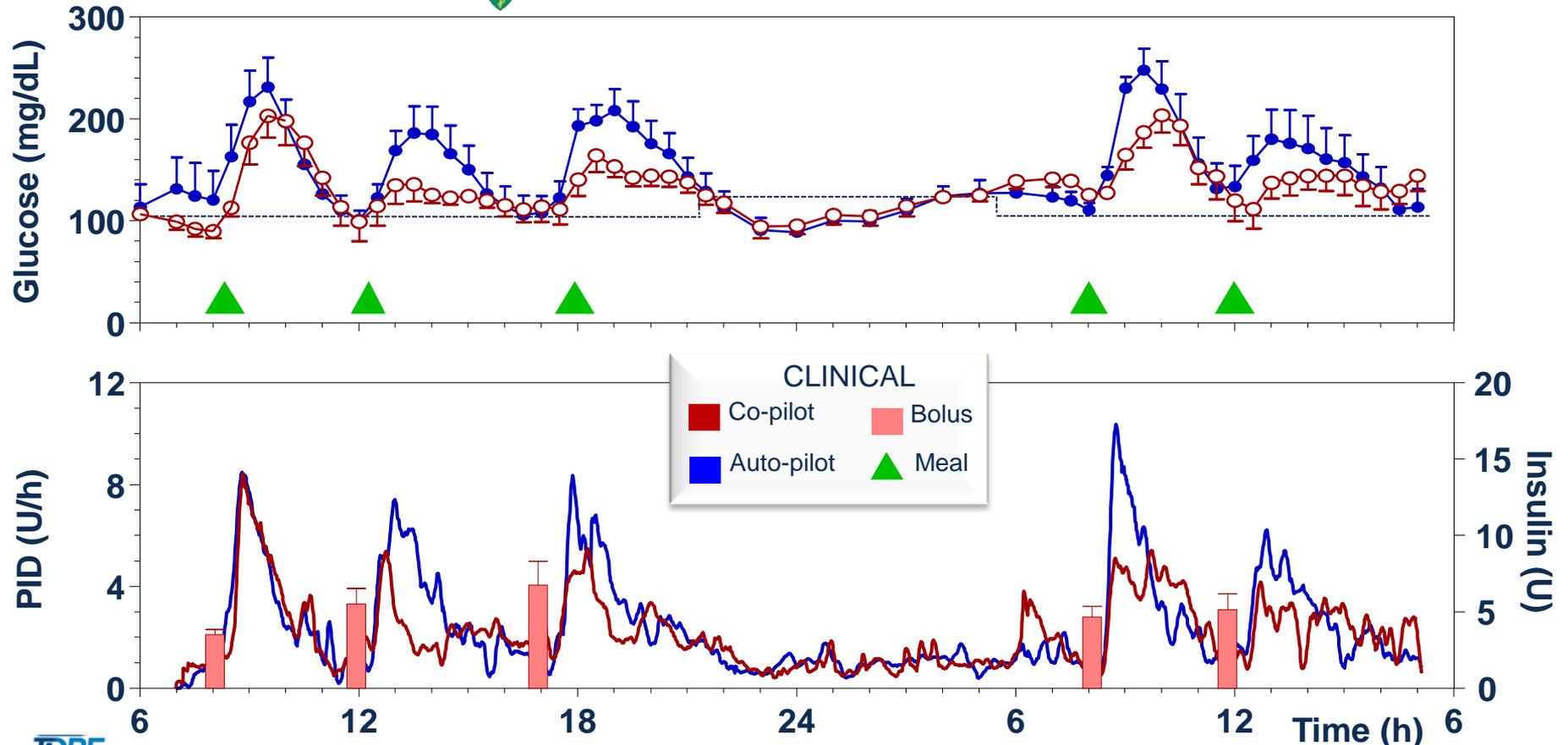
Importance of Human Factors

- **At-A-Glance Awareness**

- **Clear Mode Indications**

- **Minimizing User Error**

Home screen in
Closed Loop

Home screen in
Open Loop

Early Concepts

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New Products – Not Yet Available

Monogenic Diabetes

What is Monogenic Diabetes?
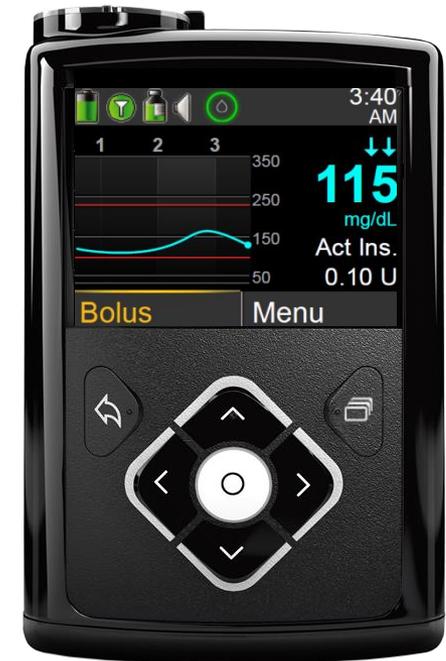
The overwhelming majority (about 98%) of those with diabetes have either type 1 or type 2 diabetes. However, in a small number of individuals and families, a single gene abnormality can cause diabetes. This is called monogenic diabetes.

Monogenic diabetes includes:

- MODY (Maturity Onset Diabetes of the Young), most commonly caused by mutations in the HNF1A gene or the GCK gene
- Neonatal diabetes, most often caused by a mutation in any one of three genes: KCNJ11, ABCC8 or INS

Genes & mutations:

The human body has about 25,000 individual genes. So far, more than 20 have been linked to monogenic diabetes. An error in any one of these genes can cause a child or adult to develop monogenic diabetes, and it can be passed on in the family.

A gene is a strand of DNA (deoxyribonucleic acid) – essentially a long "ladder" of nucleotide "letters" that are the code or blueprint for proteins that do all the work in all the cells of the body. Genes contain information to pass traits from parents to their children. If a genetic error occurs, it causes a

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Come See Us!

- Acknowledgements

- These are just a few of the incredible people we have on our team. To view them all please visit www.kovlerdiabetescenter.org/about-us/our-team

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Questions?

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