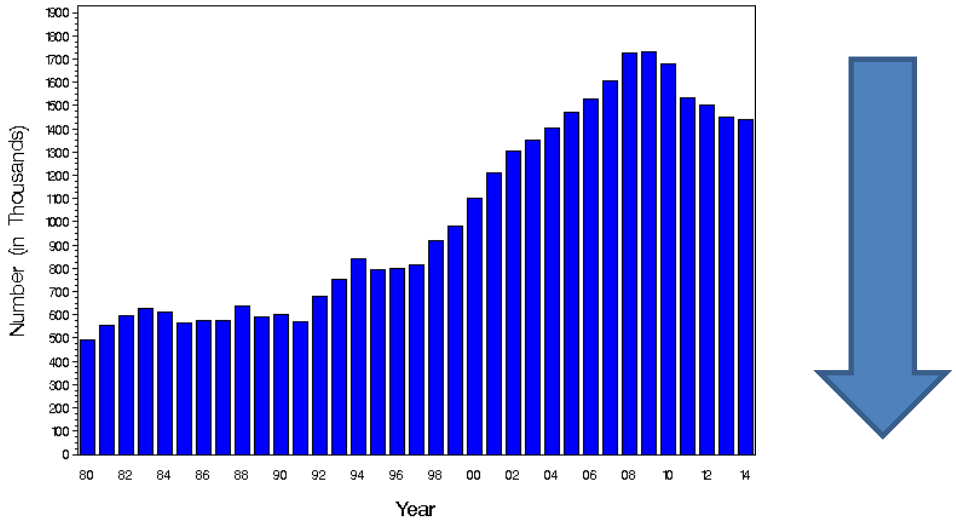
Joslin Diabetes Center | Affiliated with Harvard Medical School

Reimagining Diabetes Care: Leveraging Digital Health Technologies

William Hsu, MD

Current Diabetes Care Model
What's Not to Like?

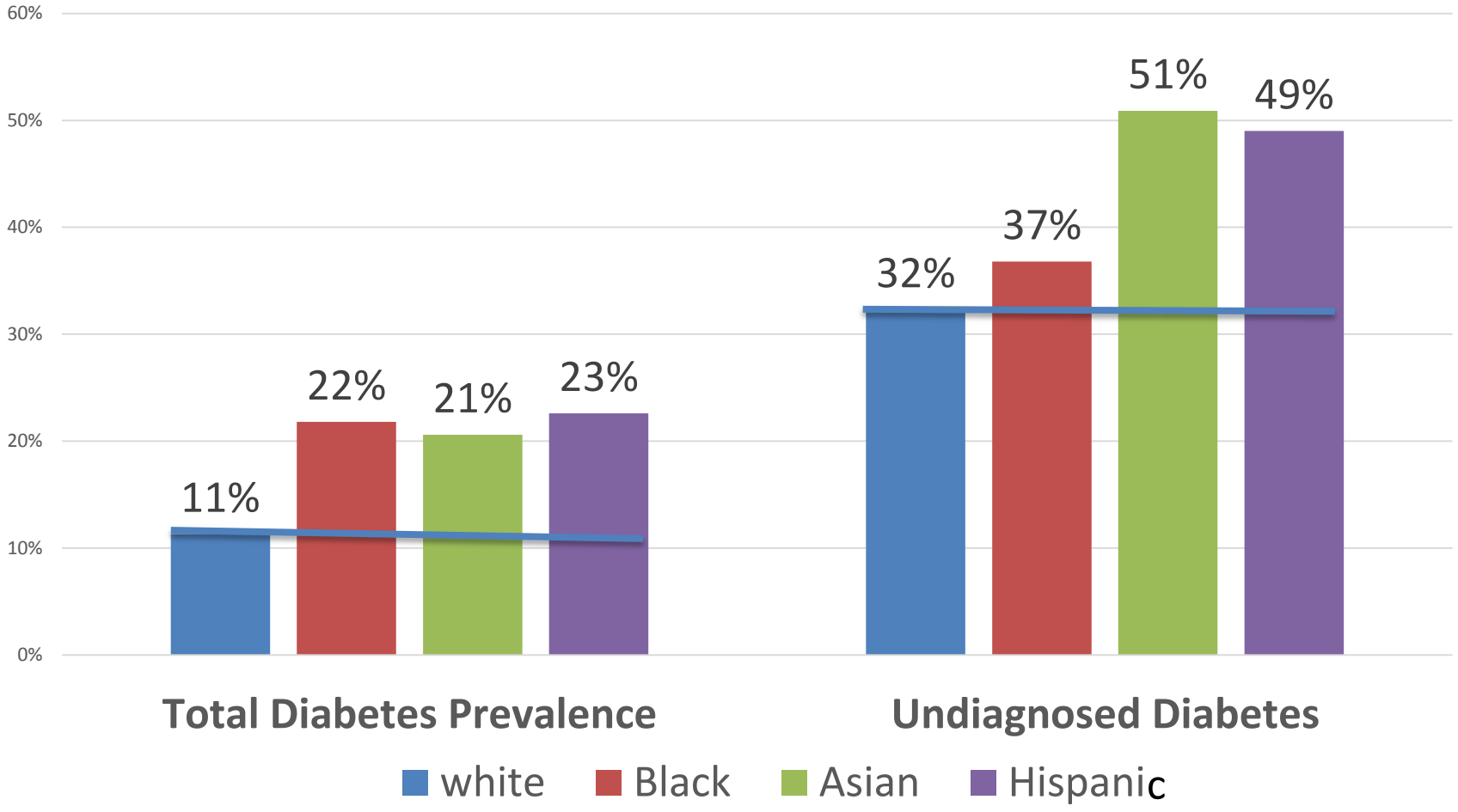


Achievement of Goals in US Diabetes Care, 1999–2010

Factor or Practice	1999–2002	2003–2006	2007–2010	Change from 1999–2002 to 2007–2010 (95% CI)	Change from 2003–2006 to 2007–2010 (95% CI)
	% of survey participants			*percentage points*	
Risk factors					
Glycated hemoglobin					
>9.0%	18.4	13.0	12.6	–5.8 (–10.5 to –1.1)	–0.4 (–3.8 to 3.0)
<8.0%	67.4	78.0	79.1	11.7 (6.3 to 17.1)	1.1 (–3.5 to 5.7)
<7.0%	44.3	56.8	52.2	7.9 (0.8 to 15.0)	–4.6 (–11.1 to 1.9)
Blood pressure <130/80 mm Hg	39.6	45.3	51.3	11.7 (5.7 to 17.7)	6.0 (0.4 to 11.6)
LDL cholesterol†					
<100 mg/dl	36.0	46.6	56.8	20.8 (11.6 to 30.0)	10.2 (2.5 to 17.9)
<70 mg/dl for persons with CVD	15.9	23.2	27.5	11.6 (–4.1 to 27.3)	4.3 (–8.5 to 17.1)
Current smoker, self-reported or cotinine >10 ng/ml	24.0	23.4	22.3	–1.7 (–6.2 to 2.8)	–1.1 (–5.4 to 3.2)
Glycated hemoglobin, blood-pressure, and LDL cholesterol targets and nonsmoking status achieved	4.6	9.5	14.3	9.7 (5.1 to 14.3)	4.8 (–0.4 to 10.0)

N Engl J Med 2013;368:1613-24

Disparities Across Ethnicity



THE COST OF DIABETES

Diabetes and pre-diabetes
cost America

$322 billion annually

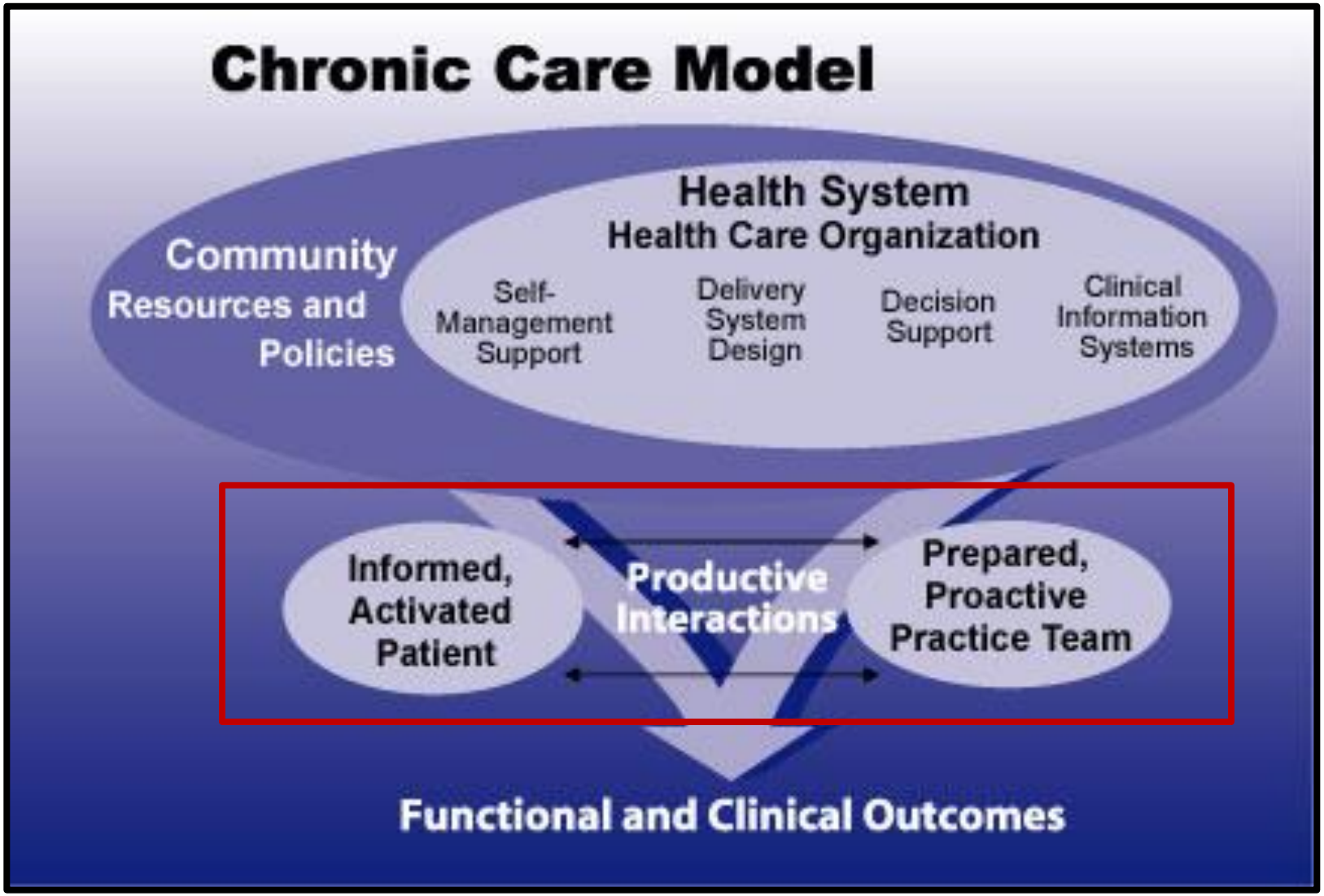
are spent caring for people living with diabetes in the U.S.

Back to the Patient

24 x 7 x 365

“It’s A Really Hard Job!”

Current Care Model Is A Direct Result of the Reimbursement Model



NEWMEDIAMEDICINE
MIT Media Lab

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Radical new collaborations **catalyzing a revolution in health.** Follow Subscribe Search

Health and Wellness Innovation 2013

Project Videos are Now Online

Projects

- CollaboRhythm — Redefining healthcare delivery
- I'm Listening — Giving patients the chance to speak
- Collective Discovery — Discovering cures in 'everyday experiments'
- Oovit PT — Making physical therapy fun and effective
- WeightMate — Getting to know your food moods

People

- Frank Moss PhD — Principal Investigator
- John Moore MD — PhD Candidate
- Ian Eslick — PhD Candidate
- Scott Gilroy — Software Developer
- Mar Gonzalez Franco — Visiting PhD Student

Recent Blog Posts

- Health and Wellness Innovation 2013 Covered in Fast Company
- Health and Wellness Innovation 2013 Awards
- Health and Wellness 2013 - 80 Amazing Participants - 6 Exciting Projects for Patient Empowerment
- GeckoCap, a Health and Wellness Innovation 2012 Spin-off, is Gaining Momentum
- Moore Explores Apprenticeship as a Powerful New Paradigm of Chronic Disease Management
- Chameleon Wins Health and Wellness Innovation 2012
- Frank Moss in the Times - Consumer Health Can

Focus on Problem Area in Diabetes

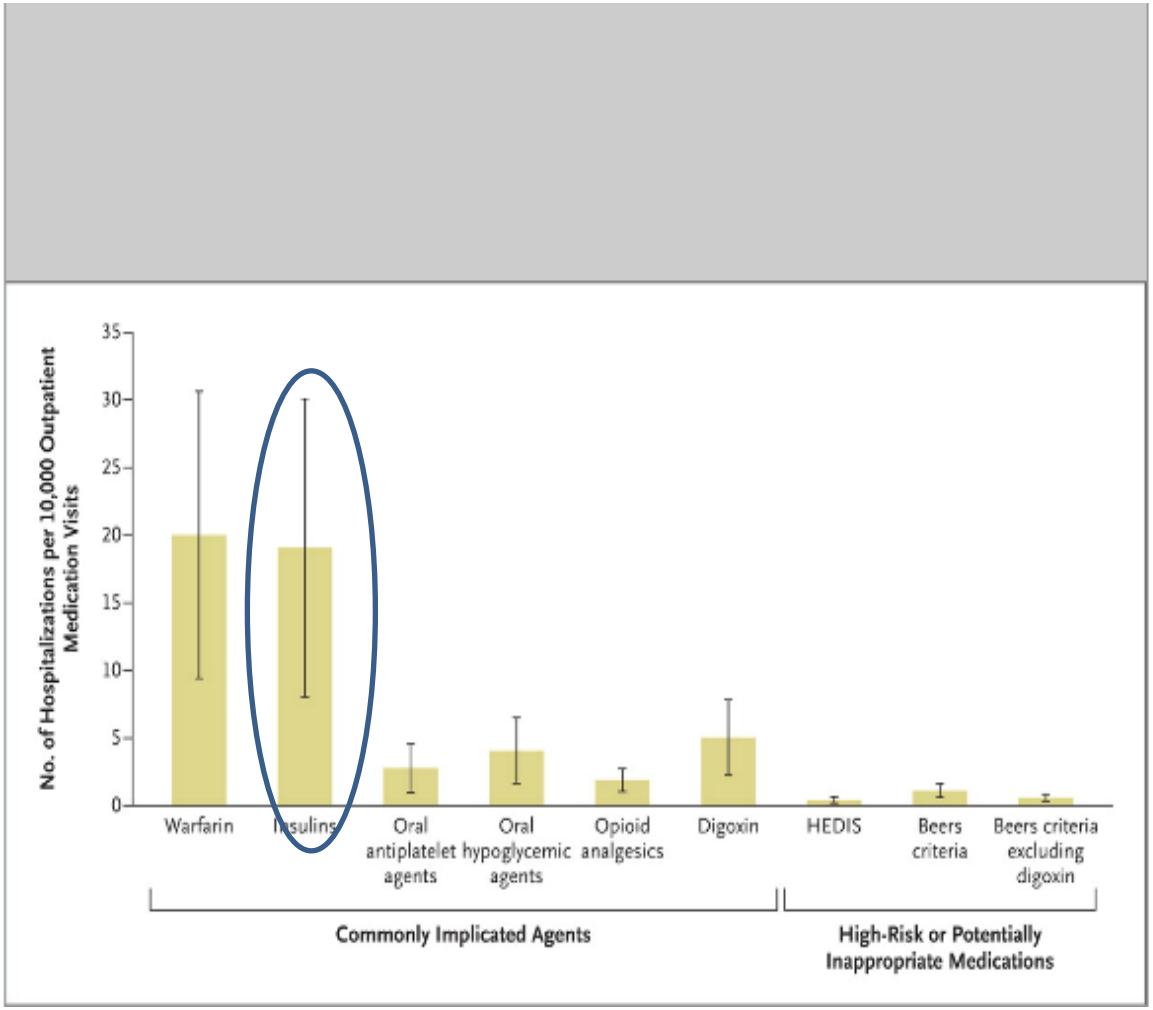


Figure 1. Estimated Rates of Emergency Hospitalizations for Adverse Drug Events in Older U.S. Adults, 2007–2009.

Estimates were based on hospitalization data from the National Electronic Injury Surveillance System–Cooperative Adverse Drug Event Surveillance project for 2007 through 2009, and data for outpatient visits during which medications were ordered or continued are from the National Ambulatory Medical Care Survey and National Hospital Ambulatory Medical Care Survey for 2007 and 2008. High-risk medications are those designated as such in the elderly by the 2011 Healthcare Effectiveness Data and Information Set (HEDIS).12 Potentially inappropriate medications are those identified by the updated 2002 Beers criteria for potentially inappropriate medication use in older adults.13 All high-risk or potentially inappropriate medications were included in the analysis, regardless of the dose, frequency of use, formulation (e.g., short-acting), or duration of use. I bars denote 95% confidence intervals. For oral antiplatelet agents, the coefficient of variation was greater than 30%.

N Engl J Med 2011; 365:2002-2012

Proof of Concept

- Develop a DM management program to support individuals with type 2 diabetes working with health coaches to initiate and titrate basal insulin, guided by the PREDICTIVE 303 algorithm and hypoglycemia treatment guidelines.

Rethinking Educational Model

- Approximately 5% of Medicare beneficiaries with newly diagnosed diabetes used DSMT services.
- 6.8% of privately insured, newly diagnosed adults participated in DSMT during the first year after diagnosis of diabetes.

Drag ‘N Cook


Asian American Diabetes Initiative
Drag n
Joslin Diabete
Non-starchy Vegetables
Drag
food
to make
a meal
Portion of Bitter melon
8
9
10
11
12

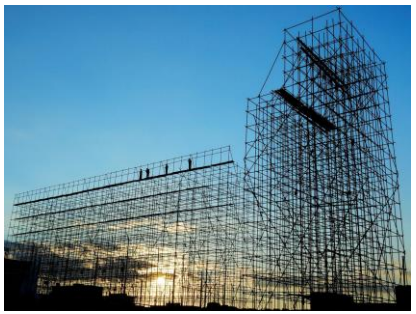
1/8
1/4
1/3
cup
Traditional Chines
Carrot
Portion: 1 cup (128 g)
Review
New Recipe
This is a new recipe. Drag foods into the cookware, then stir or shake to make it yours.
Cooking Directions
You can also provide step by
cooking directions for the reci
Home
AADI
Nutrition Revie
AADI Guideline
Amount per Dish
Calories 6932 kcal
Total Fat
Saturated Fat
Trans Fat
Cholesterol 2542 mg
Sodium 1916 mg
Potassium 11718 mg
Total Carbohydrate 25 g 1%
Dietary Fiber 9 g
Sugars 9 g
Protein 695 g 40%
Broccoli
Portion: 2 1/8 cup (193 g)
Cilantro leaves
Portion: 1 x 0.25 cup (4 g)
Beef sirloin
Portion: 39 7/8 x 3 oz (3389 g)
Review
Edit
New Recipe
This is a new recipe. Drag foods into the cookware, then stir or shake to make it yours.
Cooking Directions
You can also provide step by step cooking directions for the recipe.
Share your recipe
Email
Facebook Login
Cancel

Theoretical Framework

Cognitive Apprenticeship

Coach Articulates

Coach Fades and support



Patient Emulates

Enabled through Digital Technology Connectivity

Hypothesis

- Use of system with HCP helps individuals starting basal insulin achieve better glycemic control compared with standard clinical practice

Materials and Methods

- RCT, 12 $\pm$ 2 weeks
- Type 2 DM, $\geq$ 18 y.o. A1c 9-14%
- Decided to be on basal insulin by HCP
- Sees an educator to start insulin
- V1 – collect A1c, DTSQ, clinical data
- Randomization to tablet vs standard F/U
- Control received Joslin Care

Outcomes Analysis

- Primary – A1c change in 3 months
- Secondary - A1c <7%, patient satisfaction, hypoglycemia, time HCP and patients spent
- Intention to treat analysis

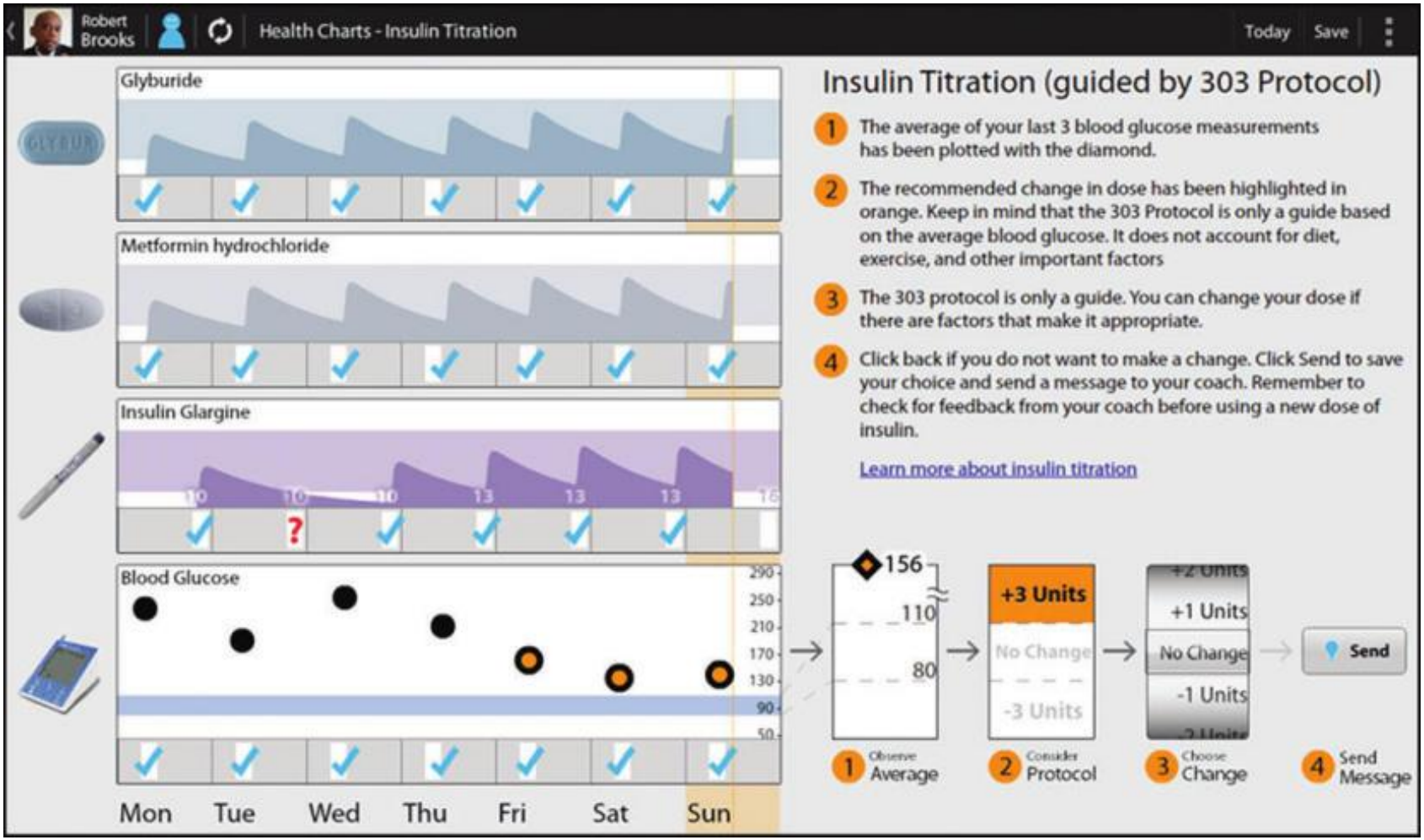
Diabetes Management System

- Open source CollaboRhythm software, designed at MIT Media Lab
- Self-tracking tools, shared decision-making interfaces, streamlined communication tools, decision support tools for hypoglycemia

Interventional Group

- Trained on tablet
- Glucosemeter wirelessly connected to tablet
- QAM glucose check to determine night dose
- Use PREDICTIVE 303 as a guide
- No face to face appointment with HCP
- No change in non-insulin meds
- Start on 10-15 units and titrate up
- Dose adjustment communicated via tablet

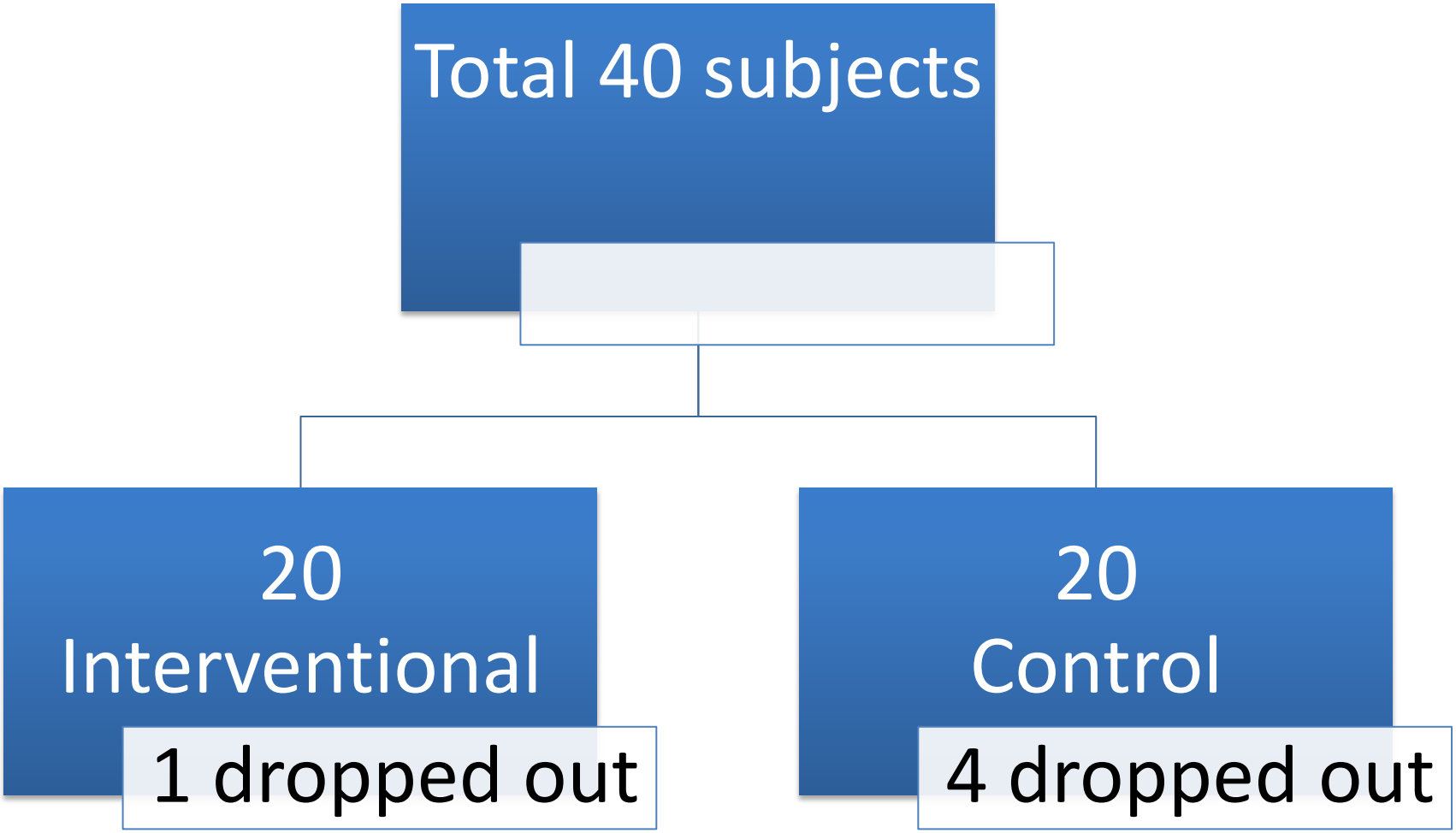
Insulin Titration Decision Support



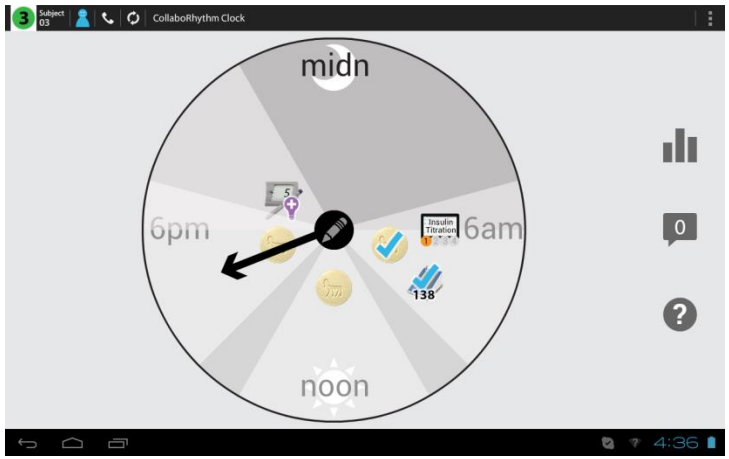
Interventional Group Continued

- Initially daily communication, then fades
- Let patient decide on insulin doses over time
- No fax, call, face to face
- Instead use costumed interface, text message or real-time video and shared screen control
- Time spent, hypo, tracked electronically

Results

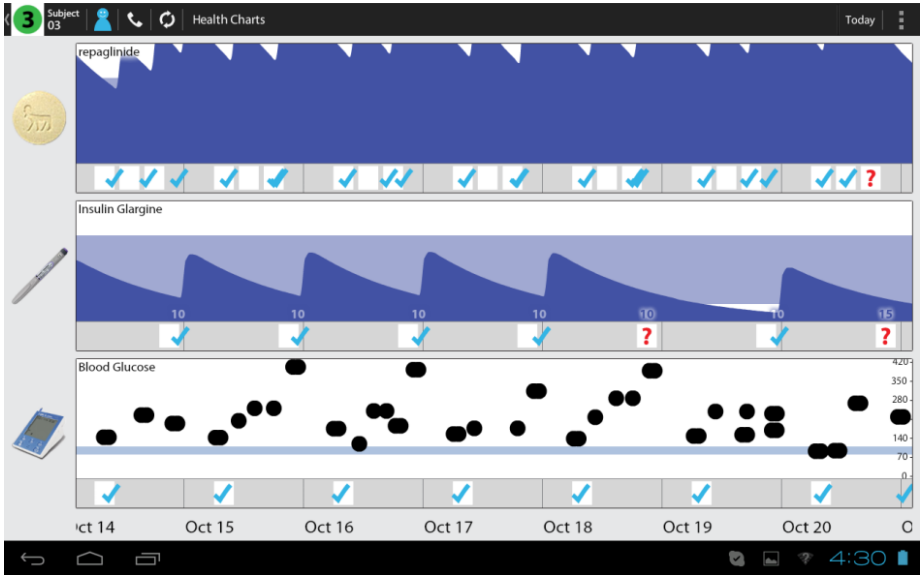

Total 40 subjects
20
Interventional
1 dropped out
20
Control
4 dropped out

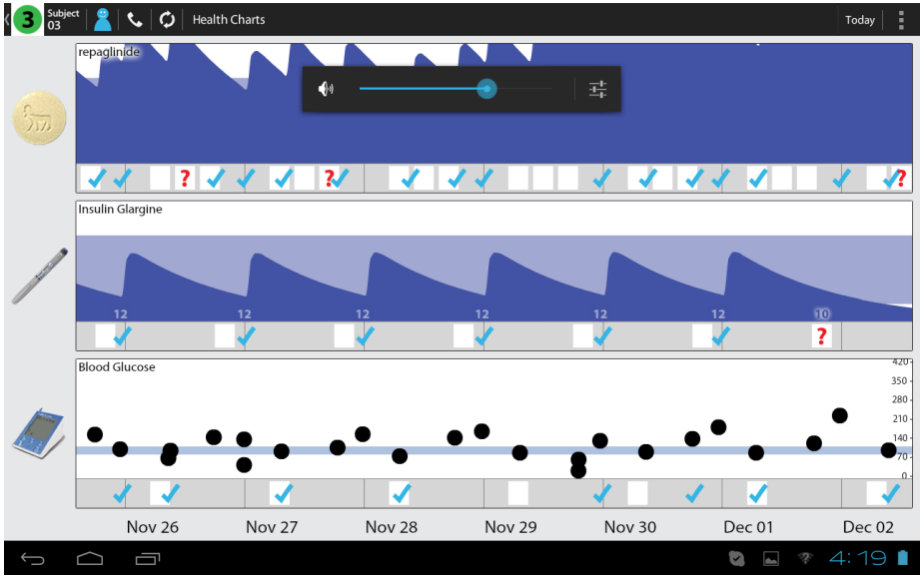
Case Study #1

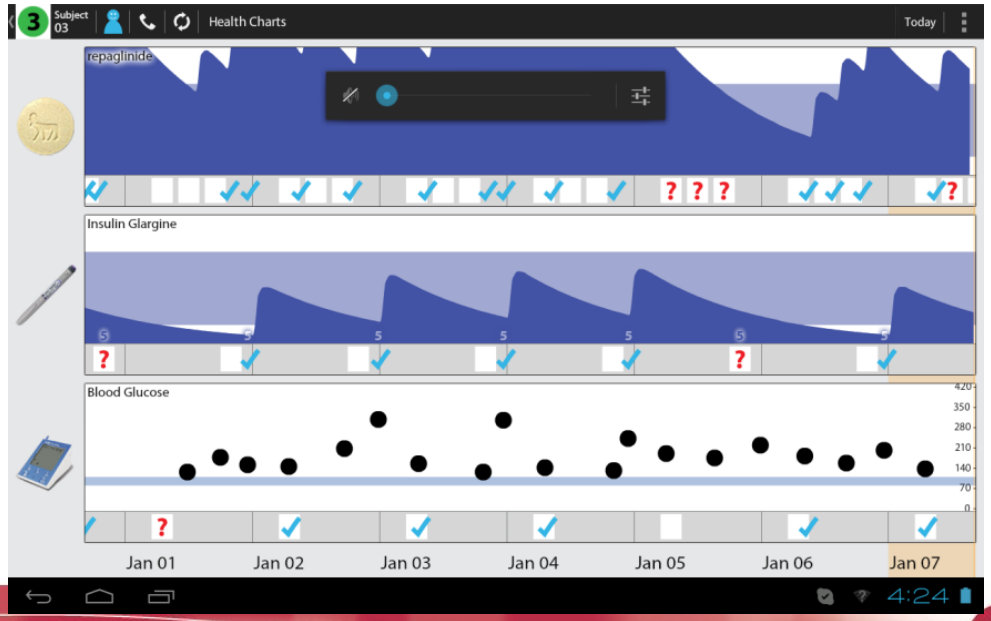


JK is a 54 y.o. woman

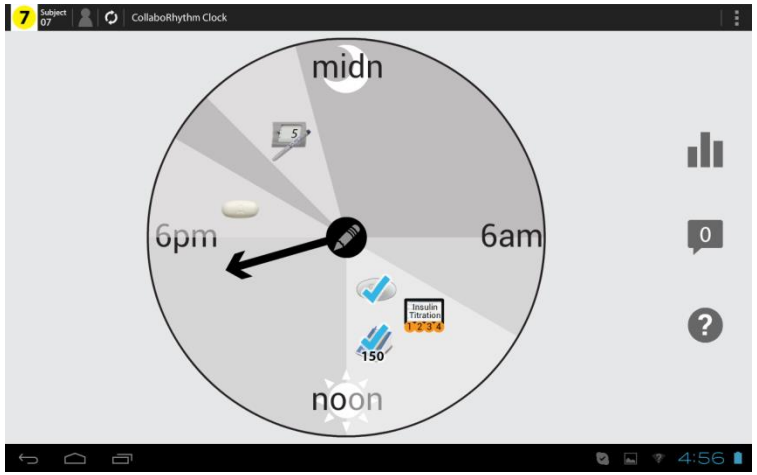
- 1 year history of DM
- BMI 21.3
- HbA1c 14.1%
- was started on repaglinide 1mg tid and glargine


Subject 03
Health Charts
Today
repaglinide
Insulin Glargine
Blood Glucose
Oct 14
Oct 15
Oct 16
Oct 17
Oct 18
Oct 19
Oct 20
4:30

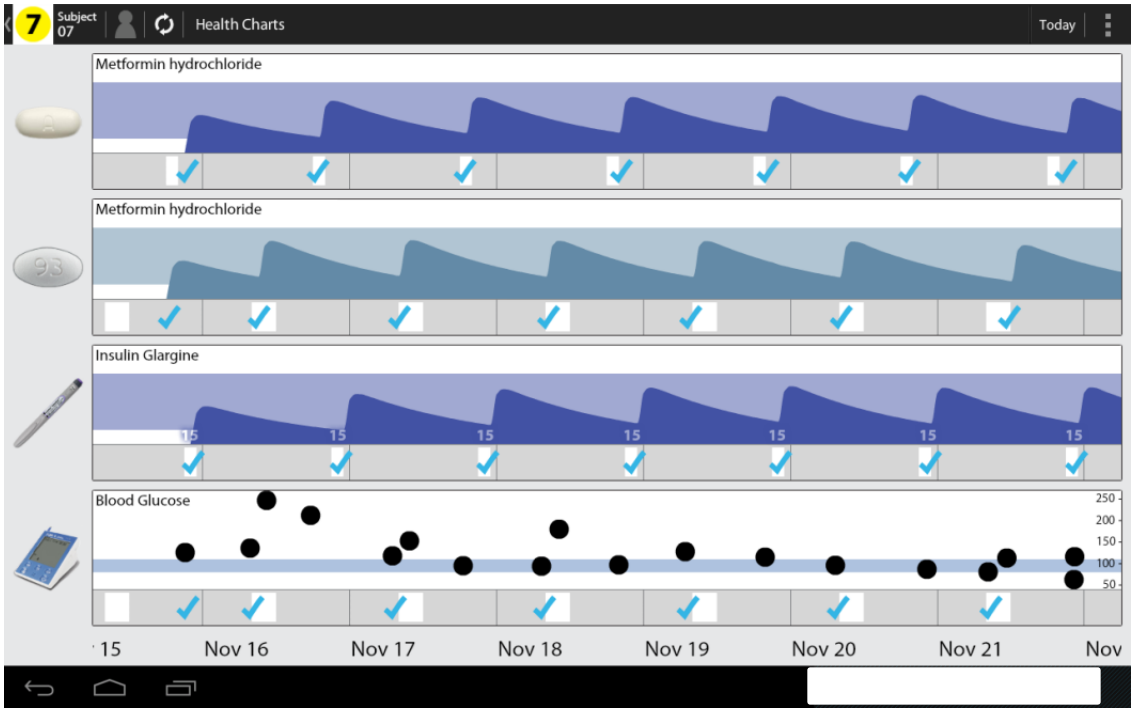

Subject 03
Health Charts
Today
repaglinide
Insulin Glargine
Blood Glucose
Nov 26
Nov 27
Nov 28
Nov 29
Nov 30
Dec 01
Dec 02
4:19

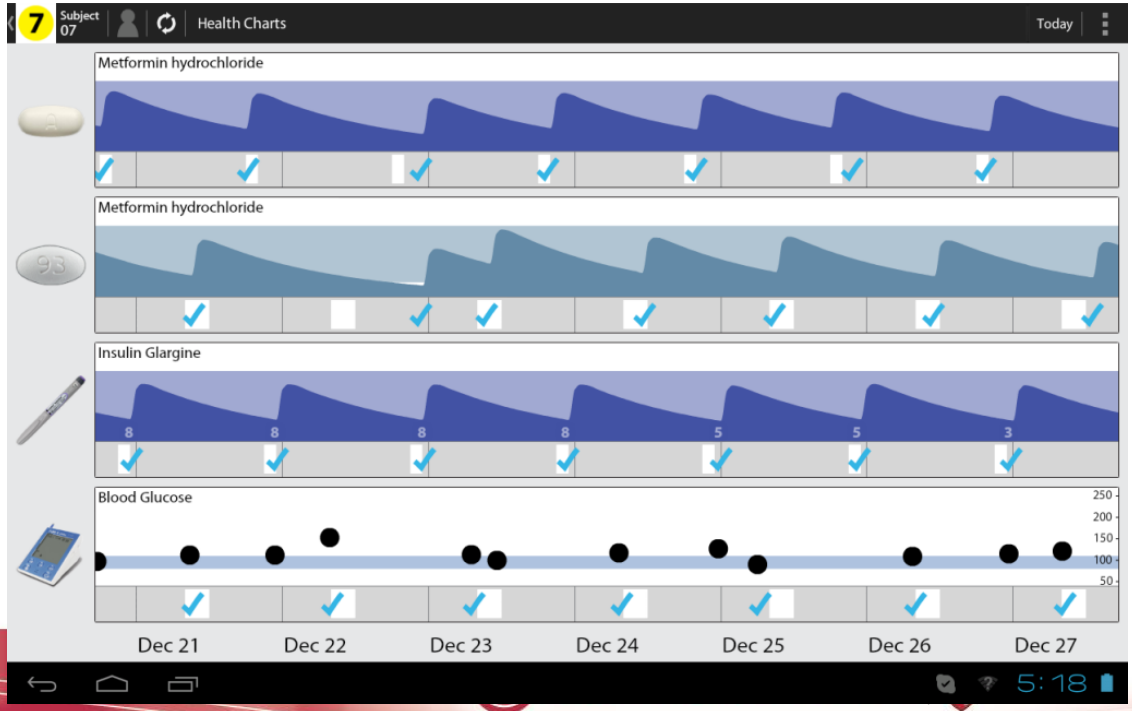

Subject 03
Health Charts
Today
repaglinide
Insulin Glargine
Blood Glucose
Jan 01
Jan 02
Jan 03
Jan 04
Jan 05
Jan 06
Jan 07
4:24

Case Study #2

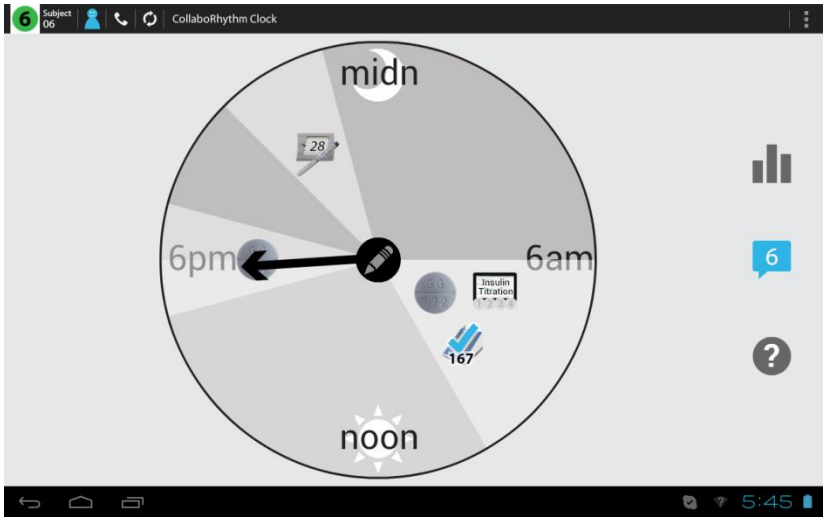


- 32 y.o. Caucasian male
- Type 2 DM, diagnosed 2007
- BMI 27
- HbA1c 9.2%
- On metformin 500mg in am and 1000mg in pm

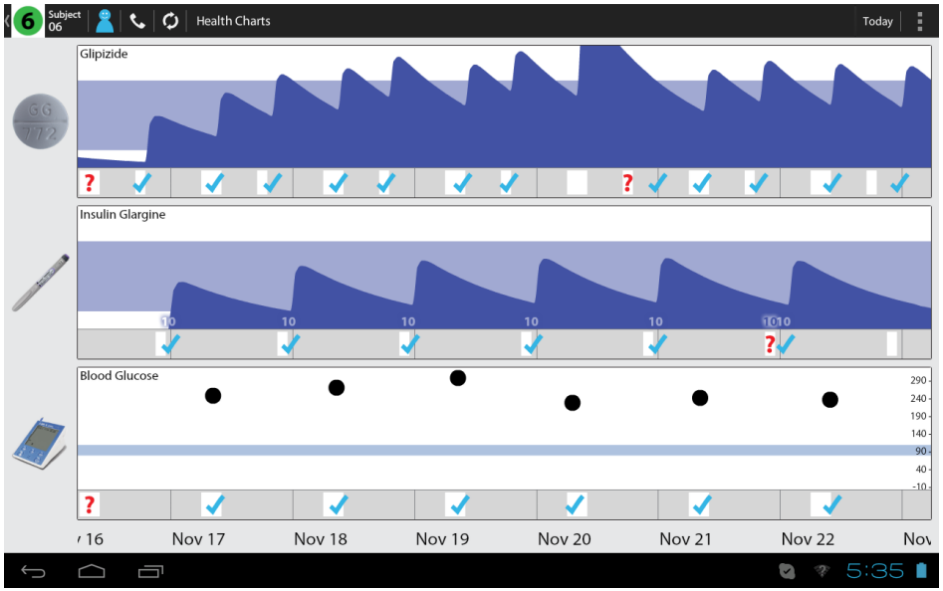

7
Subject
07
Health Charts
Today
Metformin hydrochloride
Metformin hydrochloride
Insulin Glargine
15
Blood Glucose
250
200
150
100
50
15
Nov 16
Nov 17
Nov 18
Nov 19
Nov 20
Nov 21
Nov

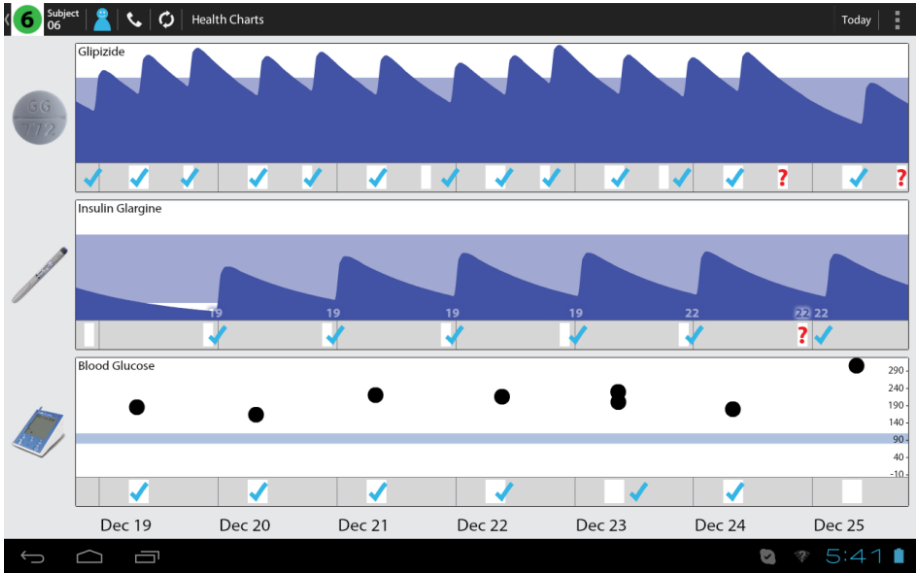

7
Subject
07
Health Charts
Today
Metformin hydrochloride
Metformin hydrochloride
Insulin Glargine
8
8
8
8
5
5
3
Blood Glucose
250
200
150
100
50
Dec 21
Dec 22
Dec 23
Dec 24
Dec 25
Dec 26
Dec 27
5:18

Case Study #3



- 80 y.o. Caucasian woman
- Type 2 DM, diagnosed 2002
- BMI 42.8
- HbA1c - 12.1
- Started on glargine and glipizide 5mg bid


Subject 06
Health Charts
Today
Glipizide
Insulin Glargine
Blood Glucose
290
240
190
140
90
40
-10
16
Nov 17
Nov 18
Nov 19
Nov 20
Nov 21
Nov 22
Nov
5:35


Subject 06
Health Charts
Today
Glipizide
Insulin Glargine
Blood Glucose
290
240
190
140
90
40
-10
Dec 19
Dec 20
Dec 21
Dec 22
Dec 23
Dec 24
Dec 25
5:41

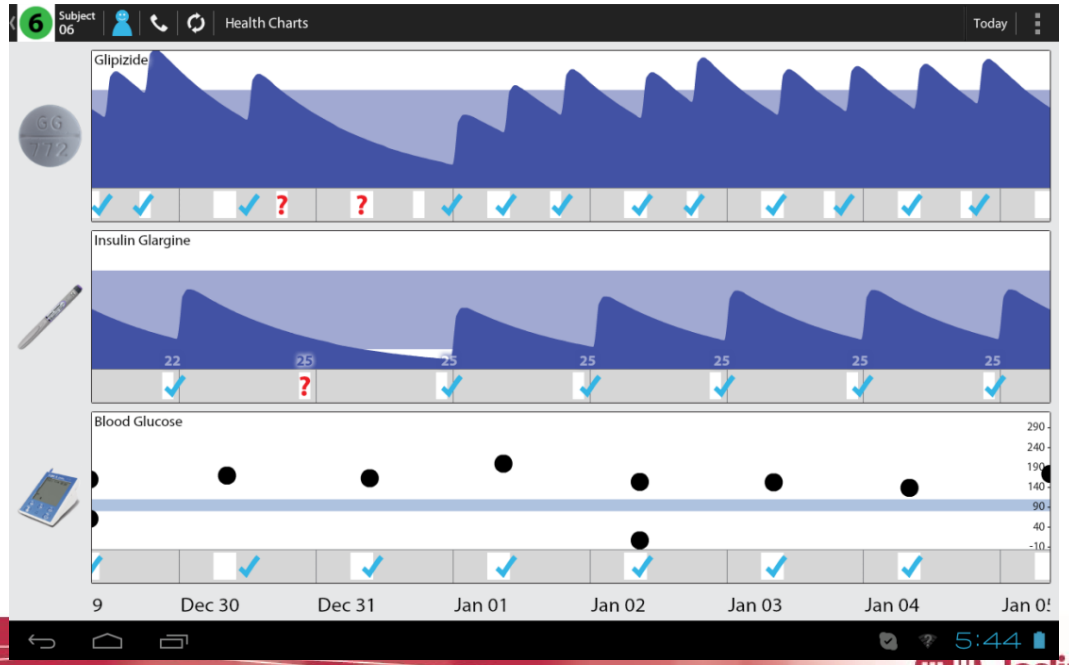
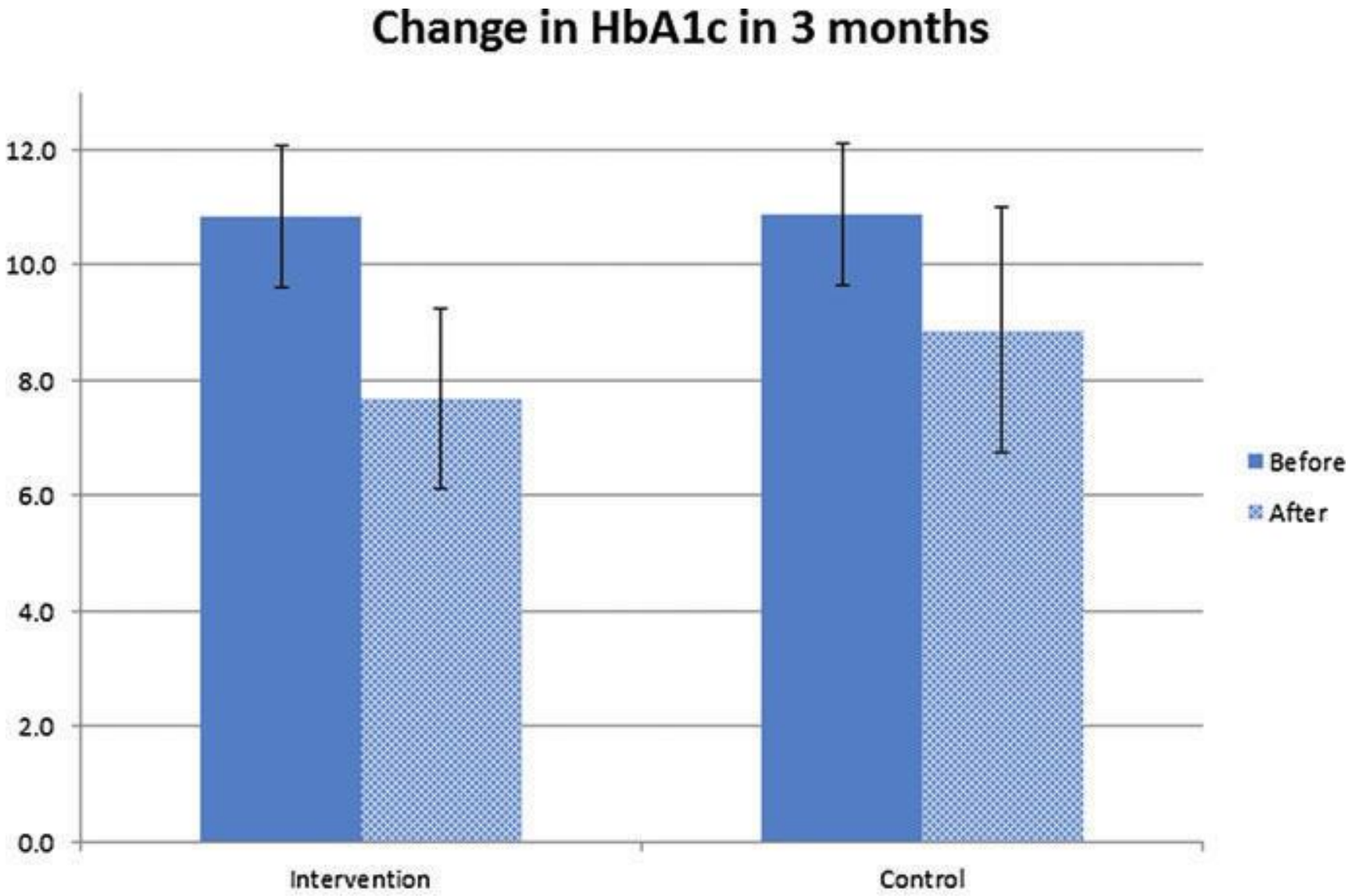

Subject 06
Health Charts
Today
Glipizide
Insulin Glargine
Blood Glucose
290
240
190
140
90
40
-10
9
Dec 30
Dec 31
Jan 01
Jan 02
Jan 03
Jan 04
Jan 0
5:44

TABLE 1. BASELINE CHARACTERISTICS ($N=40$)

	Control group (n=*20*)	*Intervention group* (n=*20*)	P *value*
Age (years)	53.8	53.3	0.90
Weight (pounds)	211.1	203.9	0.64
Height (inches)	68.7	67.4	0.27
Body mass index (kg/m^2)	31.7	30.8	0.63
Years from diagnosis	9.0	9.6	0.79
HbA1c (%)	10.9	10.8	0.92
Insulin dosage (units)	13.3	12.0	0.34
Non–insulin agents (*n*)	1.8	1.9	0.49
DTSQ score	34.3	31.9	0.41

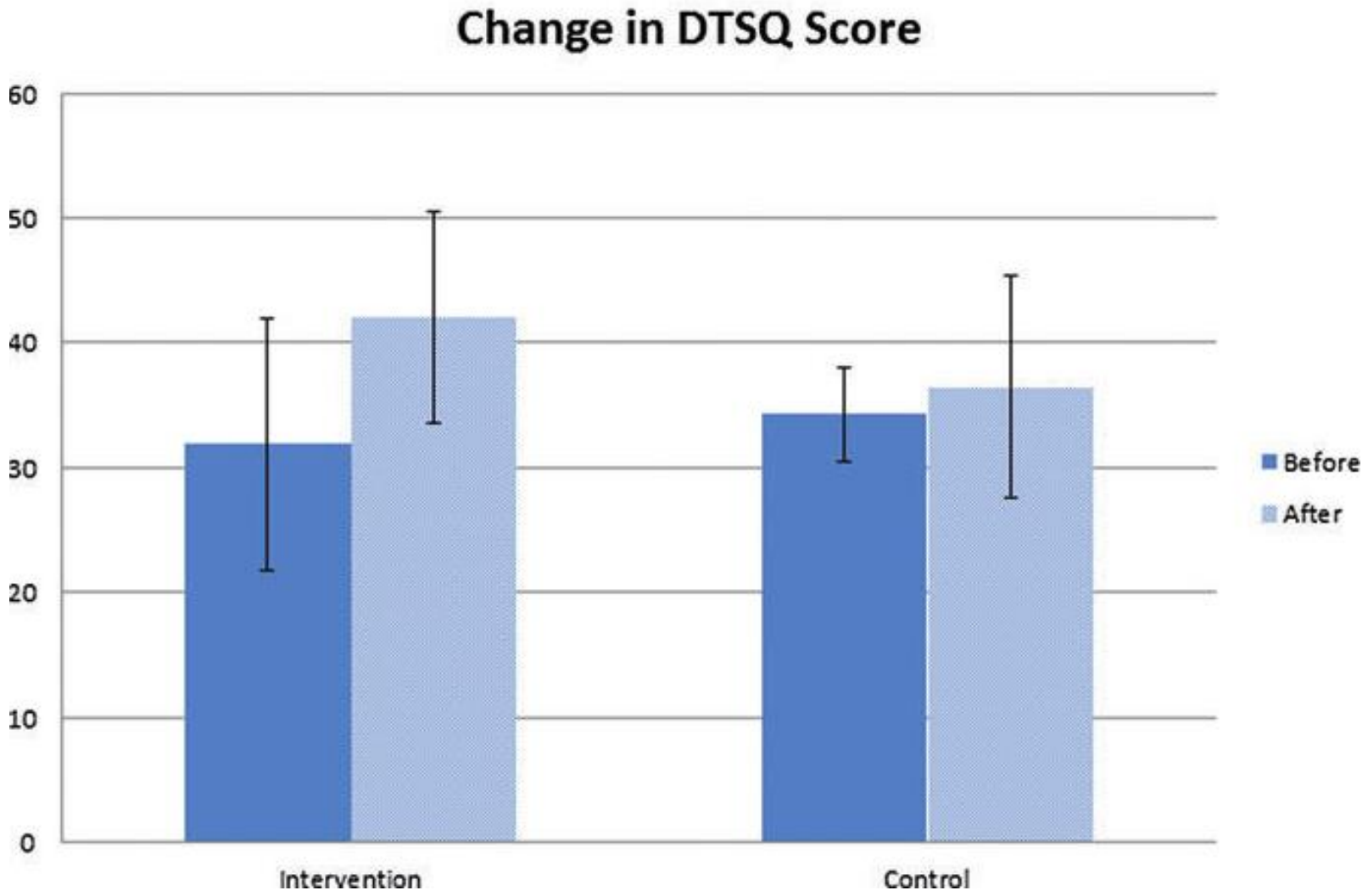
DTSQ, Diabetes Treatment Satisfaction Questionnaire; HbA1c, hemoglobin A1c.



Hsu et al. Diabetes Technol Ther. 2016

Additional Results

- Mean for first three glucose levels in month one vs month 3 (186.8 ± 56.5mg/dL vs. 141.5 ± 25.7mg/dL: P = 0.044)
- No significant changes (–0.48 pound in the intervention group vs. - 0.87 pound in the control group; P = 0.9)
- The final insulin dose was 24.6 ± 15.0 units (0.27 units/kg) in the intervention group and 21.9 ± 25.0 units (0.25 units/kg) in the control group (P = 0.69).
- Four subjects had hypo in Intervention vs two


Change in DTSQ Score
60
50
40
30
20
10
0
Intervention
Control
Before
After

Qualitative Results

- Feel less anxious and more motivated to get ‘‘back on track when I slip’’
- ‘‘I am excited to see what it [glucose reading] is going to say each day.’’
- ‘‘It’s comforting to know that they [clinician coaches] are lways there.’’
- ‘‘I like that it is convenient for me to communicate with my coach.’’
- ‘‘It [communication with my coach] did not feel intrusive.’’

- Subjects felt empowered to make insulin adjustments collaboratively: ‘‘I enjoy the power sharing in making decisions on insulin doses.’’
- ‘‘I feel more equal with the coach in making decision about my health’’
- Subjects felt that they could now make the connection between their glucose reading and their behavior: ‘‘I am more conscious of what I eat now.’’ ‘‘I didn’t know that I felt bad before.’’ ‘‘I understand the reasons behind the decision (of changing insulin dose) muchbetter.’’

Complaints

- Subject complaints mainly focused on troubles connecting with the server via their tablet computers, highlighting the importance for a smooth connectivity in the technology design

TABLE 2. INTERACTION TIME BETWEEN HEALTHCARE PROVIDERS AND SUBJECTS DURING THE STUDY PERIOD

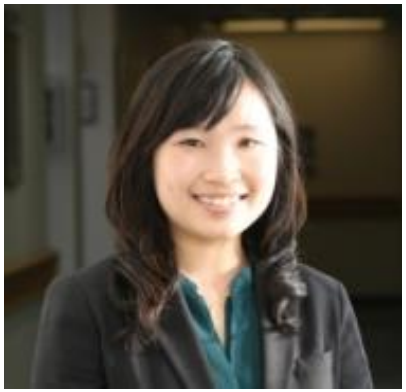
Group	*Mean face-to-face time (min) with*[a]		*Virtual visit time (min)*	*Mean messaging time (min)*	*Mean instruction time for using the app (min)*	*Mean phone time (min)*	*Total interaction time (min)*[b]	
	MD/ NP	*CDE*					*Excluding app training*	*Including app training*
Intervention	NA	NA	22.5	43.4	40.0	NA	65.9	105.9
Control	20.0	48.8	N/A	NA	NA	12.8	81.6	81.6

[a]Time excluded the initial and exit visits.
[b]No significant difference measured.
App, application; CDE, certified diabetes educator; MD, medical doctor; NA, not applicable; NP, nurse practitioner.

Discussions

Acknowledgement


Aldo Rossini MD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Paige Ricci

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- MIT Collaborators: John Moore, Scott Gilroy
- Harvard CT Chan School of Public Health: Ruyi Huang
- U Massachusetts Medical School: Hung Le