

**HEALTHcare**  
**humanFACTORS**  
a proud partner of UHN



**eHealth**  
**INNOVATION**  
a proud partner of UHN

# The role of health technologies in shaping behaviour

Joseph Cafazzo PhD PEng  
Executive Director, University Health Network  
Associate Professor, University of Toronto  
Wolfond Chair in Digital Health

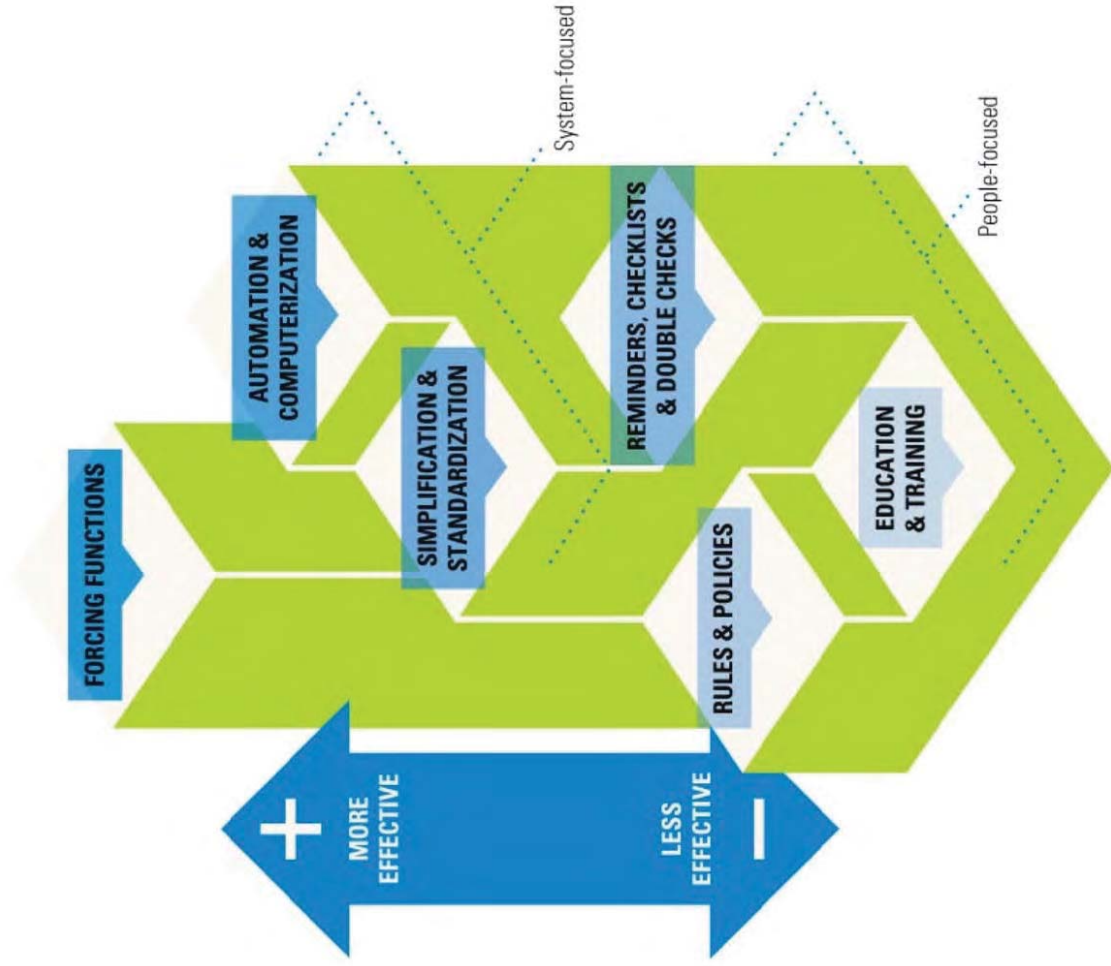
 @JosephCafazzo

# HUMAN FACTORS ENGINEERING





## The Hierarchy of Intervention Effectiveness



**HUMAN FACTORS ENGINEERING**  
is the application of what we  
know about human  
**CAPABILITIES AND LIMITATIONS**  
in the **DESIGN** of the world we  
live in, in order to enable **SAFE**  
**AND PRODUCTIVE** lives.

# HEALTHcare HumanFACTORS

a proud partner of UHN



Jess Effield  
Marketing & Communications  
Coordinator



Anjum Chaggar  
Managing Director



Joseph Calazzo  
Executive Director



Alison Besson  
President of Communications



Olivia Zajdman  
Human Factors Specialist



Jeanne Xie  
Human Factors Specialist



Peter Weinstein  
Lead, Global Ventures



Svetlana Taneva  
Human Factors Specialist



Laurenip  
Human Factors Student Intern



Ryan Cheng  
Human Factors Student Intern



Adam Badymski  
Human Factors Design Intern



Areeba Zakir  
Human Factors Specialist



Pia Nyakairu  
Human Factors Designer



Nathan Mills  
Human Factors Designer



Aarti Mathur  
Chief of Staff



Mike Lovas  
Design Director



Stephanie Hu  
Human Factors Analyst



Wayne Ho  
Managing Director



Kelsey Hampton  
Human Factors Designer



Chris Flewwelling  
Associate Director, Methods



Ilina Popovici  
Human Factors Specialist



Damon Pfaff  
Human Factors Specialist & Designer



Aastha Patel  
Human Factors Specialist



Laura Parente  
Human Factors Designer



Andreea Jovanovic  
Human Factors Specialist



Albert Jih  
Human Factors Designer



Jung-Hye Lee  
Human Factors Designer



Kathy Huynh  
Human Factors Specialist



Dedeia Lee  
Human Factors Design Intern



Neil Sokol  
Human Factors Specialist



Ashleigh Shier  
Human Factors Designer



Adhina Santoguida  
Human Factors Designer

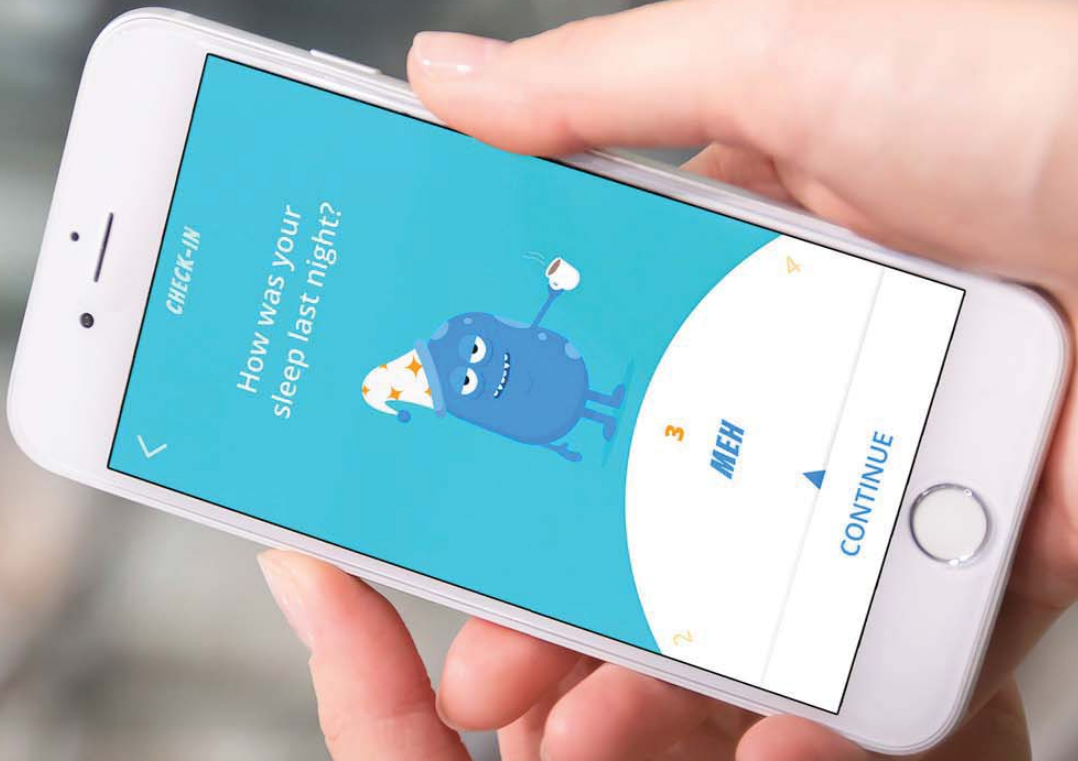


Mikael Raghuvar  
Human Factors Specialist



Elekta

Unity



# eHealth INNOVATION

a proud partner of UHN



**SEAN WATSON**  
Software Developer



**IMKY KWATOLUN**  
Software Developer



**ANNA YVANN**  
Office Coordinator & Assistant to the Executive Director



**HARRY QIU**  
Hardware Developer



**AMIR IDDIN**  
Manager



**DR. JOSEPH CAFAZZO**  
Executive Director



**RUO CHENGTONG**  
Software Developer



**ALANA TIBBLES**  
Research Analyst



**ANTHONY IBE**  
Software Developer



**CAITLIN NUNN**  
Research Analyst



**DR. SHIVANI GOYAL**  
Lead, Strategy & Research



**MELANIE YEUNG**  
Manager



**ANEEN CHANDRA**  
Software Developer



**RACHEL WALTON**  
Project Manager



**KEVIN FALLOP**  
Hardware Developer



**JAMES AGNEW**  
Technical Manager



**SHEEMA MELWANI**  
Product Manager



**DAVID NGO**  
Quality Assurance Analyst



**DAVID THAU**  
Software Developer



**KEVIN LEUNG**  
Software Developer



**EMILY SETO**  
Assistant Professor



**DR. PETER ROSSOS**  
Chief Medical Informatics Officer



**RON MARKACHMANDRA**  
Quality Assurance Analyst



**ADRIANE DE ALMEIDA**  
Software Developer



**VLAD VOLOSHYN**  
System Administrator



**LILY ALEXANDER**  
Quality System Manager



**JESS FIELD**  
Communications Coordinator



**GARY GIAMAN**  
Software Developer



**MILLA DOHARI**  
Product Manager



**AARTI MATHUR**  
Chief of Staff



**ARBOOD MAFLI**  
Software Developer



**JEREMY JURKIEWICZ**  
Software Developer



**MYLES RESNICK**  
Tier 2 S&C Coordinator



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**LAUREN RIBEIRO**  
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**MARIA AQUINO**  
Research Analyst Student



**KATHLEEN GORDON**  
PhD Candidate



**BRIAN HO**  
Project Analyst Student



**SARAH WALI**  
PhD Student

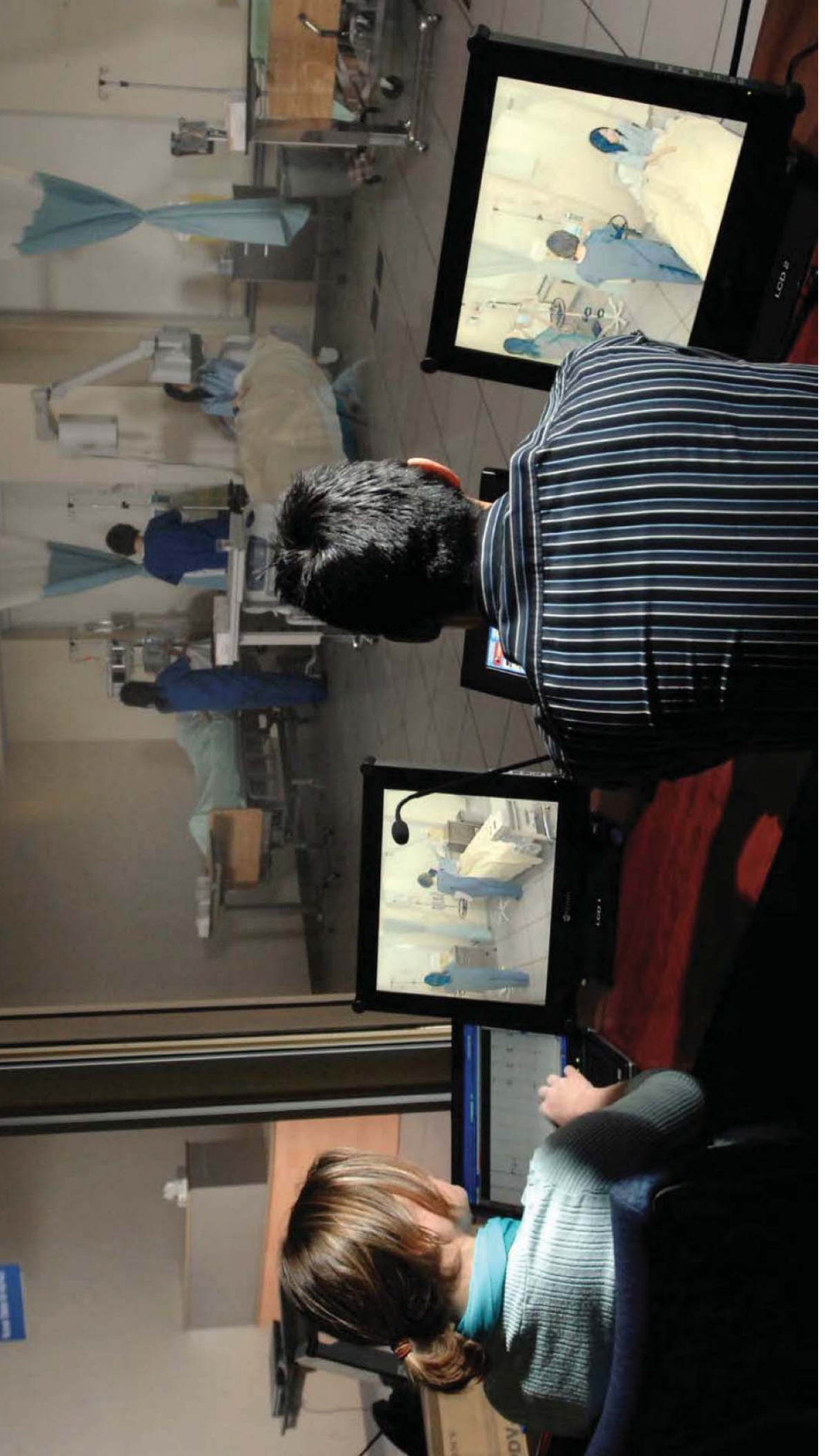


**PATRICK WARR**  
PhD Candidate



**QUYNH PHAM**  
PhD Candidate



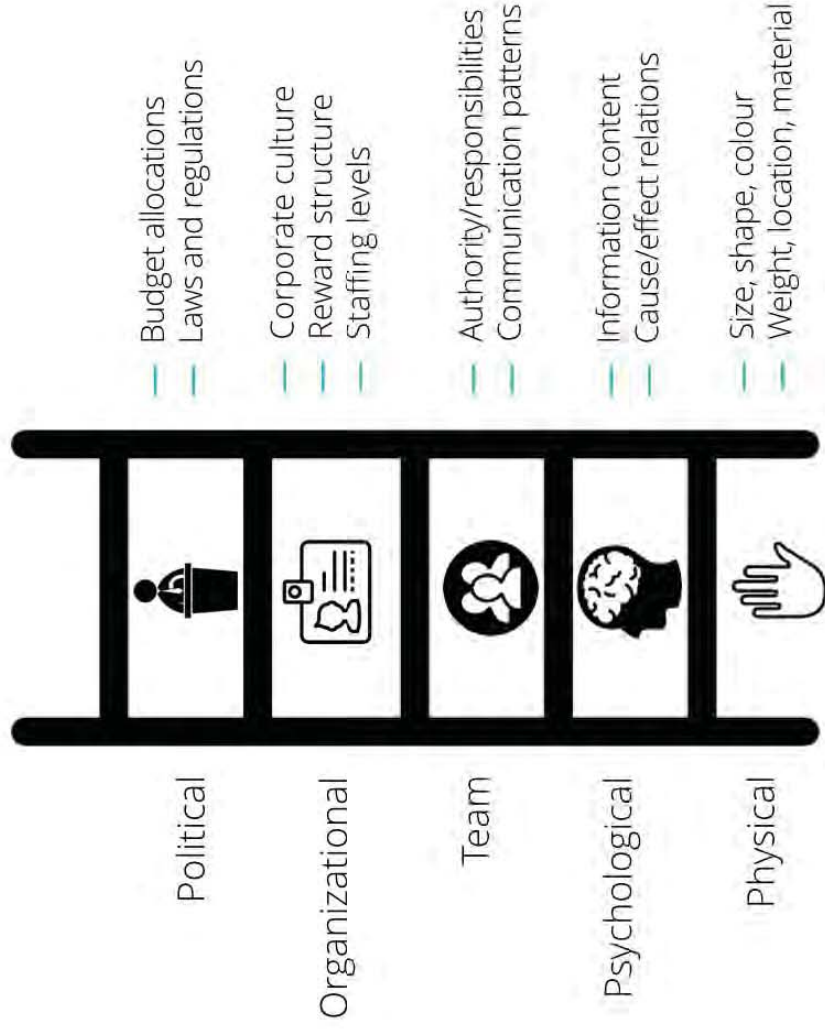






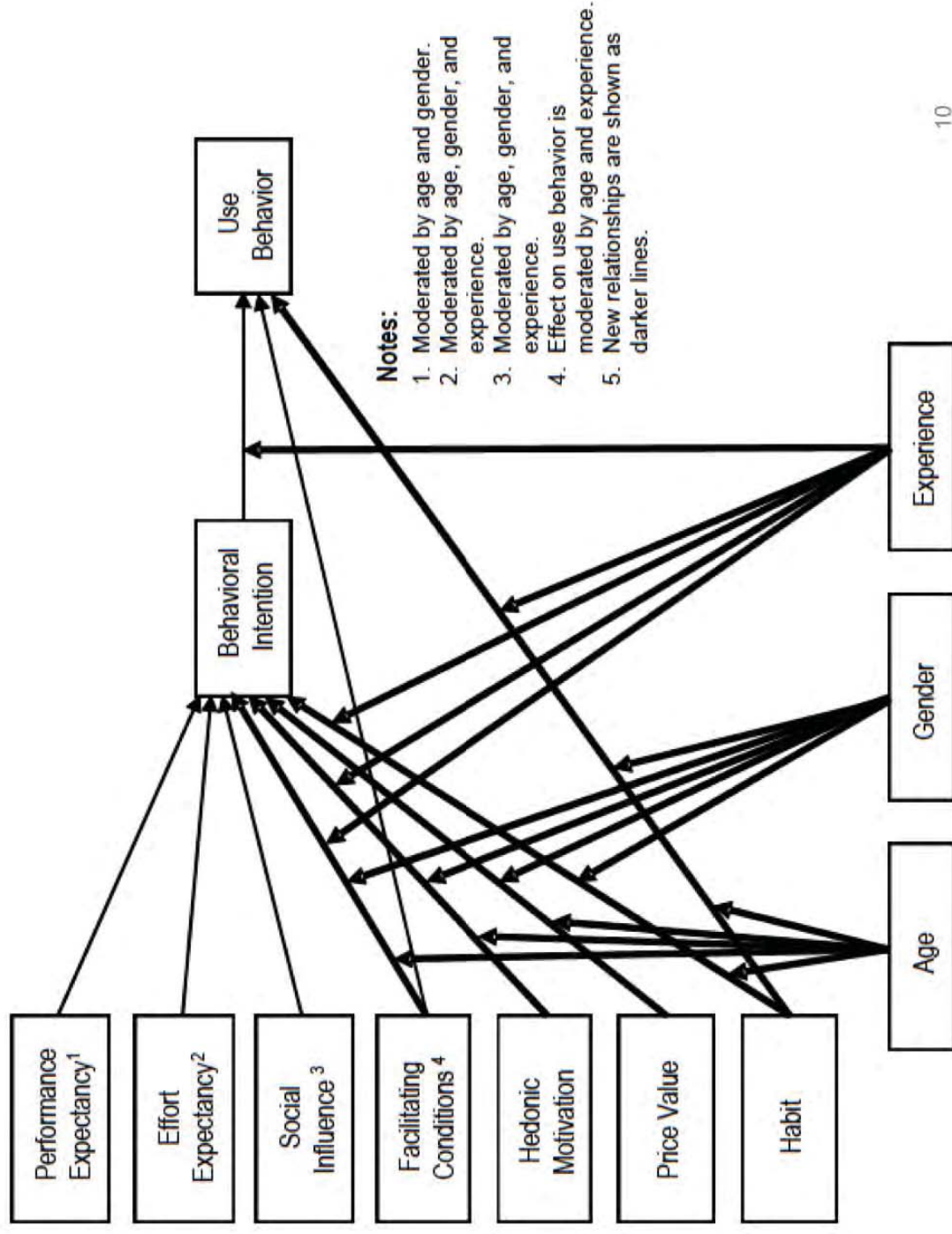
DISCOVER

## Human Tech Ladder



Vicente, K. (2004). The Human Factor: Revolutionizing the Way People Live with Technology. Random House of Canada

# Unified Theory of Use and Acceptance of Technology 2



EMPATHIZE 

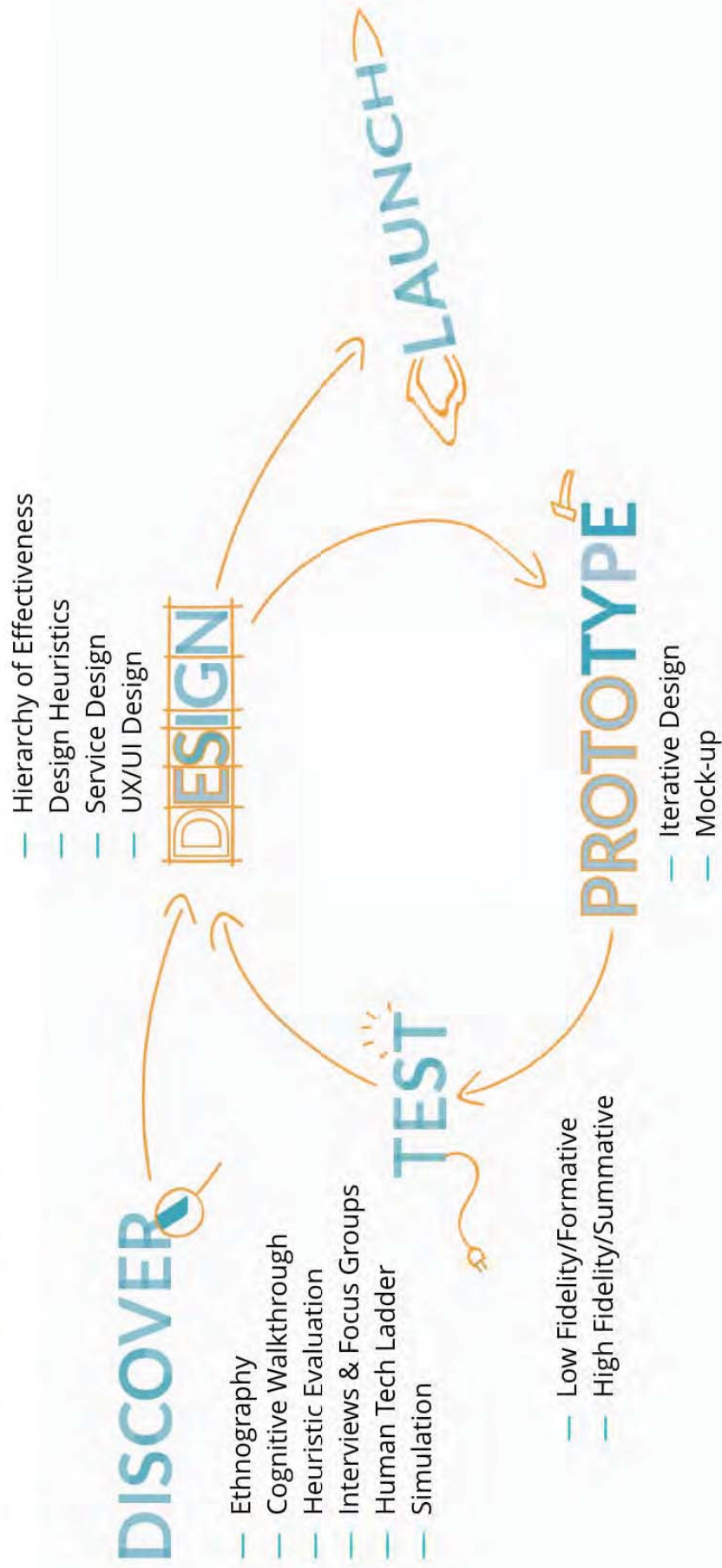
 PLAY

ITERATE 

TEST 

LAUNCH 

## Human Factors Design Process

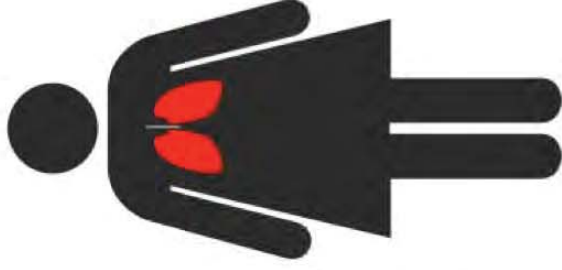
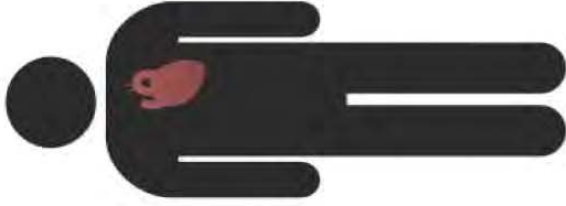
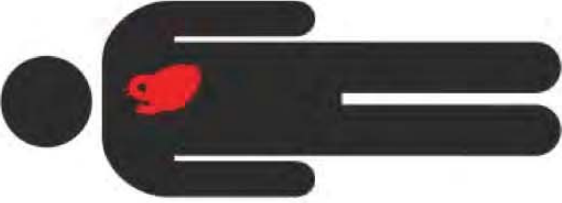
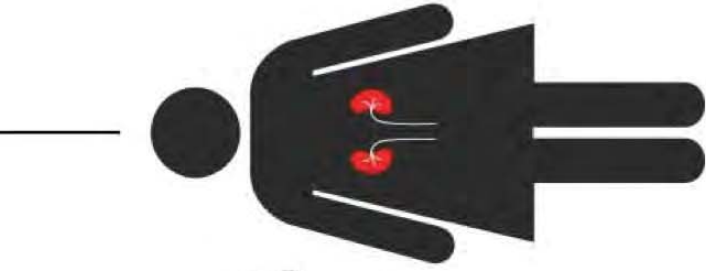
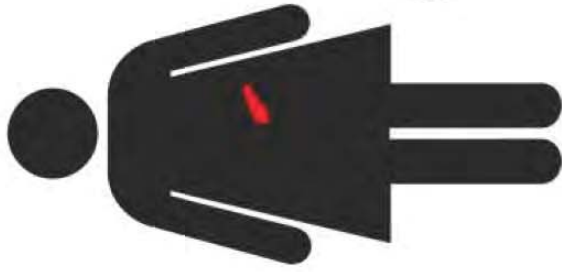


**DIABETES** | **HIGH BLOOD PRESSURE** | **HEART FAILURE** | **LUNG DISEASE**

**KIDNEY DISEASE**

**HEART FAILURE**

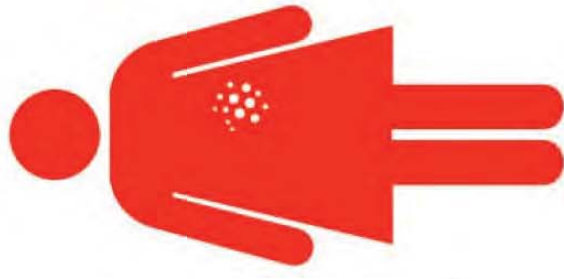
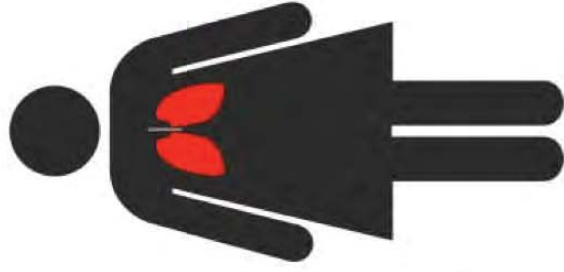
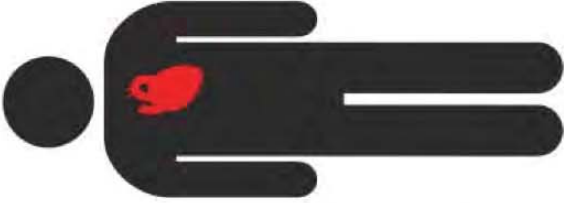
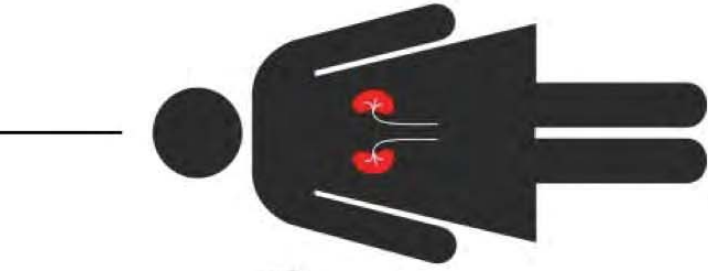
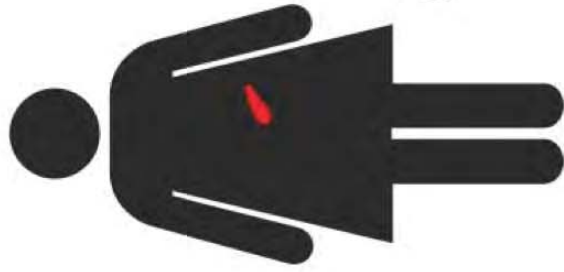
**MENTAL HEALTH**



**DIABETES** | **HIGH BLOOD PRESSURE** | **HEART FAILURE** | **LUNG DISEASE** | **CANCER**

**KIDNEY DISEASE**

**MENTAL HEALTH**

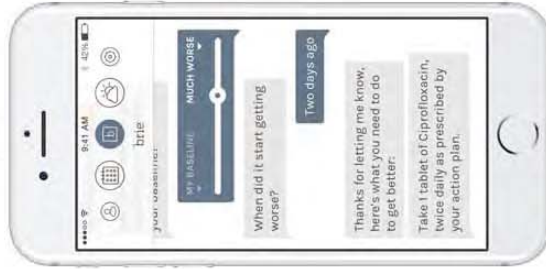


# DIGITAL THERAPEUTICS

**Ned**



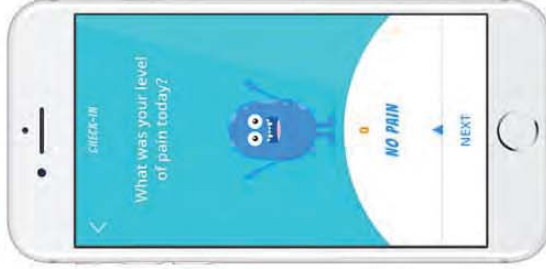
**breathe**  
for asthma & COPD



**medly**



**ICANCOPE**



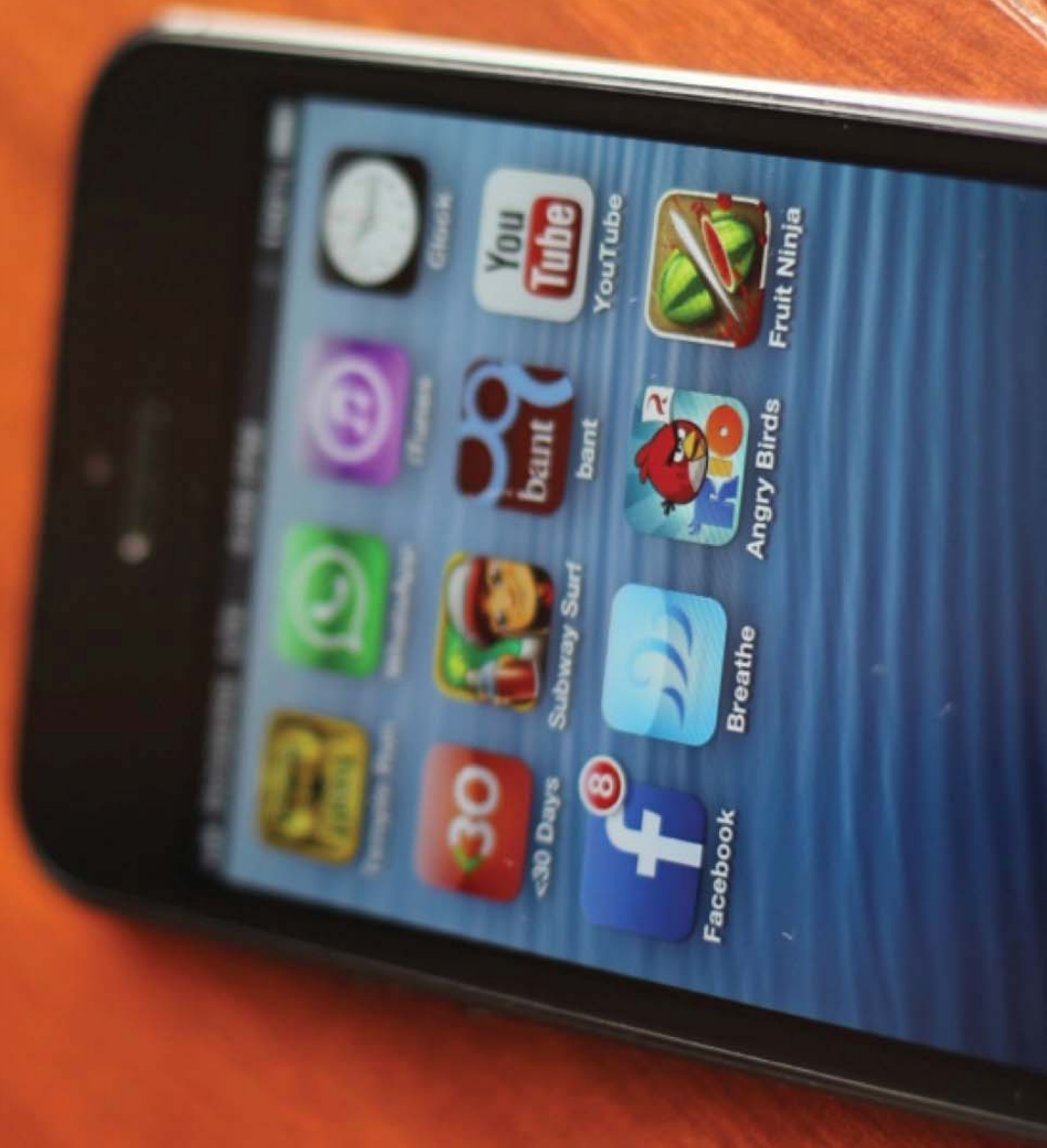
**bant**



# CELLPHONE and SMARTPHONE use - 2018

*% of U.S. adults who own the following devices*

	<b>Any cellphone</b>	<b>Smartphone</b>	<b>Cellphone, but not smartphone</b>
Total	95%	77%	17%
Men	95%	80%	16%
Women	94%	75%	19%
Ages 18-29	100%	94%	6%
30-49	98%	89%	9%
50-64	94%	73%	21%
65+	85%	46%	40%





# mHealth in 2018

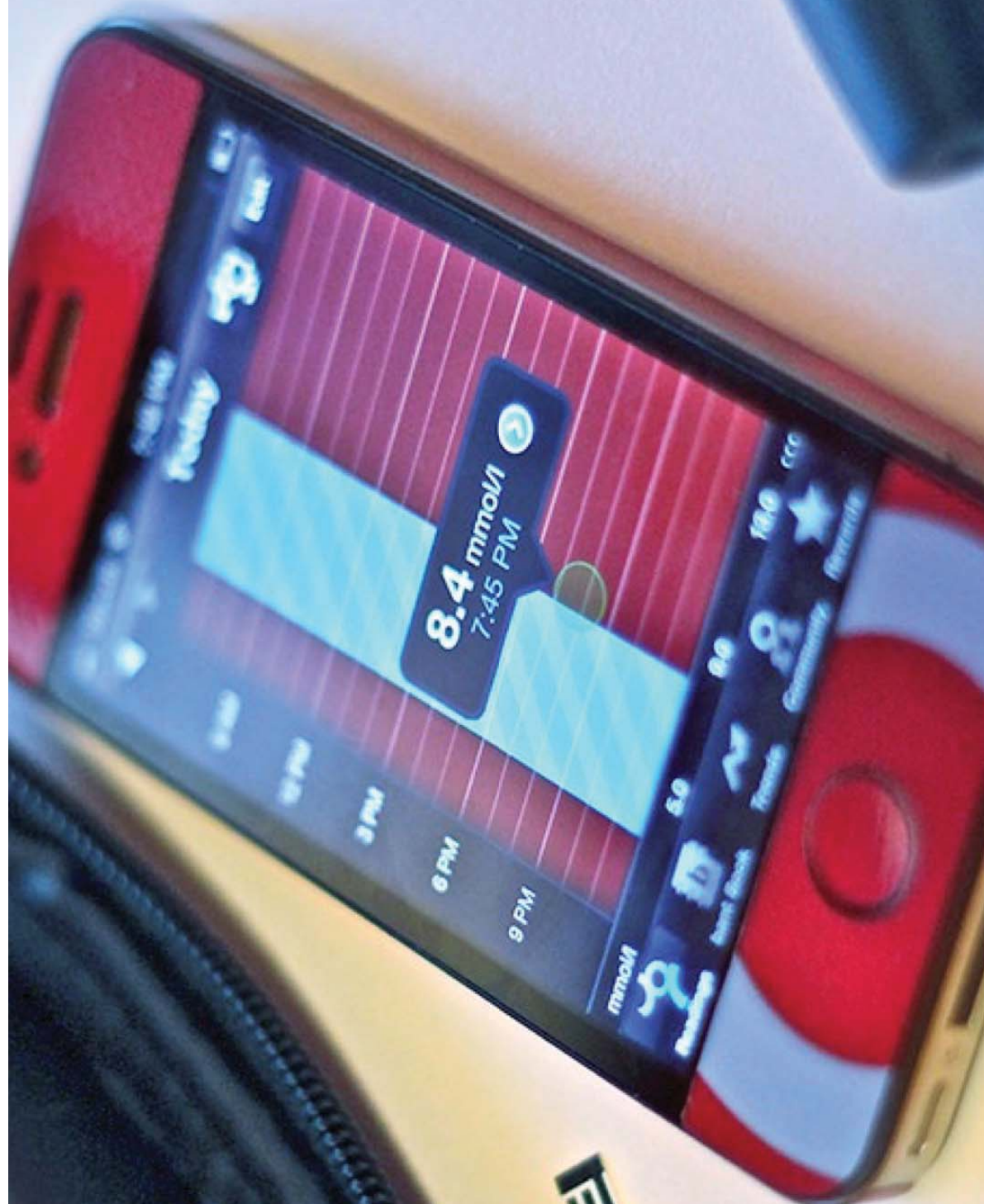
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**84,000 companies**

**325,000 mHealth apps**

**3,600,000,000 downloads**

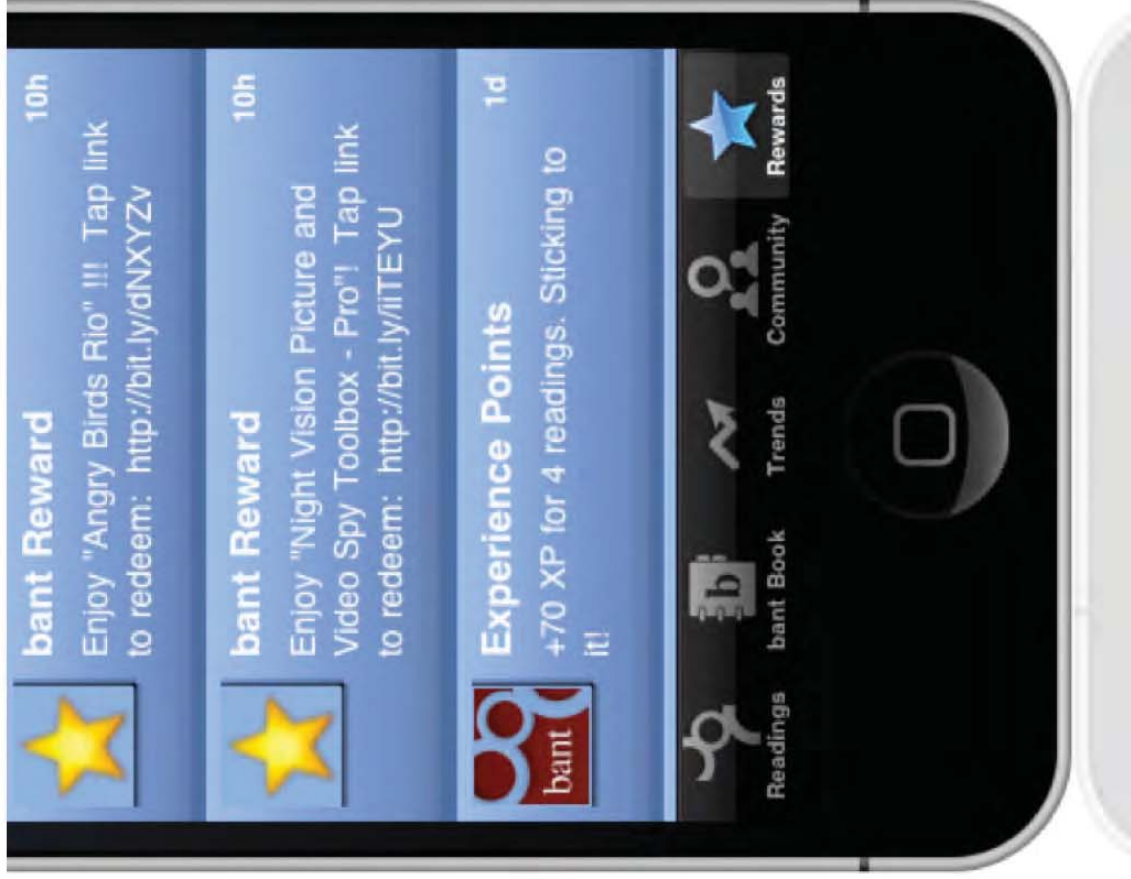




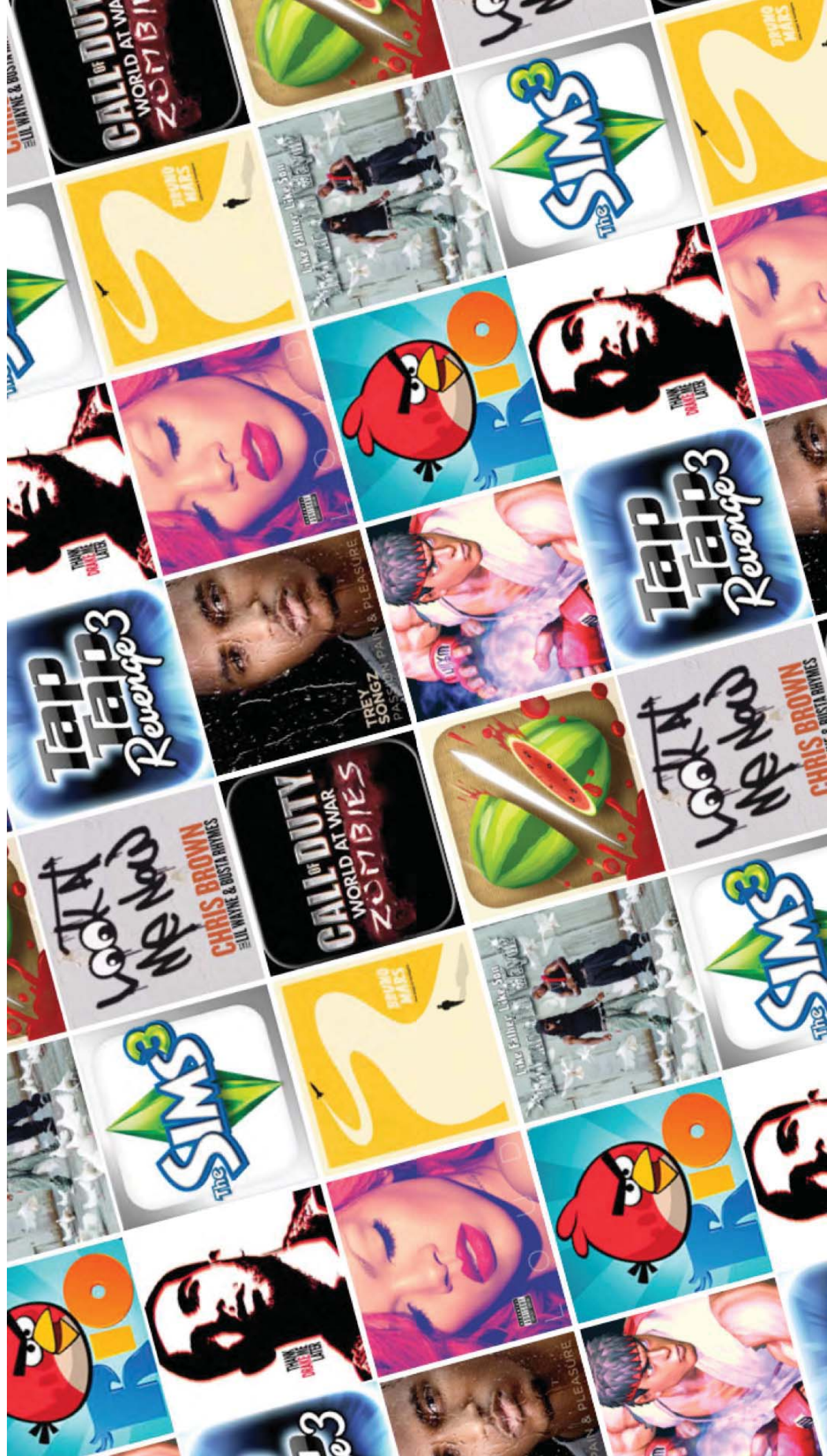
Optical Sensor  
Unit








# REWARDS



# Reward Messages

 **Experience Points** 2h  
 +100 XP for 4 readings. Sticking to it!

 **bant Reward** 10h  
 Enjoy "Angry Birds Rio" !!! Tap link to redeem: <http://bit.ly/dNXYZv>

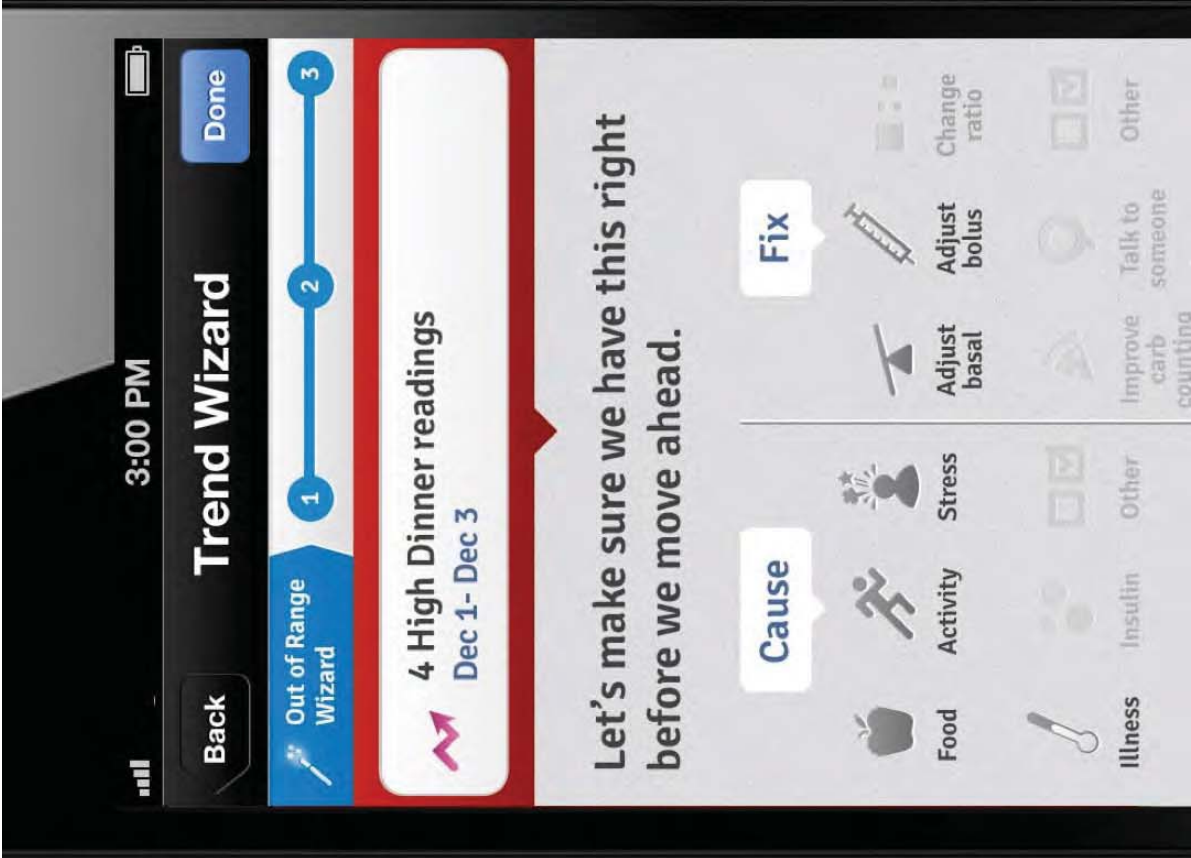
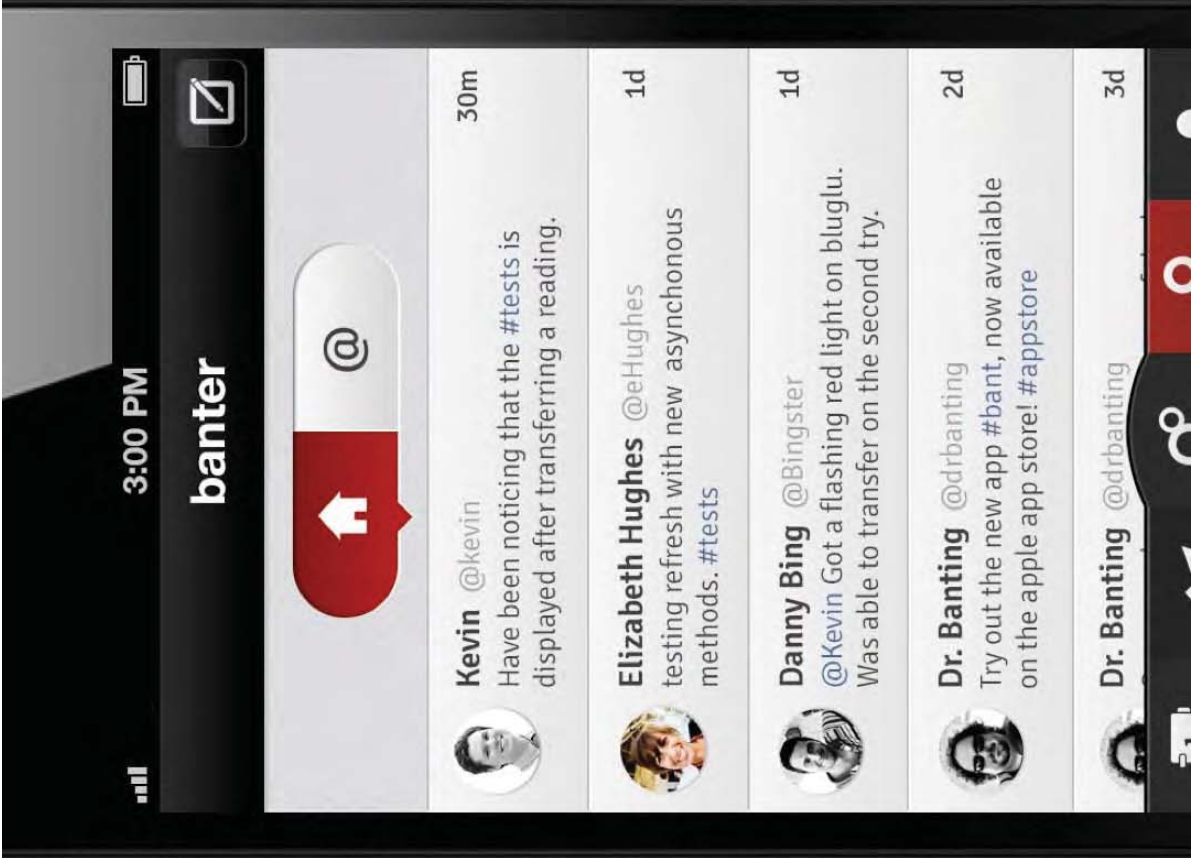
 **bant Reward** 10h  
 Enjoy "Night Vision Picture and Video Spy Toolbox - Pro"! Tap link to redeem: <http://bit.ly/iITEYU>

 **Experience Points** 1d  
 +70 XP for 4 readings. Sticking to it!

 **49.6%**

**DAILY TESTING FREQUENCY**





3:00 PM

banter



30m

...in  
...ticipating that the #tests is  
...er transferring a reading.

1d

...ughes @eHughes  
...h with new asynchronous  
...sts

1d

@Bingster  
...flashing red light on buglu.  
...ansfer on the second try.

2d

@drbanting  
...w app #bant, now available  
...app store! #appstore

3d

@drbanting



3:00 PM

# Trend Wizard

Back

Done



4 High Dinner readings  
Dec 1- Dec 3

Let's make sure we have this right before we move ahead.

## Cause



Food



Activity



Stress

## Fix



Adjust basal



Adjust bolus



Change ratio



Illness



Insulin



Other



Talk to someone



Improve carb counting

3:00

Rogers



ElizabethHughes

Rewards

My po

Today

This week

All ti



#1

C. Best



#2

ElizabethH



#3

McCleod



#4

Dr. Banting



3:00 PM

# Trend Wizard

Done

Range 1 2 3

High Dinner readings  
Dec 1- Dec 3

make sure we have this right  
we move ahead.

Cause

- Activity
- Stress
- Insulin
- Other

Fix

- Adjust basal
- Adjust bolus
- Change ratio
- Other
- Improve carb counting
- Talk to someone

3:00 PM

# Me

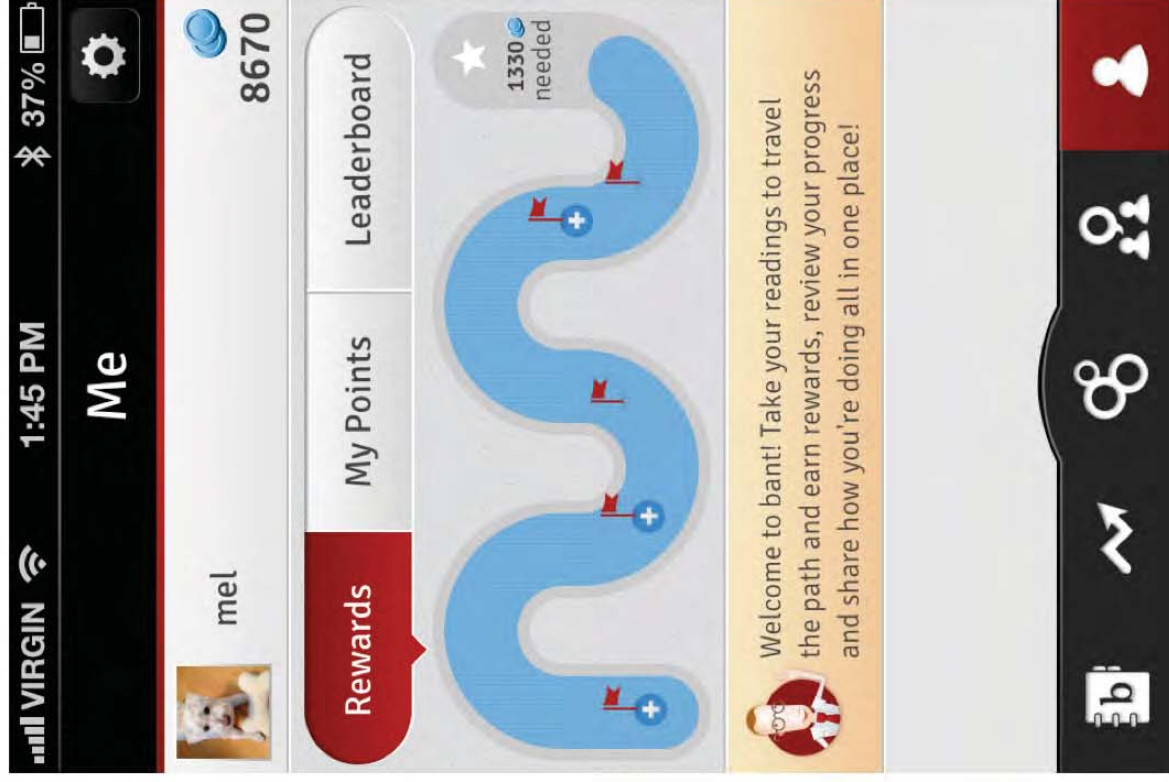
ElizabethHughes 4300

Rewards My points Leaderboard

Today This week All time You are #2 of 75

#1	C. Best	4380
#2	ElizabethHughes	4300
#3	McCleod	4190
#4	Dr. Banting	3200

Navigation icons: Home, Trend, Friends, Profile (1)



Original Paper

# A Mobile App for the Self-Management of Type 1 Diabetes Among Adolescents: A Randomized Controlled Trial

Shivani Goyal<sup>1,2\*</sup>, BEng, MSc, PhD; Caitlin A Nunn<sup>3\*</sup>, MSc; Michael Rotondi<sup>4</sup>, PhD; Amy B Couperthwaite<sup>4</sup>, MSc; Sally Reiser<sup>5</sup>, RD; Angelo Simone<sup>5</sup>, MD; Debra K Katzman<sup>6,7</sup>, MD, FRCP(C); Joseph A Cafazzo<sup>1,2,8</sup>, PhD, PEng; Mark R Palmert<sup>3,6,9</sup>, MD, PhD

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<sup>2</sup>Institute of Biomaterials and Biomedical Engineering, University of Toronto, Toronto, ON, Canada

<sup>3</sup>Division of Endocrinology, The Hospital for Sick Children, Toronto, ON, Canada

<sup>4</sup>School of Kinesiology & Health Science, York University, Toronto, ON, Canada

<sup>5</sup>Trillium Health Partners, Toronto, ON, Canada

<sup>6</sup>Research Institute, The Hospital for Sick Children, Toronto, ON, Canada

<sup>7</sup>Division of Adolescent Medicine, Department of Pediatrics, The Hospital for Sick Children, Toronto, ON, Canada

<sup>8</sup>Institute of Health Policy, Management and Evaluation, Dalla Lana School of Public Health, University of Toronto, Toronto, ON, Canada

<sup>9</sup>Departments of Paediatrics and Physiology, University of Toronto, Toronto, ON, Canada

\* these authors contributed equally

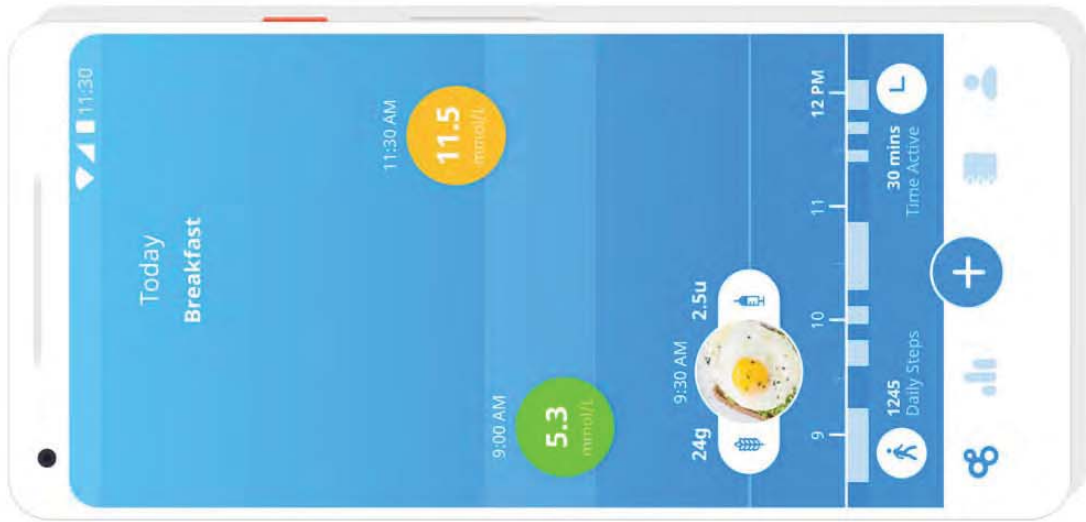


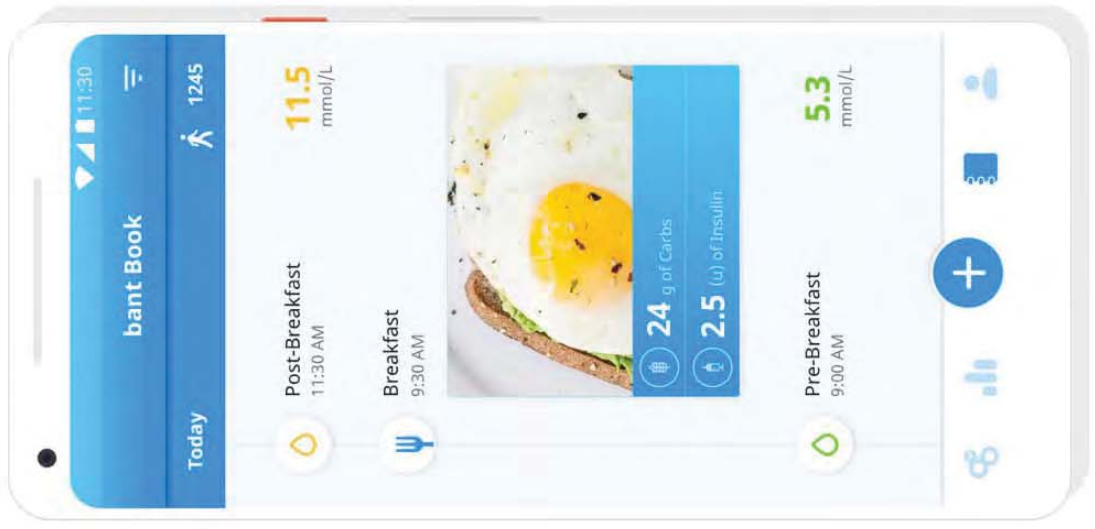
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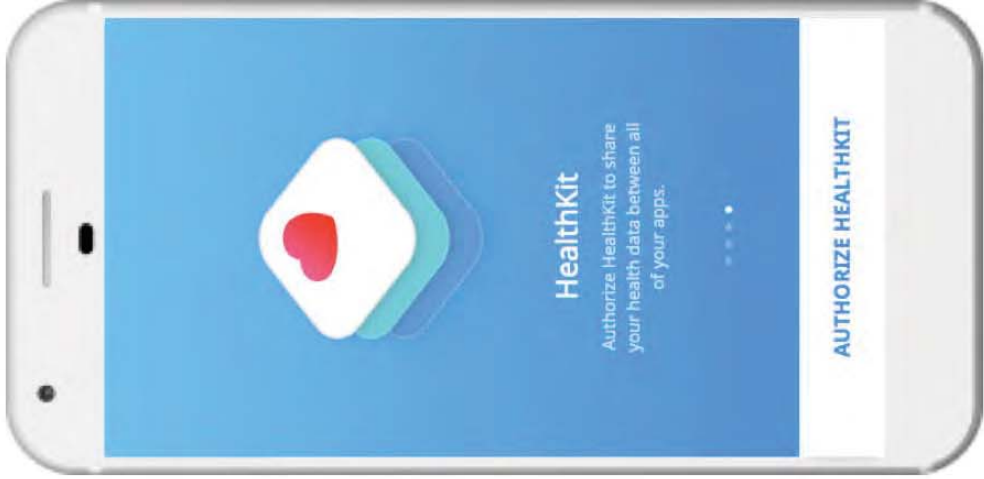
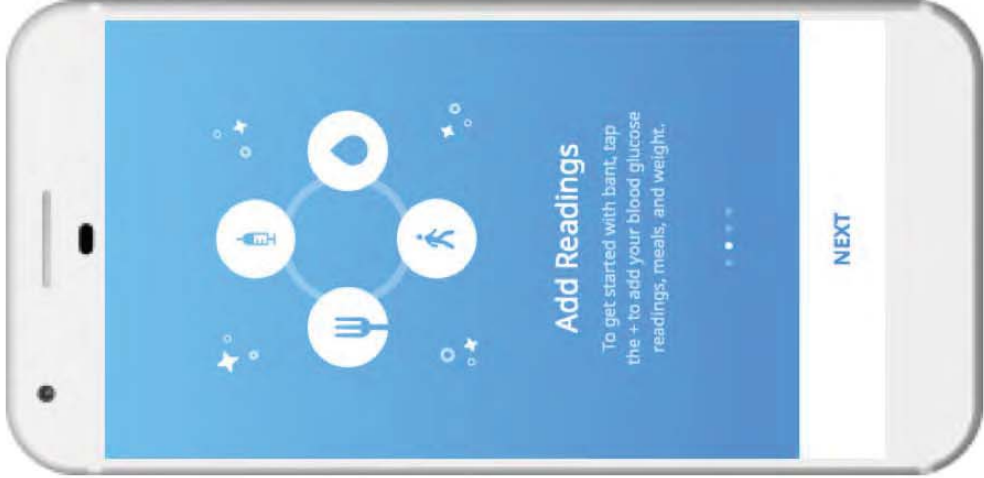
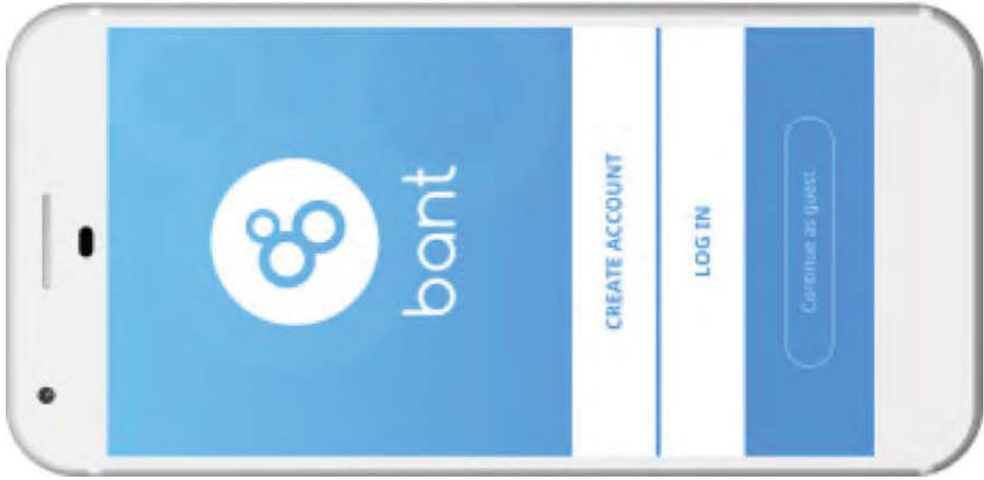
Simplifying Diabetes













**Lunch**

September 18th - 12:45PM

**24** g of Carbs

**2.5** (u) of Insulin

SAVE

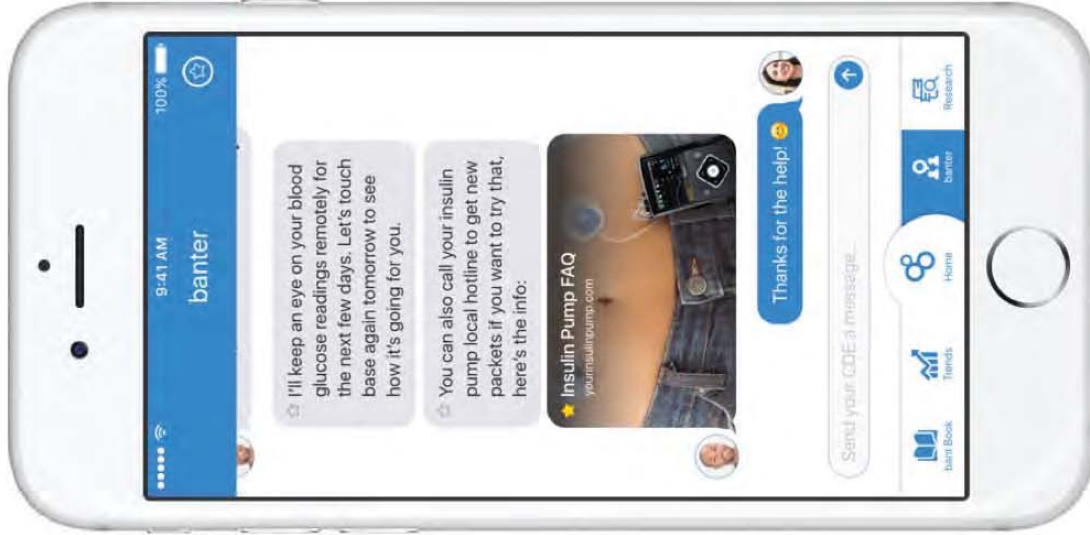
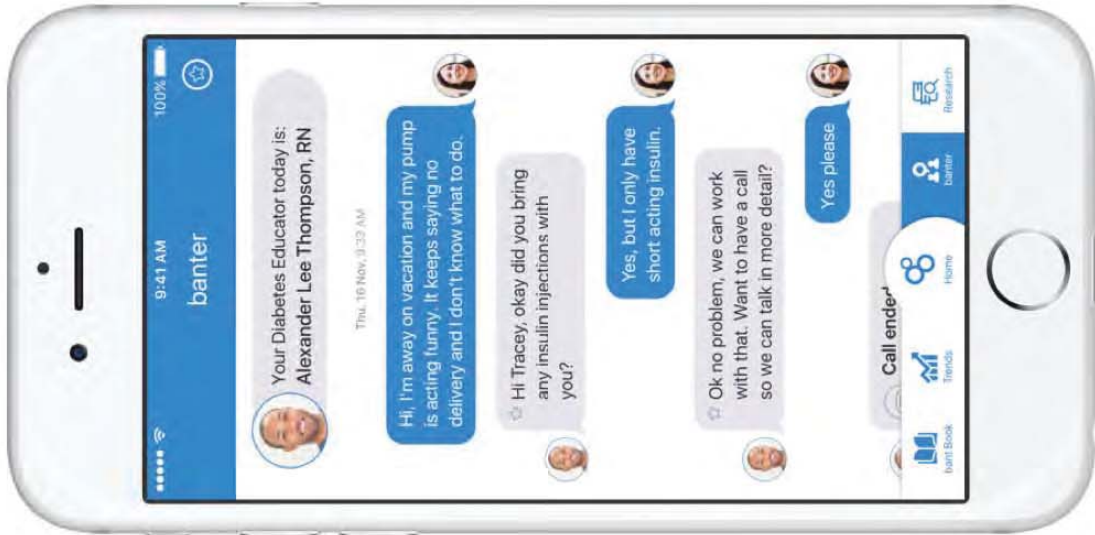
**Lunch**

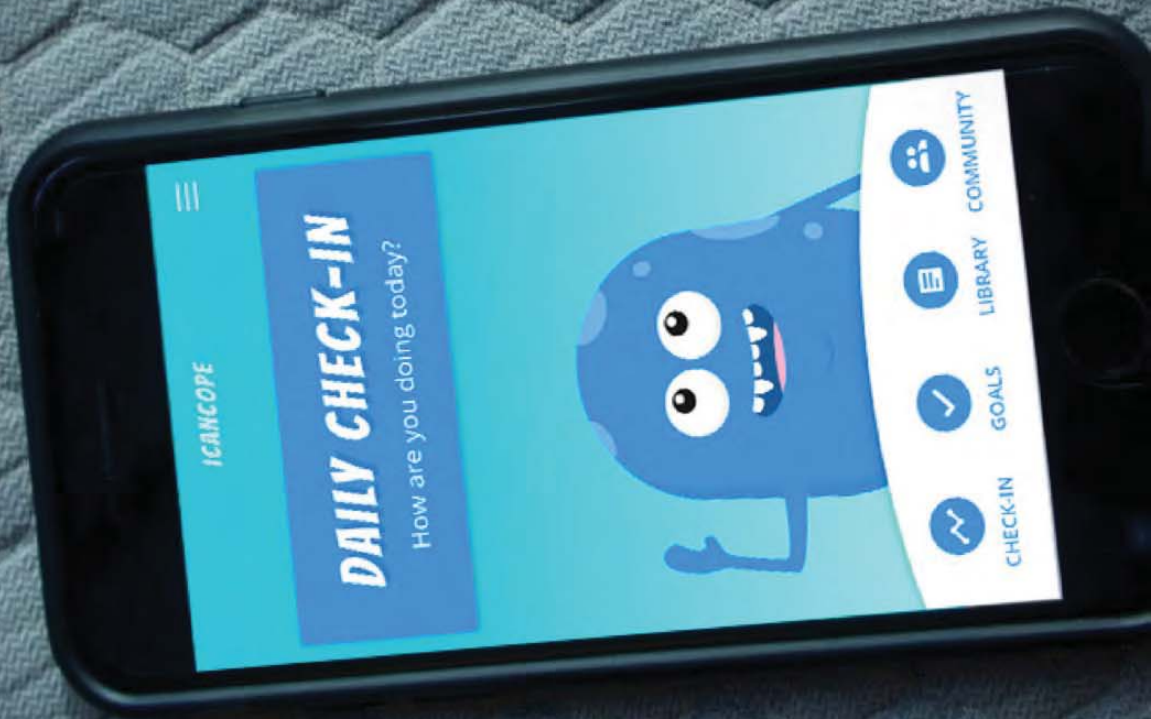
September 18th - 12:45PM

Carbs

Insulin

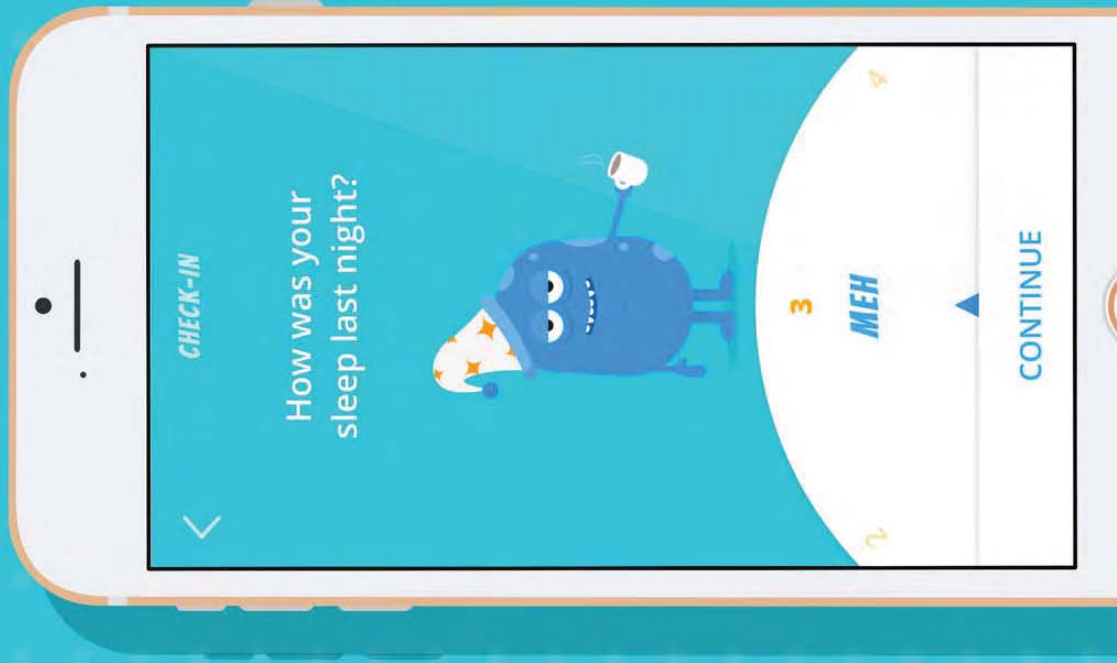
SAVE





# ICANCOPE

LIVING WELL DESPITE PAIN



# ICANSCOPE

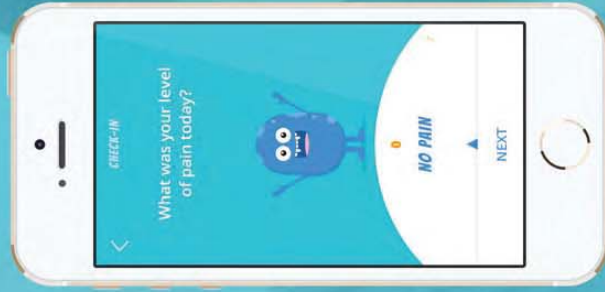
Living well, despite pain

# ***ICANCOPE***

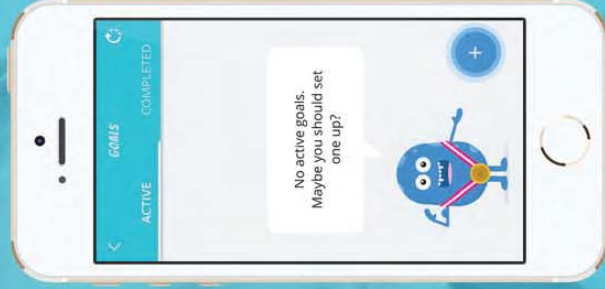
A Pain Management Platform for Kids



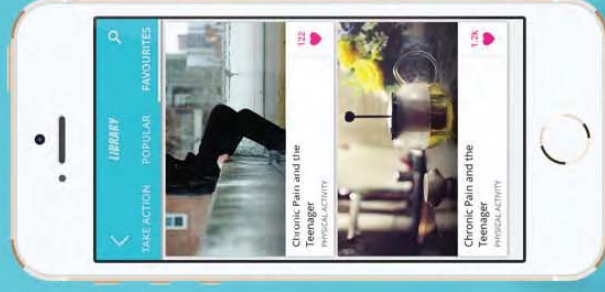
# ICANCOPE



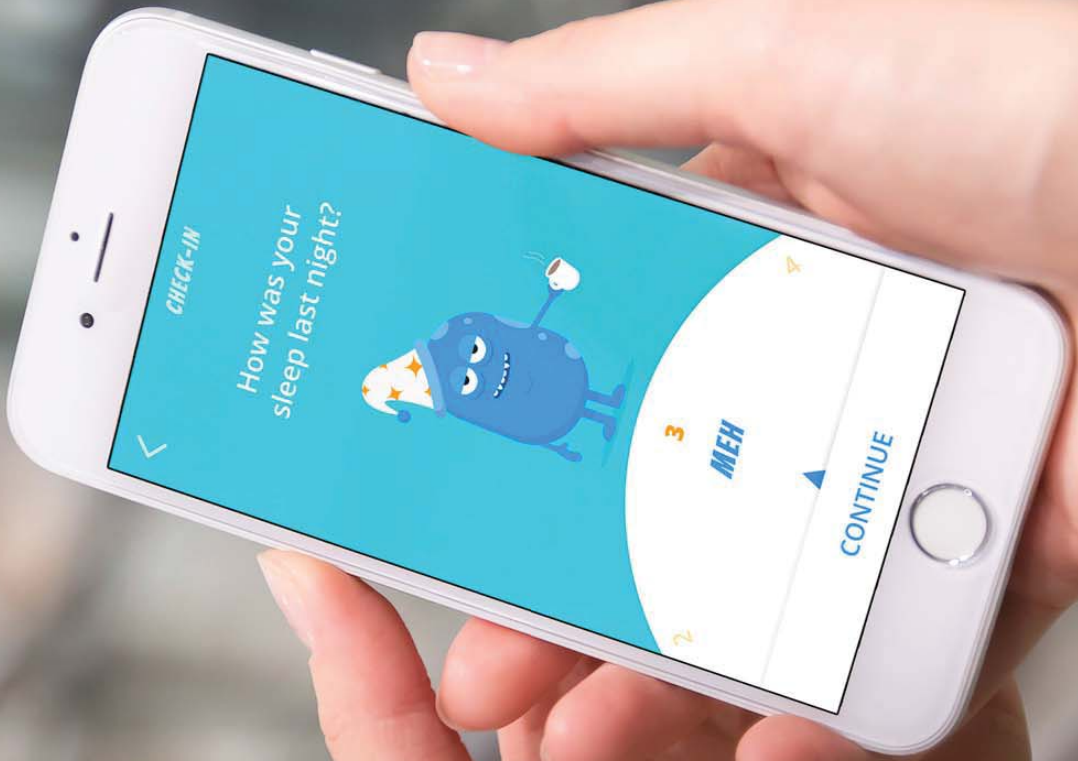
Daily Reminders



Goal Setting



Community Library

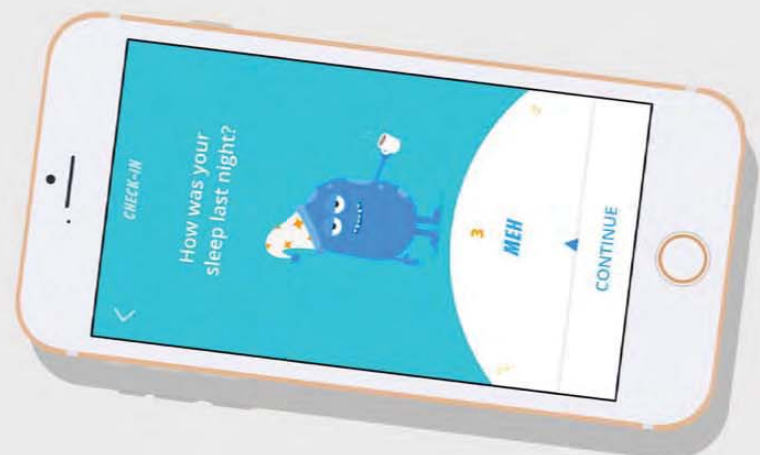
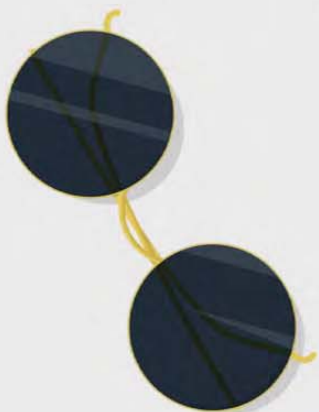


CHECK-IN

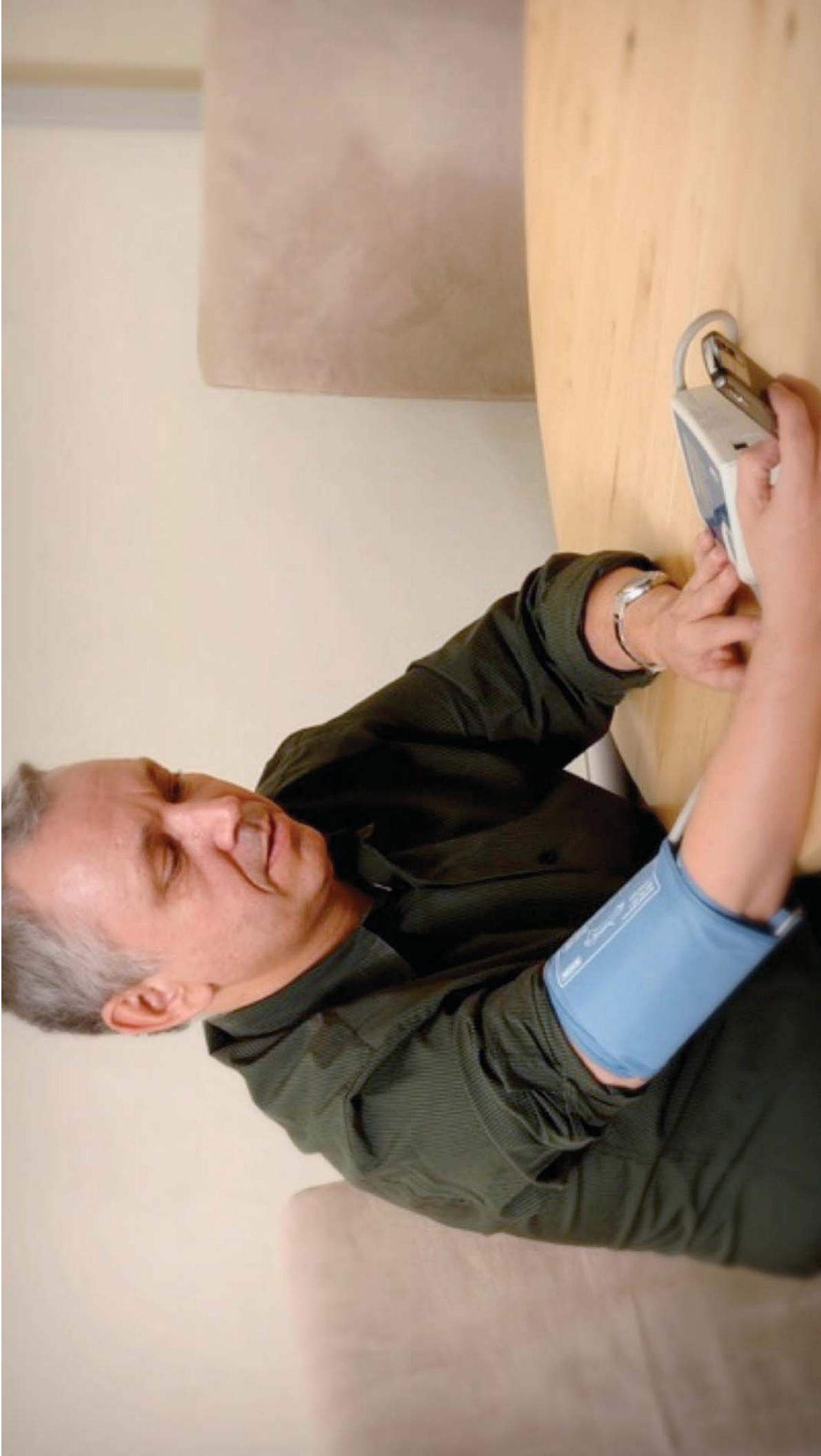
How was your sleep last night?



CONTINUE



Keep tabs on your pain, mood, sleep and other symptoms in one place!



# Mobile Phone-Based Remote Patient Monitoring System for Management of Hypertension in Diabetic Patients

Alexander G. Logan, Warren J. McIsaac, Andras Tisler, M. Jane Irvine, Allison Saunders, Andrea Dunai, Carlos A. Rizo, Denice S. Feig, Melinda Hamill, Mathieu Trudel, and Joseph A. Cafazzo

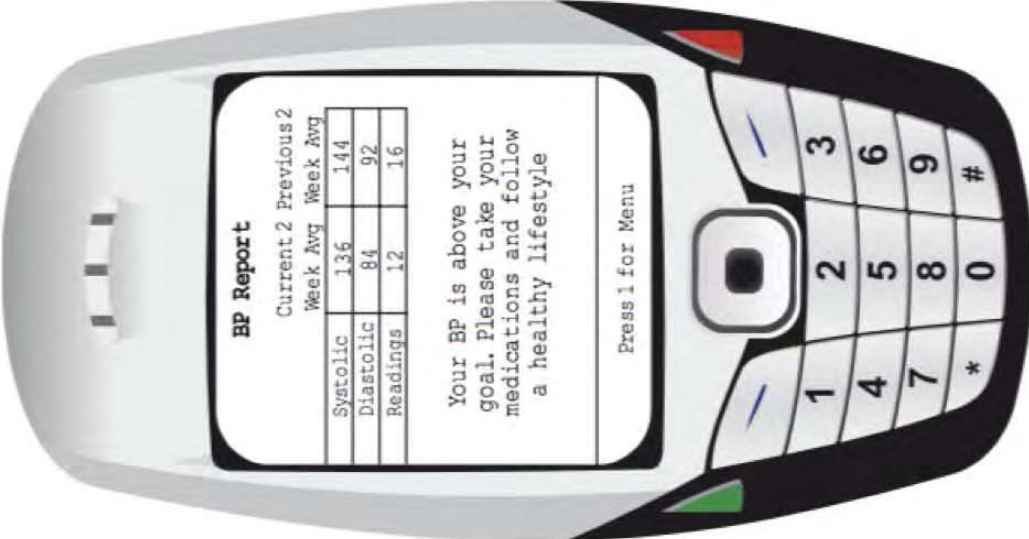
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**Background:** Rising concern over the poor level of blood-pressure (BP) control among hypertensive patients has prompted searches for novel ways of managing hypertension. The objectives of this study were to develop and pilot-test a home BP tele-management system that actively engages patients in the process of care.

**Methods:** Phase 1 involved a series of focus-group meetings with patients and primary care providers to guide the system's development. In Phase 2, 33 diabetic patients with uncontrolled ambulatory hypertension were enrolled in a 4-month pilot study, using a before-and-after design to

ports, and a BP alerting system. In the pilot study, 24-h ambulatory BP fell by 11/5 ( $\pm 13/7$  SD) mm Hg (both  $P < .001$ ), and BP control improved significantly. Substantially more home readings were received by the server than expected, based on the preset monitoring schedule. Of 42 BP alerts sent to patients, almost half ( $n = 20$ ) were due to low BP. Physicians received no critical BP alerts. Patients perceived the system as acceptable and effective.

**Conclusions:** The encouraging results of this study provide a strong rationale for a long-term, randomized, clinical trial to determine whether this home BP tele-man-



**BP Report**

Current 2 Previous 2

	Week Avg	Week Avg
Systolic	136	144
Diastolic	84	92
Readings	12	16

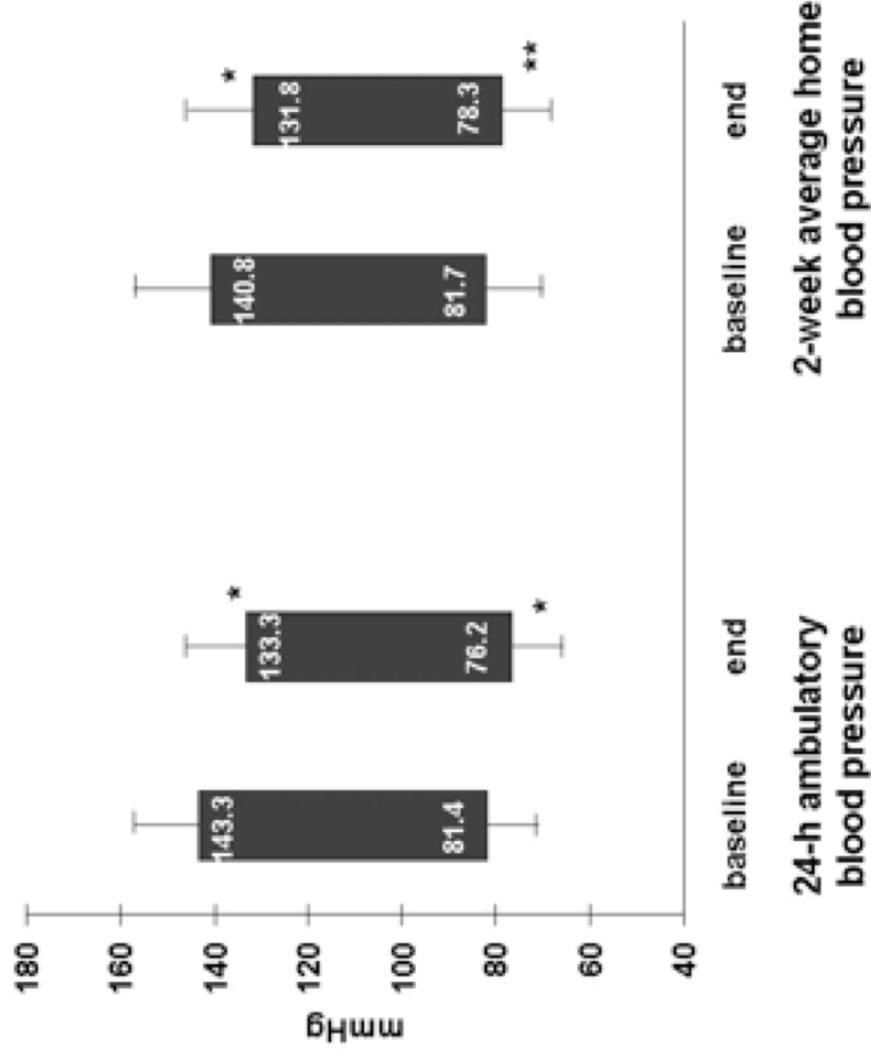
Your BP is above your goal. Please take your medications and follow a healthy lifestyle

Press 1 for Menu

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- \*
- 0
- #

# Pilot Results

## Diabetic Hypertension



American Journal of Hypertension, 20(9), pp. 942-948, 2007



# BLOOD PRESSURE TRANSMITTED AUTOMATICALLY TO BLACKBERRY

# Effect of Home Blood Pressure Telemonitoring With Self-Care Support on Uncontrolled Systolic Hypertension in Diabetics

Alexander G. Logan, M. Jane Irvine, Warren J. McIsaac, Andras Tisler, Peter G. Rossos, Anthony Easty, Denice S. Feig, Joseph A. Cafazzo

**Abstract**—Lowering blood pressure reduces cardiovascular risk, yet hypertension is poorly controlled in diabetic patients. In a pilot study we demonstrated that a home blood pressure telemonitoring system, which provided self-care messages on the smartphone of hypertensive diabetic patients immediately after each reading, improved blood pressure control. Messages were based on care paths defined by running averages of transmitted readings. The present study tests the system's effectiveness in a randomized, controlled trial in diabetic patients with uncontrolled systolic hypertension. Of 244 subjects screened for eligibility, 110 (45%) were randomly allocated to the intervention (n=55) or control (n=55) group, and 105 (95.5%) completed the 1-year outcome visit. In the intention-to-treat analysis, mean daytime ambulatory systolic blood pressure, the primary end point, decreased significantly only in the intervention group by  $9.1 \pm 15.6$  mmHg (SD;  $P < 0.0001$ ), and the mean between-group difference was  $7.1 \pm 2.3$  mmHg (SE;  $P < 0.005$ ). Furthermore, 51% of intervention subjects achieved the guideline recommended target of  $< 130/80$  mmHg compared with 31% of control subjects ( $P < 0.05$ ). These improvements were obtained without the use of more or different antihypertensive medications or additional clinic visits to physicians. Providing self-care support did not affect anxiety but worsened depression on the Hospital Anxiety and Depression Scale (baseline,  $4.1 \pm 3.76$ ; exit,  $5.2 \pm 4.30$ ;  $P = 0.014$ ). This study demonstrated that home blood pressure telemonitoring combined with automated self-care support reduced the blood pressure of diabetic patients with uncontrolled systolic hypertension and improved hypertension control. Home blood pressure monitoring alone had no effect on blood pressure. Promoting patient self-care may have negative psychological effects. (*Hypertension*. 2012;60:00.)

blood pressure ■ hypertension ■ diabetes mellitus ■ blood pressure ■ self-care ■ depression





**NO CHANGE**



**- 9.1 mmHg** systolic  
**- 4.6 mmHg** diastolic

**NO ADDITIONAL MEDS**  
**NO ADDITIONAL VISITS**

**SELF AWARENESS**  
**MED ADHERENCE**

Original Paper

# Mobile Phone-Based Telemonitoring for Heart Failure Management: A Randomized Controlled Trial

Emily Seto<sup>1,2</sup>, PhD, PEng; Kevin J Leonard<sup>1,2</sup>, PhD, MBA; Joseph A Cafazzo<sup>1,2,3</sup>, PhD, PEng; Jan Bamsley<sup>2</sup>, PhD; Caterina Masino<sup>1</sup>, MA; Heather J Ross<sup>4,5</sup>, MD, MSc, FRCPC

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