

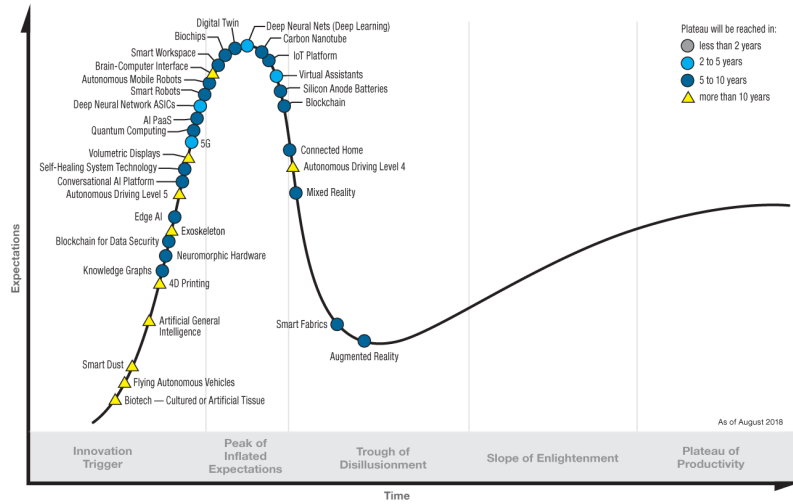
**PERIOPERATIVE DIGITAL HEALTH:
HOW SMARTPHONES, WEARABLES &
CONNECTED DEVICES CAN TRANSFORM CARE
FOR THE SURGICAL PATIENT**

JOHN F. PEARSON, MD
Assistant Professor of Anesthesiology
Department of Anesthesiology
University of Utah School of Medicine
Salt Lake City, UT

DISCLOSURES

Principal of SPRYTHM, LLC, digital health startup

Hype Cycle for Emerging Technologies, 2018



gartner.com/SmarterWithGartner

Source: Gartner (August 2018)
© 2018 Gartner, Inc. and/or its affiliates. All rights reserved.

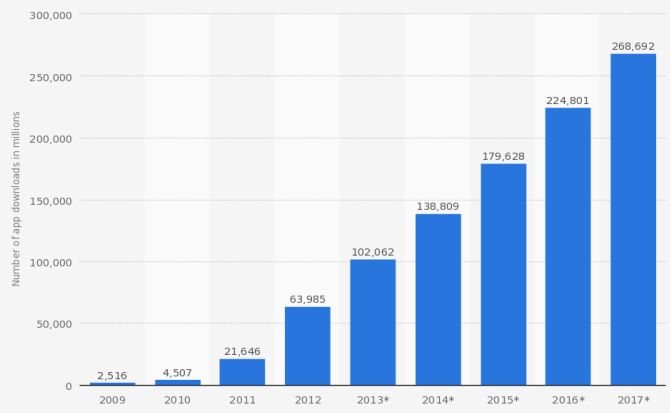


IEEE SPECTRUM
FOR THE TECHNOLOGY INDUSTRY

Your Smartphone Will See You Now
Digital psychiatry apps that collect and monitor data can spot when something's wrong—and then help you get back on track.

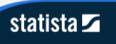
SEASON VALLERT'S PHISHING...
A BETTER...
HOW FRANKS HELPED...
THE BOLD-EDGE...

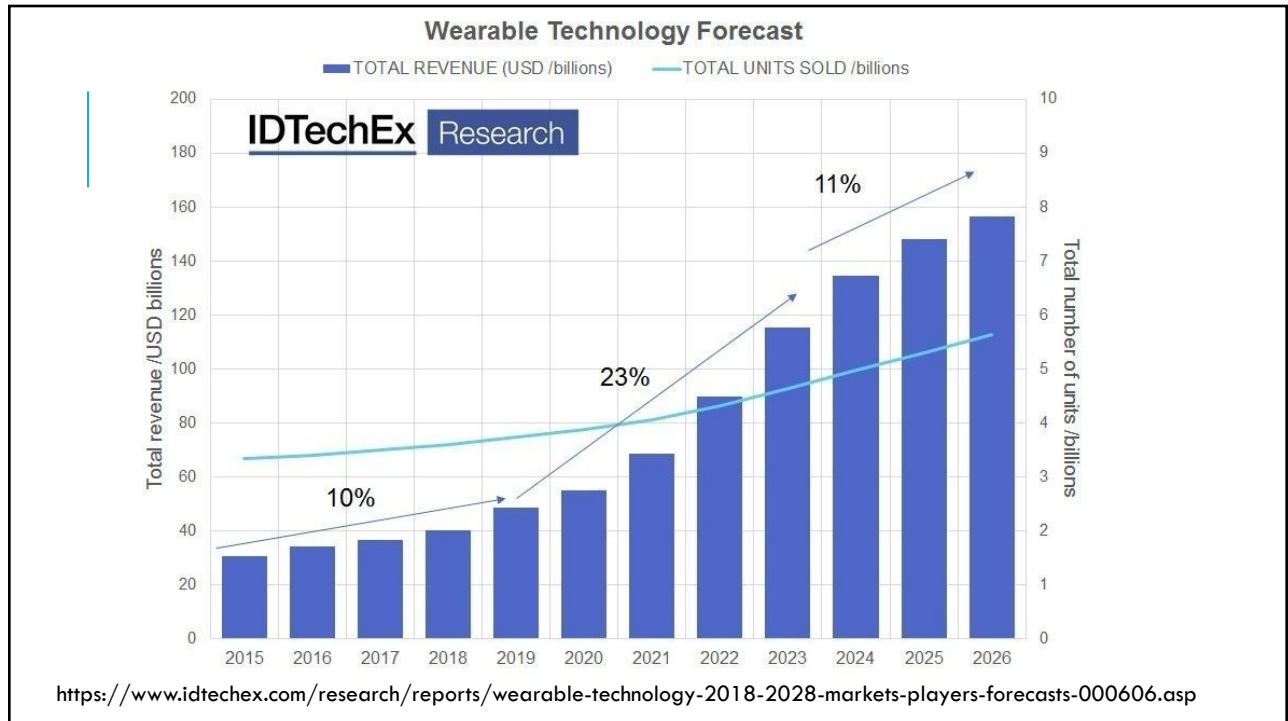
Number of mobile app downloads worldwide from 2009 to 2017 (in millions)




Source: Gartner
© Statista 2015


Additional Information
Worldwide: Gartner, 2009 to 2013







Contents lists available at ScienceDirect
International Journal of Medical Informatics
journal homepage: www.elsevier.com/locate/ijmedinf



Mobile device ownership among emergency department patients

Eugene Kim*, John Torous, Steven Horng, Anne V. Grossestreuer, Jorge Rodriguez, Terrance Lee, Larry A. Nathanson

Beth Israel Deaconess Medical Center, 330 Brookline Avenue, Boston, MA, 02215, USA

<https://doi.org/10.1016/j.ijmedinf.2019.03.020>

Table 2
Mobile Device Ownership Among Emergency Department Patients.

Device (n = 248)	No. (%)
Cell phone	238 (96)
Smartphone	226 (91)
Android	65 (26)
iPhone	158 (64)
Other	3 (1)
Tablet	144 (58)
Android	21 (9)
iPad	100 (40)
Kindle	7 (3)
Microsoft	9 (4)
Other	7 (3)
Wearable device	58 (23)
Apple Watch	18 (7)
Fitbit	32 (13)
Other	8 (3)

In general, what is your comfort level using a smartphone or tablet:

During a hospital visit I would be interested in using an app to:

- Enter medical information
- Enter non-medical information
- Track progress of visit
- View test results
- Communicate with providers

After a hospital visit I would be interested in using an app to:

- See instructions from doctor
- View a summary of the visit
- Receive reminders for medications
- Receive reminder for appointments

For general, every day use I would be interested in using an app to:

- Learn more about medical conditions
- Manage medications
- Play health-related games
- Manage mental health

I feel that health-related apps:

- Protect my privacy
- Are hard to use
- Are safe and effective
- Are costless

IN PHONES WE TRUST?

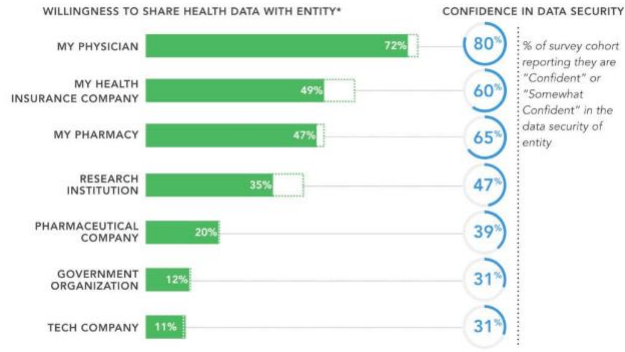
LEGITIMATE CONCERNS AROUND PRIVACY & TECH

TECH COMPANIES RANK NEAR BOTTOM FOR TRUST

PHYSICIANS RANKS HIGHEST

CONSUMER SENTIMENT ON DATA SHARING AND SECURITY

By entity, 2017-2018



Note: **"Health data" includes medical records, genetic information, and physical activity data. Dashed lines show 2017 responses. Source: Rock Health Digital Health Consumer Adoption Survey (n₂₀₁₈ = 4,000; n₂₀₁₇ = 3,997; n₂₀₁₈ = 4,015; n₂₀₁₇ = 4,017)

Use of Short Message Service and Smartphone Applications in the Management of Surgical Patients: A Systematic Review

406 TELEMEDICINE and e-HEALTH © MARY ANN LIEBERT, INC. • VOL. 24, NO. 6 • JUNE 2018

Table 3. Patient Satisfaction Scores with the Intervention

STUDY	MESSAGE PURPOSE	PARTICIPANT SATISFACTION SCORES
Carrier et al. ²⁰	Monitoring	Median score of 5 (scale 1–5)
Debono et al. ²³	Monitoring/Adherence	Mean score of 3.5 (scale 1–4)
Martinez-Ramos et al. ¹⁷	Monitoring	Mean score of 8.9 (scale 1–10)
Semple et al. ²⁹	Monitoring	Patient satisfaction was 3.9 for breast reconstruction surgery and 3.7 for orthopedic surgery (scale 1–4)

Table 2. Message Type Sent to the Patient and Conclusion for Each Study Evaluated

STUDY	MESSAGE TYPE	RESULTS
Debono et al. ²³	Application	31.7% patients generated an alert. 62.1% of alerts were triggered on day 1 and only 10.3% after day 3. 72.4% of the alerts were due to pain. Healthcare team response resulted in decreased in-person visits.
DeVito Dabbs et al. ²⁴	Application	Estimated odds of reporting critical care symptoms of application group were 8.9 times that of control and showed slightly higher adherence to the prescribed regimen (OR 1.64, 95% CI [1.01, 2.66]).
Jiang et al. ²⁶	Application	55% of patients generated an alert for surpassing threshold symptom values for temperature, blood pressure, or pulse rate.
Semple et al. ²⁹	Application	Two potential surgical complications were detected for breast reconstruction, and one orthopedic patient was identified with increased erythema.
Cleland et al. ³⁰	Automated phone calls	Intervention group experienced a greater reduction in symptom threshold events (19% vs. 8%). Clinicians responded to 84% of alerts within 24 h.
Mundi et al. ¹³	Application + SMS	The average patient BMI decreased from 46.3 to 45.1 (p < 0.001). 33.3% of participants in the study versus 22.4% of patients not in the study pursued surgery. Approximately 70% of educational modules were completed by subjects. 33.3% of patients did not complete the study.
Martinez-Ramos et al. ¹⁷	Phone, photos sent through email	31.3% of patients reported problems with surgical wound during postoperative period. 66.7% of reports were for hematoma and 23.3% for blood stains on bandage. Reported that 16 patients would have returned to the hospital without photos prompting healthcare team intervention.
Carrier et al. ²⁰	SMS	90% of patients answered all SMS sent. There were 48 alerts generated (56% due to pain and 40% due to no SMS response). Alerts led to in-hospital care for 4% of patients, including three rehospitalizations and two unplanned reoperations. Overall, the intervention led to earlier detection of postoperative complications.
Chen et al. ²¹	SMS	88% response rate to all SMS. Zero patients contacted due to high pain scores. Concluded that SMS can be a useful tool in following outcomes in children post-tonsillectomy.
Chung et al. ²²	SMS	Significant difference in adherence rates to self-breast examination with SMS intervention (81% vs. 62% in intervention vs. control groups, respectively).
Lin et al. ¹⁸	SMS	47.2% increase in attendance for all follow-up appointments in SMS group over control.
Miloh et al. ⁸	SMS	Patients with tacrolimus levels above threshold decreased from 58.5% to 14.6% after 1 year. Acute, cellular rejection episodes decreased from 12 to 2 from the previous year. Patient dropout rate was 41% over the 1 year.
Odeny et al. ²⁰	SMS	No significant difference in early resumption of sexual activity, 28.3% SMS versus 25.2% control.
Rao et al. ¹⁶	SMS	Fewer clinic visits in first 30 (p = 0.0004) and 90 days (p = 0.017). Quicker drain removal in intervention versus control group (9.67 vs. 12.45 days, respectively, p = 0.013).
Sachse et al. ²⁸	SMS	95% found the text messages to be helpful and increased positive behavior. 42% said that the most important text was to apply plenty of sunscreen.

BMI, body mass index; CI, confidence interval; OR, odds ratio.

Provider Benefits

User Friendly

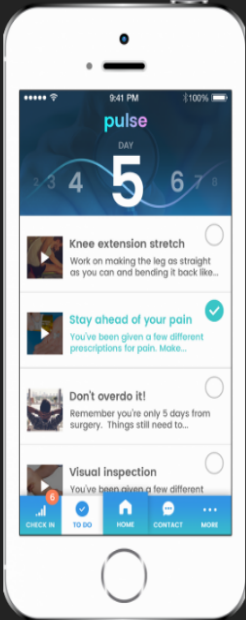
The Pulse Dashboard has been beautifully designed so provider teams can efficiently manage a large joint replacement patient population with an easy-to-use and easy-to-understand interface

Customizability

Providers have maximal flexibility and ease of developing care plans for their patients joint recovery

Risk Management

The ability to monitor patients and be alerted of potential issues before they become major complications



Patients Benefits

Trackability

Patients can easily track their joint recovery and monitor their recovery on a daily basis

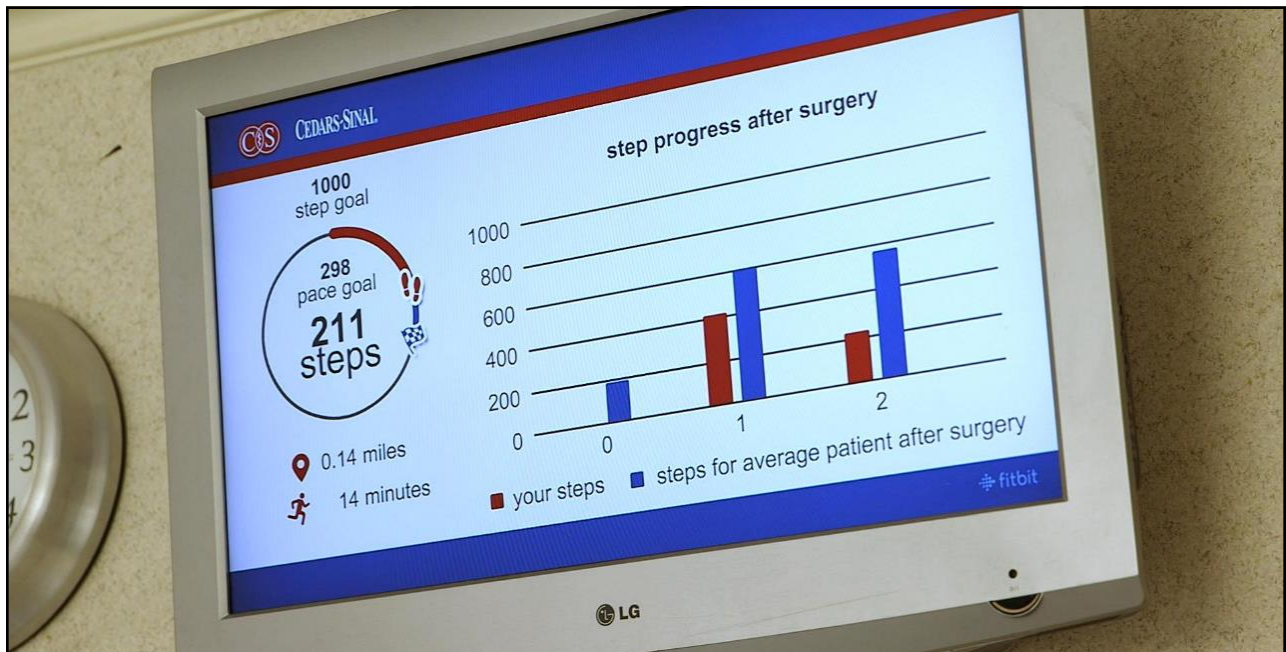
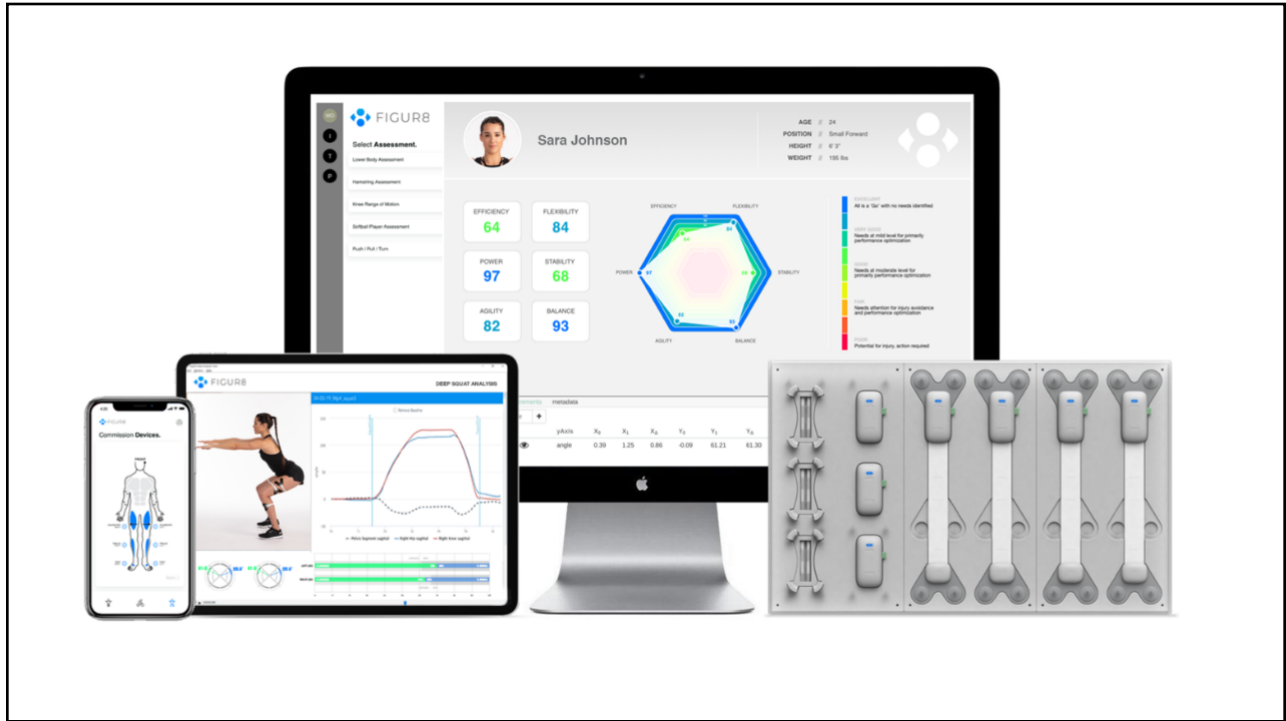
Direct Communication

Tools for patients and provider teams to facilitate communication so questions and answers can be conveyed rapidly and easily

Content Library

A dedicated library of original content to guide patients through their entire joint recovery process





<https://www.cnbc.com/2017/12/02/cedars-sinai-gives-out-fitbits-to-help-its-patients-get-home-sooner.html>

ann. behav. med. (2018) 52:88–92
DOI: 10.1093/abm/kax022

BRIEF REPORT

Fitbit step counts during inpatient recovery from cancer surgery as a predictor of readmission

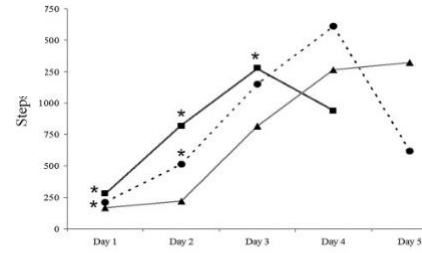
Carissa A. Low, PhD • Dana H. Bovbjerg, PhD • Steven Ahrendt, MD • M. Haroon Choudry, MD • Matthew Holtzman, MD • Heather L. Jones, PA-C • James F. Pingpank, Jr. MD • Lekshmi Ramalingam, MD • Herbert J. Zeh III, MD • Amer H. Zureikat, MD • David L. Bartlett, MD

NEW TECHNOLOGY

Functional Recovery in the Elderly After Major Surgery: Assessment of Mobility Recovery Using Wireless Technology

David J. Cook, MD, Jeffrey E. Thompson, MHA, Sharon K. Prinsen, RN, Joseph A. Dearani, MD, and Claude Deschamps, MD

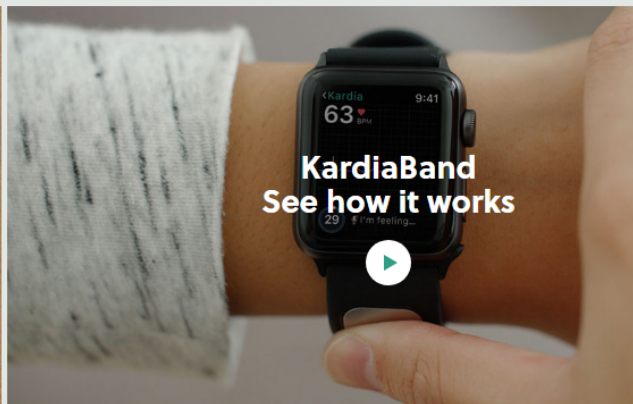
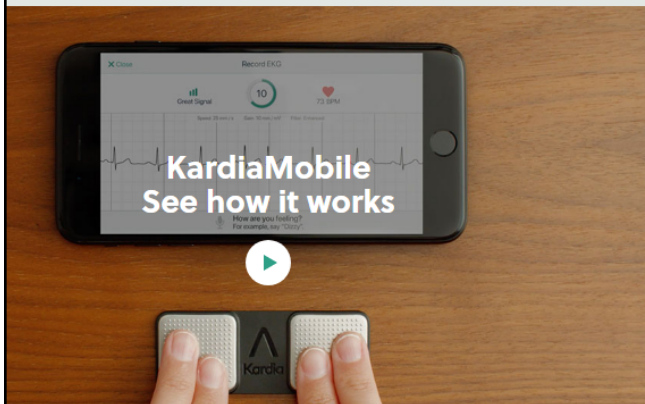
Departments of Anesthesiology, Nursing, and Surgery, Systems and Procedures, and Division of Cardiovascular Surgery, College of Medicine, Mayo Clinic, Rochester, Minnesota



Recovery Day		1	2	3	4	5
Short (n=64)	Median	284	818	1279	853	
	IQ Range	381	843	1241	947	
Intermediate (n=44)	Median	213	514	1151	1613	629
	IQ Range	298	886	1304	1549	629
Long (n=11)	Median	187	223	817	1287	1323
	IQ Range	248	624	1130	1419	1805

Take an EKG anytime, anywhere

Take a medical-grade EKG in just 30 seconds. Simply open the Kardia app on your smart phone, put your fingers on the electrodes and see results instantly.



Pacing Clin Electrophysiol. 2018 Mar 1. doi: 10.1111/pace.13317.

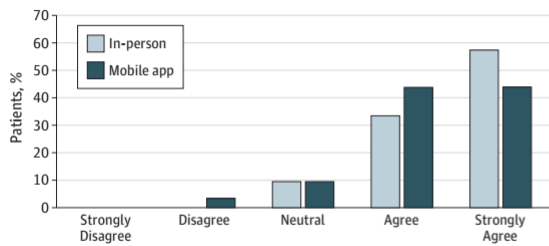
LOTS OF INTEREST.LOTS OF EVIDENCE?

419,297 people who had an Apple Watch
 0.5 percent — or 2,161 people — were notified that they might have atrial fibrillation
 945 people reported the notification to the researchers and had a visit with a telemedicine company, American Well.
 • Some told to go to ER, some excluded as had afib dx
 658 had a patch shipped to them that could perform an electrocardiogram, or EKG, and 450 patients actually used the EKG patch



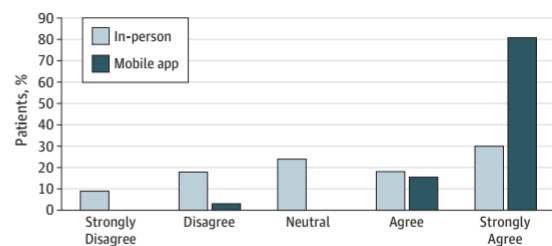
SURGICAL FOLLOW UP APPS

Figure 2. Satisfaction Scores Between Groups



Patients' responses to the question, "Were you satisfied with the type of follow-up care (mobile app or in-person) you received?"

Figure 3. Convenience Scores Between Groups



Patients' responses to the question, "Would you describe the type of follow-up care (mobile app or in-person) you received as convenient?"

WOUND CARE APPS



J Am Coll Surg. 2018 Mar;226(3):277-286. doi: 10.1016/j.jamcollsurg.2017.12.013. Epub 2018 Jan 19.

Invited Commentary

October 24, 2018

Smartphone Photographs—Proceed, but With Caution

F. Thurston Drake, MD, MPH¹

» Author Affiliations

JAMA Surg. 2019;154(2):125. doi:10.1001/jamasurg.2018.3862

In this study, the pitfalls take center stage. The study was designed to evaluate whether patient-generated photographs improve a surgeon's ability to remotely determine the likelihood of a wound complication. The answer appears to be no, but even more concerning, the use of photographs seemed to make surgeons more confident in their wrong answers. If a similar false confidence plays out in actual clinical decision making, delays in care may lead to progression of disease.

Figure 2. Association of Wound Photograph With Correct Diagnosis

Scenario	Still Incorrect	Diagnosis Changed With Addition of Wound Photograph	Still Correct
No SSI	30%	Changed from incorrect to correct: 14% Changed from correct to incorrect: 7%	49%
SSI Present	27%	Changed from incorrect to correct: 14% Changed from correct to incorrect: 23%	36%
No SSO	18%	Changed from incorrect to correct: 9% Changed from correct to incorrect: 13%	60%
SSO Present	12%	Changed from incorrect to correct: 6% Changed from correct to incorrect: 25%	57%

PATIENT TABLETS + SMARTPHONES IN THE HOSPITAL

[Washington Post – April 7, 2019](#)

[Health & Science](#)

For hospital patients, bedside tablets and apps are providing some control over care

Patient family members appreciate access

Can root out medical errors

Improve messaging with care team and hospital staff/facilities -> improved satisfaction

Only 20% of hospitals currently use



Shannon Olson and daughter Emilia check out the girl's medical chart on a tablet provided by Geisinger Janet Weis Children's Hospital. "It made it so much easier knowing that all of Emilia's updated chart information was available to me on the tablet," Olson said. (Marc Stempka)

PERIOP INCLUDES AT HOME...

Beyond mainstream devices like [Amazon's Echo](#), which can set medication reminders, [Apple's](#) smartwatch with fall detection and the Nest thermostat's motion sensors, Yap has been trying new products specifically designed to monitor aging parents. One example is [Silver Mother](#), which incorporates sensors on pill boxes, front doors and mattresses for remote monitoring of health, safety and sleep.



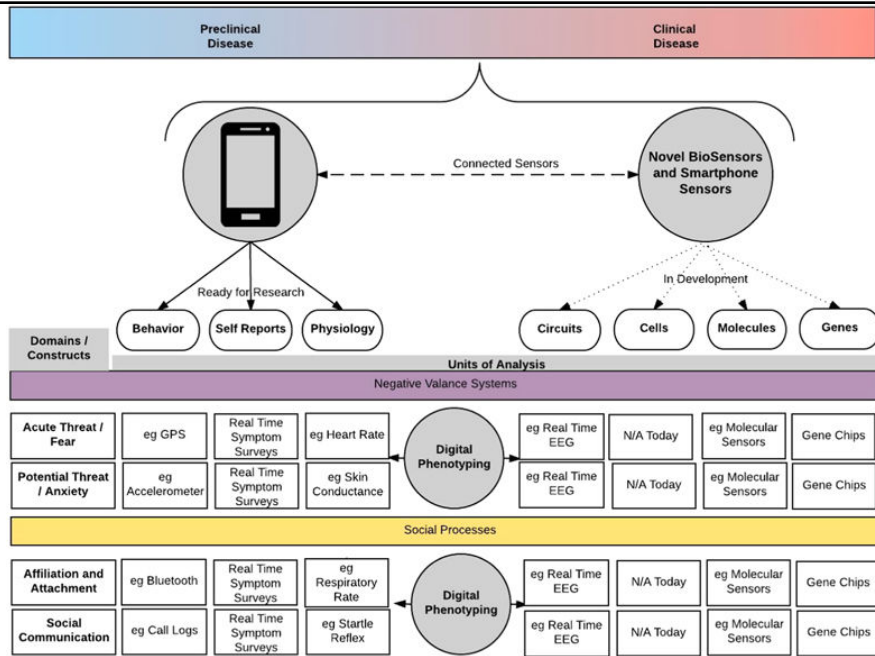
<https://www.cnn.com/2019/02/17/aging-americans-are-a-big-market-for-tech-investors.html>

VOICE SKILLS W/ALEXA FOR POST-OP RECOVERY

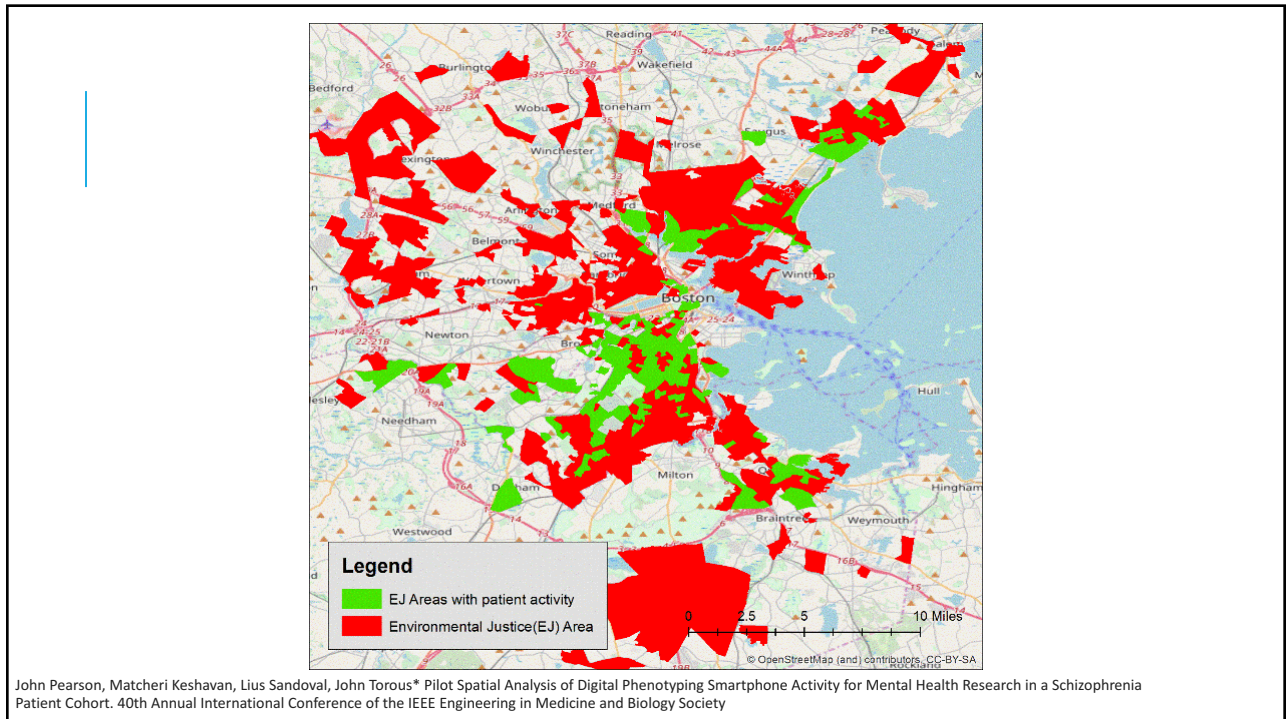
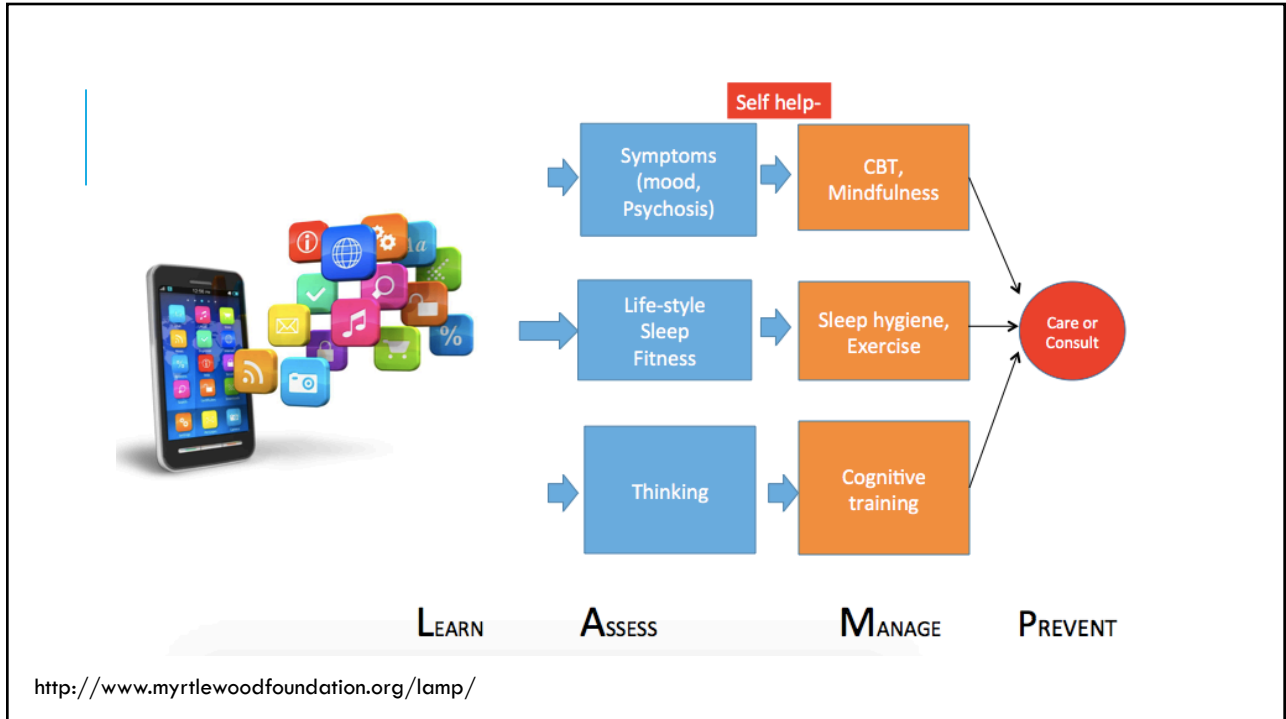


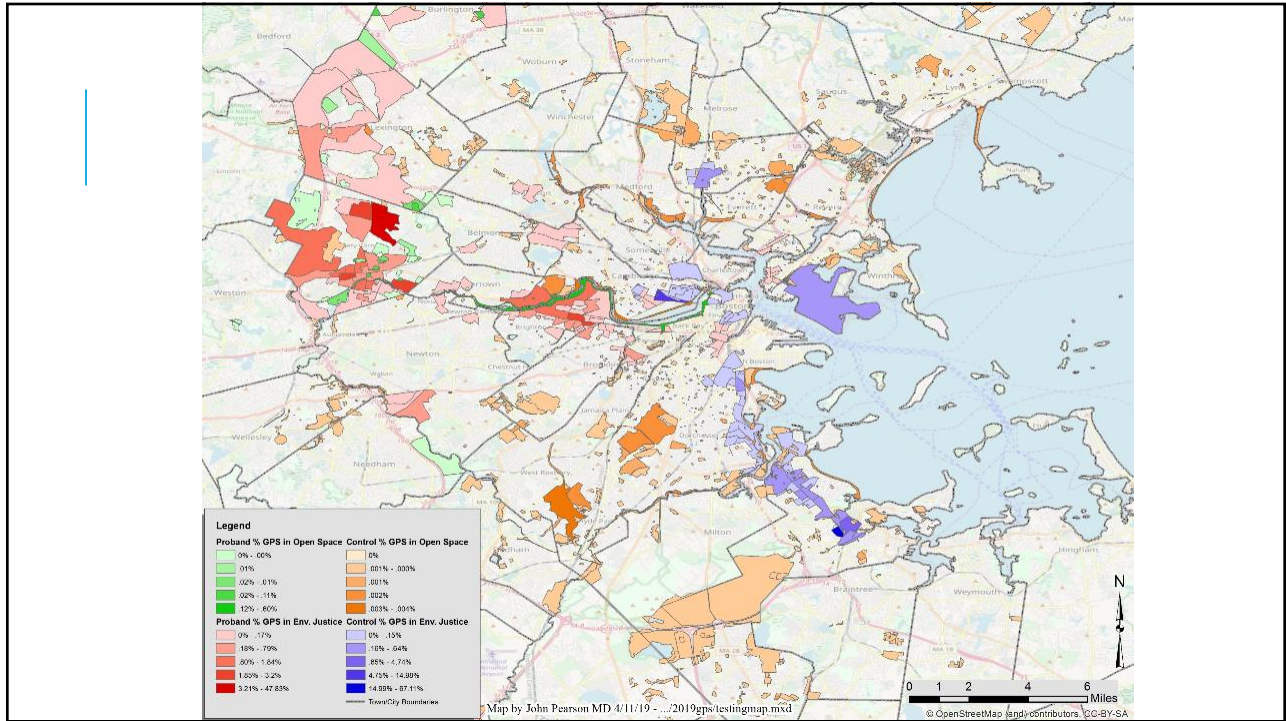
<https://www.youtube.com/watch?v=3p6fehRliEg&feature=youtu.be>

<https://www.voice.health/news/my-childrens-enhanced-recovery-after-surgery-eras-alexa-skill>

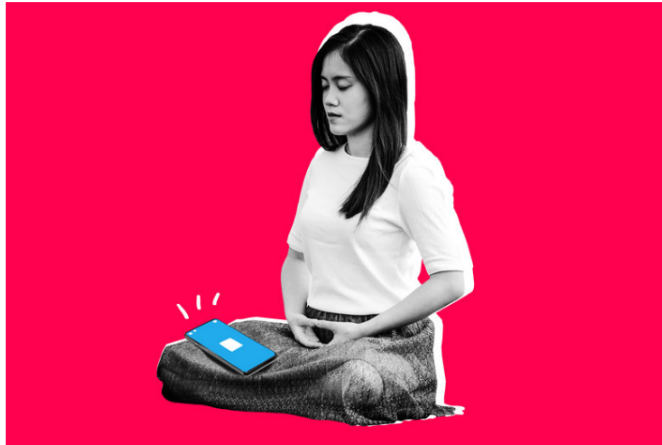


Neuropsychopharmacology volume 41, pages1691–1696(2016)





CHALLENGES



World Psychiatry. Volume16, Issue3 October 2017 Pages 287-298