

# Technological Innovations in Sleep Disorders Management

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# LEARNING OBJECTIVES:

- Increased awareness of consumer products for improving sleep
- Learn about new technologies for diagnosing and treating sleep disorders
- Be prepared for how technological advances could impact the sleep center of the future

# Consumer Innovations





# Consumer Sleep Innovations

- Trackers/Wearables
  - Smart Home
  - Family Management
  - Sports Optimization
  - Driving Safety
-

# Sleep Trackers: Types

- Wearables
  - Wrist
  - Finger
  - Patches
  - Headpiece
- Bed/bedside sensors
- Phone Apps

## Sleep Trackers: Considerations

- Accuracy and validation
- Impact: sustained engagement?
- Pathway to help
- Integration: practice, EHR, other medical trackers
- Longevity of vendor
- Populations most in need might not be serviced
- Ownership, privacy and portability of patient data

# Validation

- Timeline
- 30 sec vs. 1 min
- Lawsuits
- Different rules?



## Judge denies Fitbit's motion to dismiss sleep tracking class-action suit

By **Jonah Comstock** | July 20, 2016

SHARE 26

The judge in the class action suit against Fitbit, a suit that alleges the wearable company made misleading claims about its sleep tracking feature, has denied Fitbit's motion to dismiss



### REGULATORY NEWS

## FDA Aims to Develop Faster Approach to Regulating Digital Health Tech; Fitbit, 8 Others Picked for Pilot

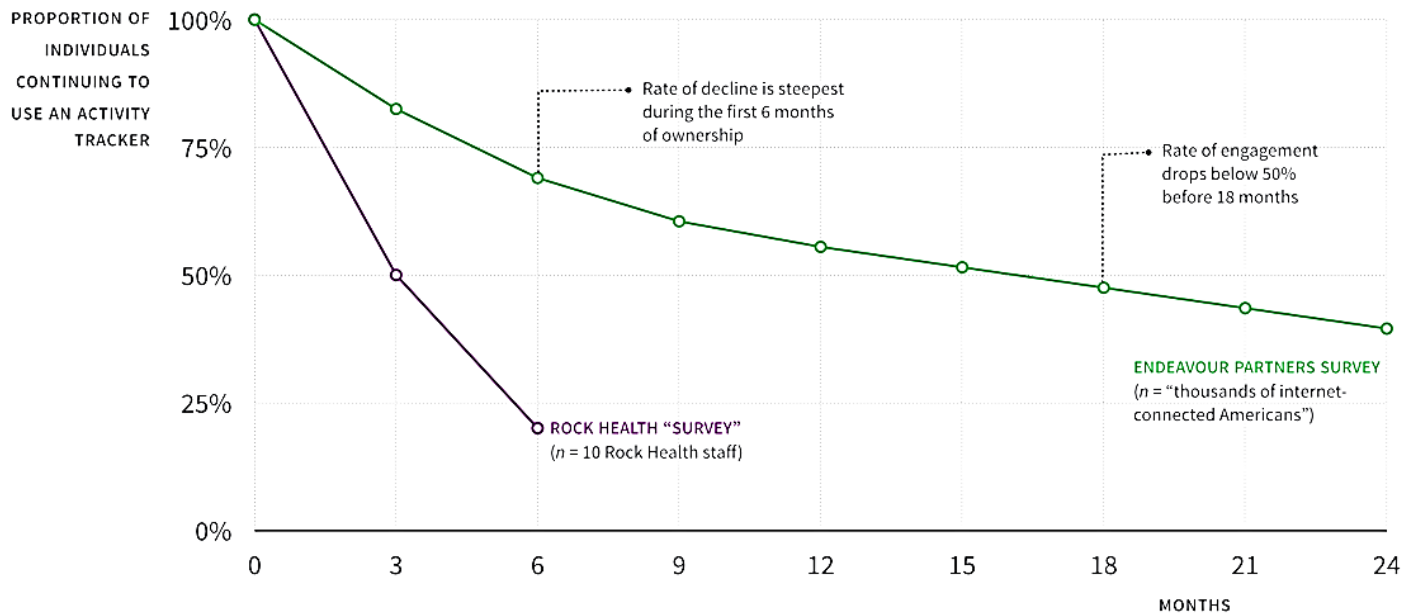
Published on October 9, 2017



“Fitbit trackers are not intended to be scientific or medical devices, but are designed to provide meaningful data to our users to help them reach their health and fitness goals.” – Fitbit spokesperson in email to Mobihealthnews

# Engagement

Rate of sustained activity tracker use over months of ownership




Note: We sincerely appreciate and respect the Endeavour Partners work; however we would be surprised if the survey could be replicated

<https://rockhealth.com/reports/the-future-of-biosensing-wearables/>

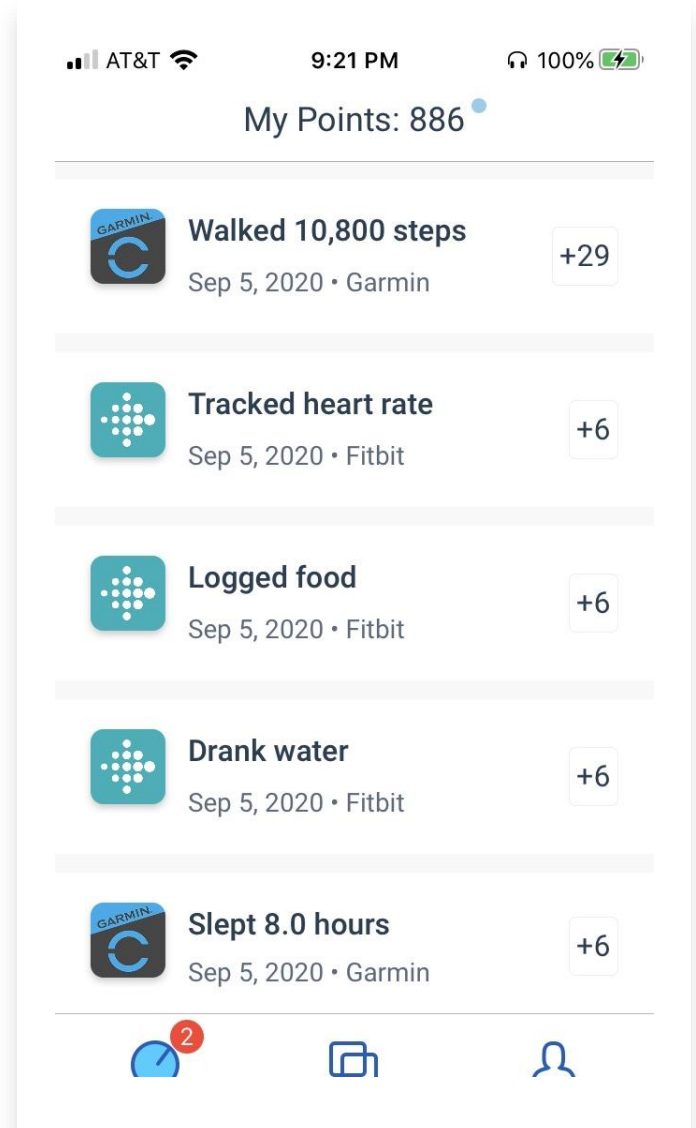


# Do wearables impact health behavior?

- *People that stay engaged and show improvement may already be self-motivated*
- *The device needs to be user friendly and deliver the right mix of data and health information*
- *Behavioral economics*
- *Close the loop*



# Apps to reward behavior

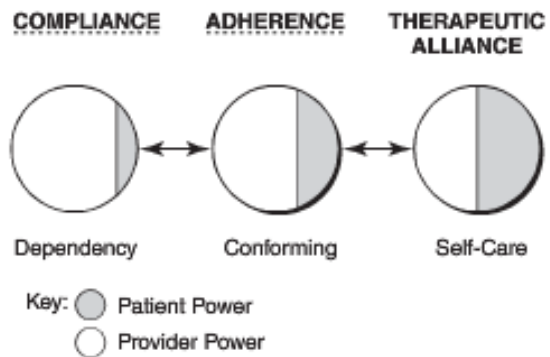


# Pathway to help

- Legal and ethical implications of giving health advice
  - Trackers that screen vs. diagnose
  - Barriers to clinical evaluation
  - Reimbursement issues for treatment
  - Withings Sleep Analyzer with “medical-grade sleep apnea detection is currently pending FDA approval”. Possibly in 2020.
    - “Sleep (device) is not intended to diagnose apneic episodes or assist with a diagnosis. Please seek medical advice if you need a personal sleep apnea diagnosis.”

# Integration

- With other medical trackers
  - Sleep and steps with weight scale and BP monitor
- With clinical practice
  - Share reports easily (ResMed S+)
- With EHR
  - As wearables become more clinical grade, an auto-upload to the EHR may be desirable



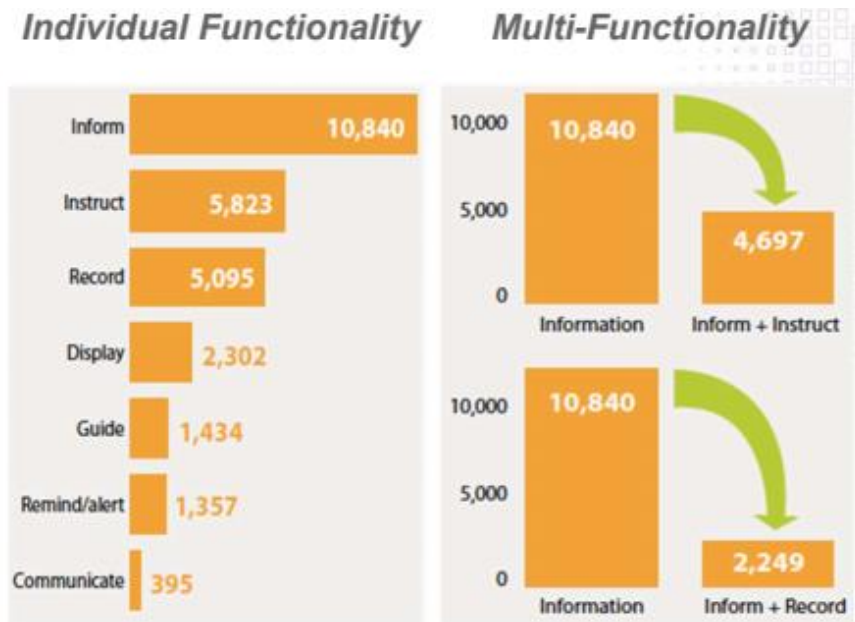
- Trackers can be used as a tool that transfers power from provider to patient

# From Fitbit forum

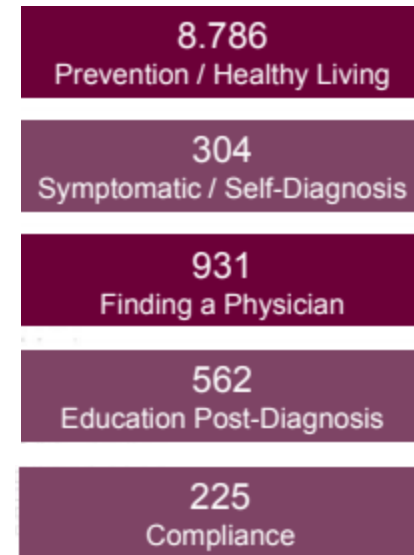
“For my entire adult life I have been tired, I wake up every night over and over. I literally live in a fatigued state, it's ridiculous. My main reason for purchasing a Fitbit, was to see just how "normal" my sleeping was. Of course, I realize it's not an accurate gauge. In the past week my sleep efficiency is 40-55% with around 4 hours sleep per night, from 8-9 hours in bed. I have the Fitbit one and it's set to "sensitive" as I did suspect sleep problems. I don't snore and I am not overweight, so my GP wouldn't entertain anything like sleep apnea. I have no idea why I keep waking up. Any suggestions as to where I could start figuring out the reason for my bad sleep?”

# Mobile Health Apps: numbers

- Track



- Treat



# Trackers: iPhone Apps/features

## Health Data – default app

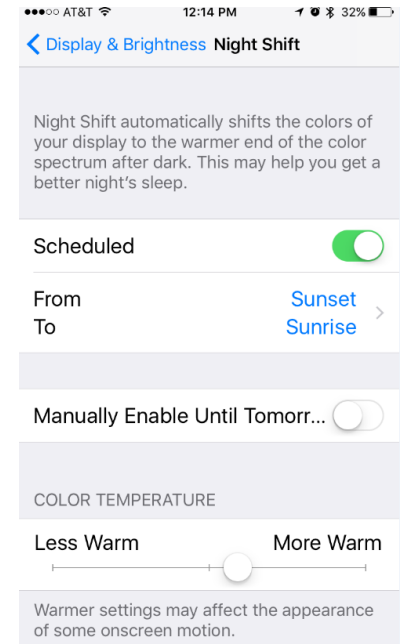
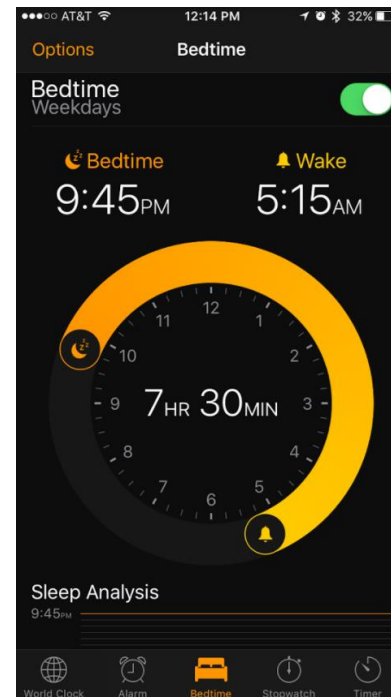
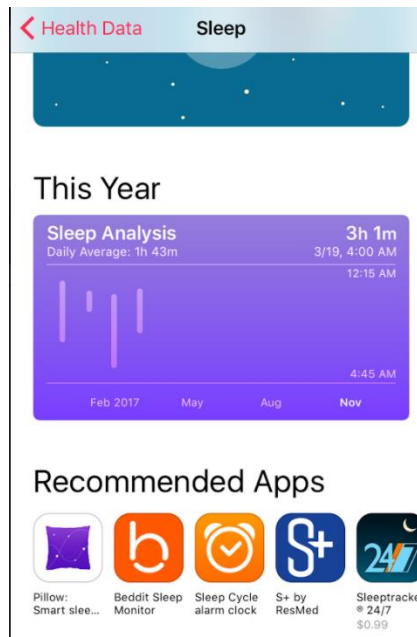
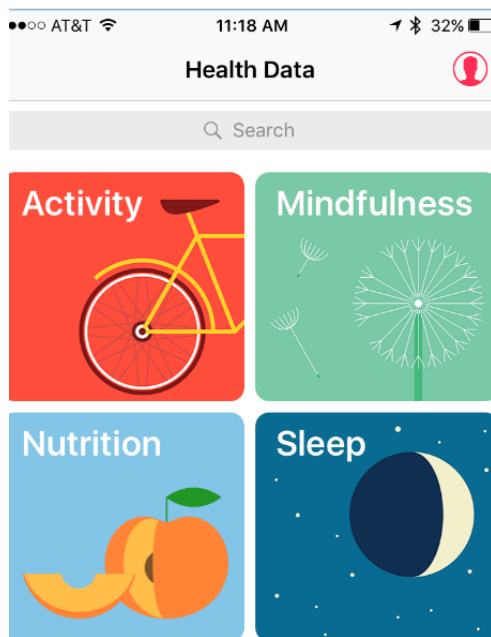
- Logs sleep time (place nearby during sleep)
- Correlate with Apple Health Data

## • Bedtime

- Reminders to go to bed based on alarm
- Nicer alarm sounds

## Night Shift

- Warmer tones
- Manually set, or auto





# Trackers: Apps

- Pillow by Neycox digital Ltd
- Logs sleep (W, R, light, deep), motion & records sound
- Smart alarm
- Snooze Lab- “personalized experiments & recommendations, research updates and sleep facts”
- Track sleep and correlate with Apple Health Data

## App of the Week: Pillow promotes sleep accountability

BY BLAIR HANLEY FRANK on March 13, 2015 at 2:42 pm

2 Comments [f Share](#) [Tweet](#) [Share 14](#) [Reddit](#) [Email](#)



#GivingTu

Back  
Infor

Dec



# Wearables

- Activity & sleep trackers worn on the body

*Triaxial accelerometers, HR variability, algorithms*

- *Wrist: Fitbit, Jawbone Up, Apple & Samsung Watch, Misfit, Basis/Intel, Garmin, Withings/Nokia*

- Volatile, competitive market

- JCSM: most consumers are unaware that the claims of these devices often outweigh the science to support them as devices to measure and improve sleep

- Megadata: 3 billion+ nights of sleep logged on Fitbit devices

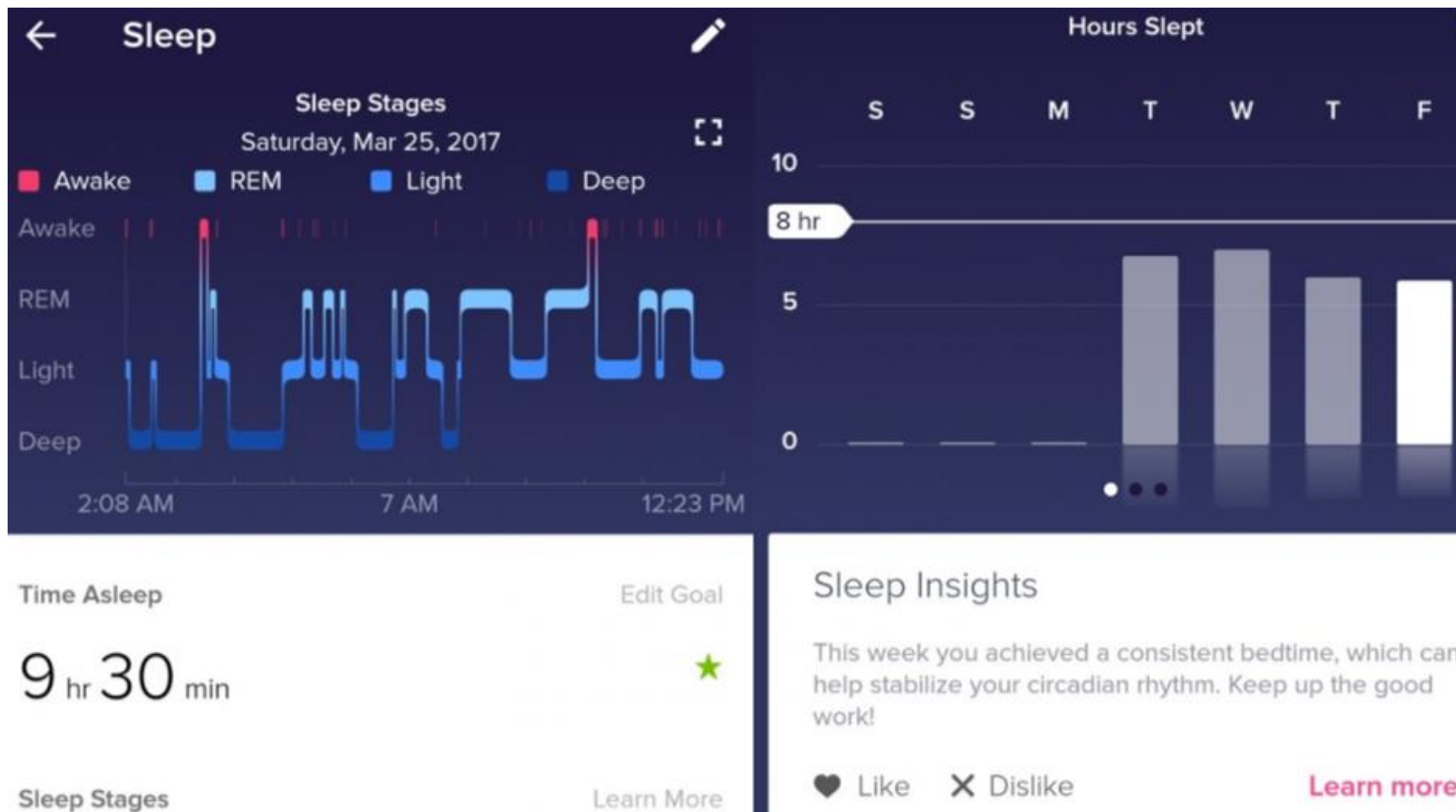
# Wearable Research

- FitbitChargeHR™ vs. PSG (30 screened adolescents)
  - *Fitbit device is reliable in detecting standard polysomnographic (PSG) metrics*
  - *Fitbit device performed well in detecting heart rate during sleep*
  - *Similar to standard actigraphy, Fitbit device had lower ability in detecting wake*
  - *FitbitChargeHR™ may be a valid alternative to PSG in healthy populations*

de Zambotti M, Baker FC, Willoughby AR, Godino JG, Wing D, Patrick K, Colrain IM. Measures of sleep and cardiac functioning during sleep using a multi-sensory commercially-available wristband in adolescents. *Physiology & Behavior*. 2016;158:143–149.

	Polysomnography			FitbitChargeHR™		
	Mean ± SD	-95%CI	+95%CI	Mean ± SD	-95%CI	+95%CI
<b>Lights-off</b> (hh:mm)	23:13 ± 1:03	22:50	23:37			
<b>Lights-on</b> (hh:mm)	07:04 ± 00:45	06:47	07:21			
<b>TIB</b> (min)*	471.3 ± 55.9	450.4	492.2			
<b>TST</b> (min)	427.9 ± 56.8	406.7	449.1	435.9 ± 51.1	416.8	455.0
<b>SOL</b> (min)	16.2 ± 11.7	11.8	20.5	13.6 ± 9.4	10.1	17.1
<b>WASO</b> (min)	27.2 ± 20.4	19.6	34.9	21.7 ± 19.3	14.5	28.9
<b>SE</b> (%)	90.8 ± 5.6	88.7	92.9	92.3 ± 4.2	91.0	94.2
<b>REM latency</b> (min)	116.2 ± 38.1	102.0	130.5			
<b>Awakening Index</b> (No./h sleep)	3.1 ± 1.2	2.6	3.5			
<b>Arousal Index</b> (No./h sleep)	8.3 ± 2.9	7.3	9.4			
<b>Time in N1</b> (%TST)	5.4 ± 2.1	4.6	6.2			
<b>Time in N2</b> (%TST)	49.1 ± 6.6	46.6	51.5			
<b>Time in N3</b> (%TST)	23.7 ± 7.3	21.0	26.4			
<b>Time in REM</b> (%TST)	21.8 ± 4.7	20.1	23.6			

# Fitbit: Alta HR personal data



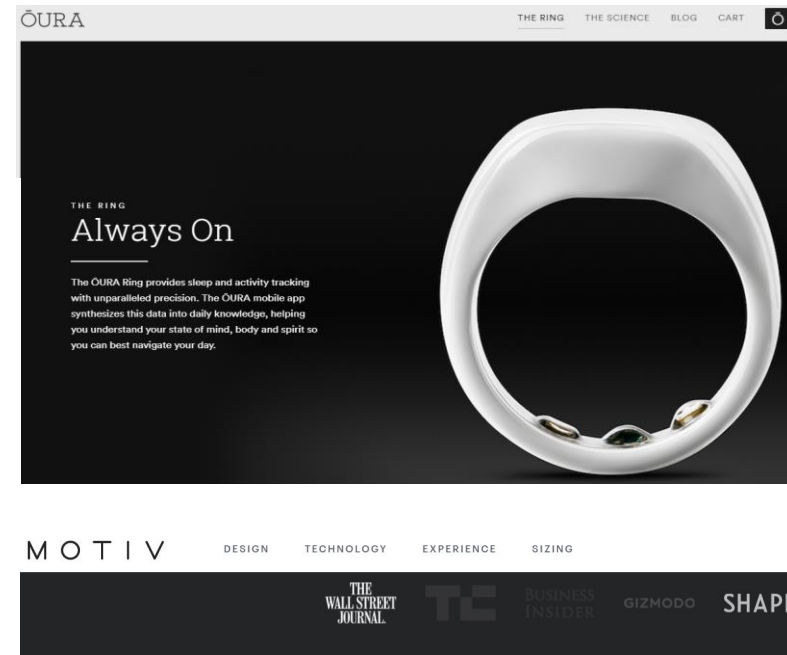
# Wearables: Finger

■ Less hair, tattoos



The most accurate device for sleep and activity tracking, the ÖURA ring:

- Senses the arteries in your finger, just like the hospital pulse oximeter
- Captures 250 samples per second for a constant flow of reliable data
- Detects blood volume pulse, body temperature and activity level with advanced sensors
- Determines sleep stages with precision comparable to clinical sleep labs



24/7 Fitness and Sleep Tracking

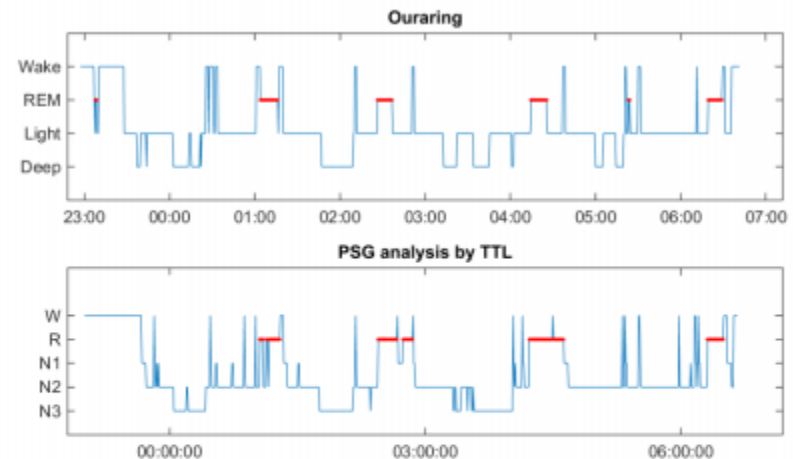
# Oura Validation (?)

CONFIDENTIAL

Sleep Lab validation of a wellness ring in detecting sleep patterns based on photoplethysmogram, actigraphy and body temperature  
 Hannu Kinnunen (Ouraring, Oulu, Finland) Feb 9, 2016

**Table 1.** Confusion matrix from epoch by epoch comparison of the sleep stages determined by the ÖURA ring and manually scored based on Polysomnography. Sleep stages were classified into Wake, REM, Light and Deep by both methods. The ÖURA ring was worn on the non-dominant hand. The ÖURA ring displays 65.3% agreement, Cohen's kappa 0.449.

		PSG scoring			
		Deep	Light	REM	WAKE
ÖURA	Deep	933	635	30	56
	Light	736	5036	627	394
	REM	78	932	1425	135
	WAKE	15	524	145	844



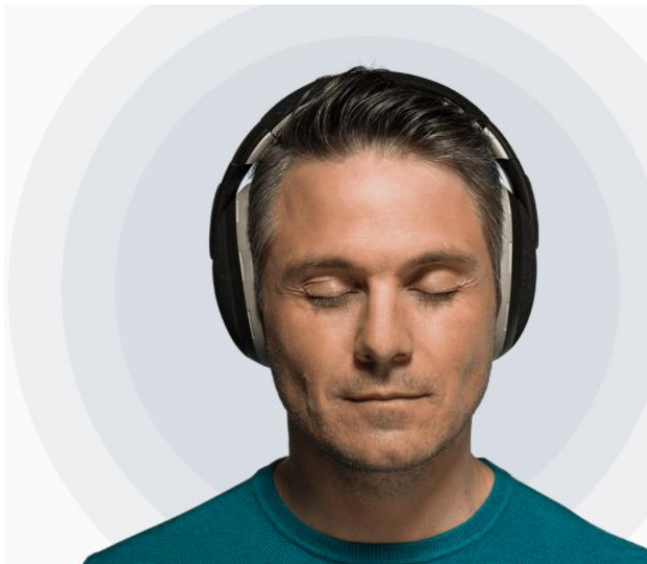
**Figure 2.** Example sleep patterns from one night, simultaneously measured by the ÖURA ring (top), and manually scored Polysomnography (PSG) made by the Finnish Occupational Health Institute (TTL) (bottom).

<https://ouraring.com/wp-content/uploads/2017/04/Validity-of-the-Oura-Ring-in-determining-Sleep-Quantity-and-Quality.pdf>

"usable for sleep analysis in the home environment without need for user actions to initiate sleep measurements."

# Trackers: Earphones

- Kokoon
  - Kickstarter
  - EEG
  - Noise -cancelling



## Intelligent Sleep Monitoring

Improving your sleep requires accurate monitoring. Kokoon headphones bring EEG brainwave sensing technology from the sleep clinic to your home giving you unparalleled insight and real-time audio optimisation.



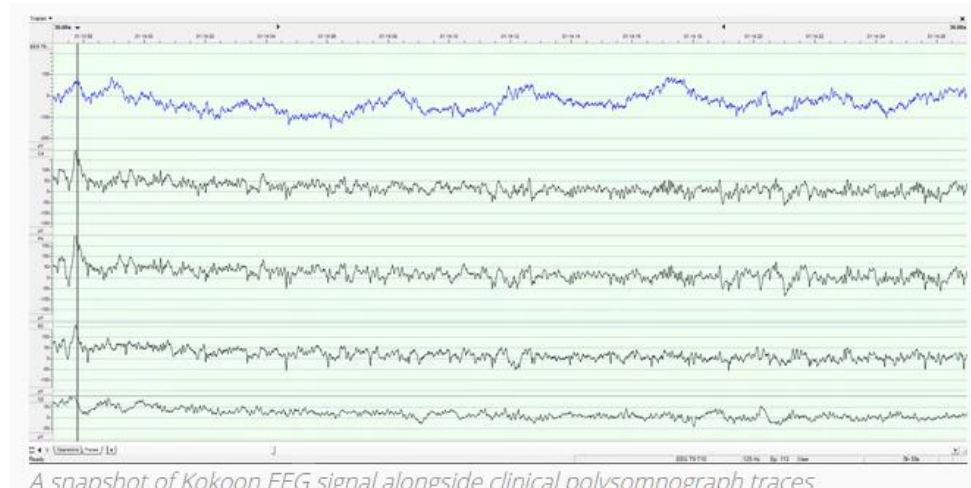
**Integrated EEG Sensors**  
Kokoon uses movement and EEG data to understand and analyse your individual sleep pattern.



**Intelligent Sleep Alarm**  
Kokoon finds the lightest point in your sleep cycle to wake you, so you wake refreshed and well rested.



**Smart Sleep Scoring**  
Our smartphone app monitors your EEG data and gives intelligent insight with a nightly sleep score.

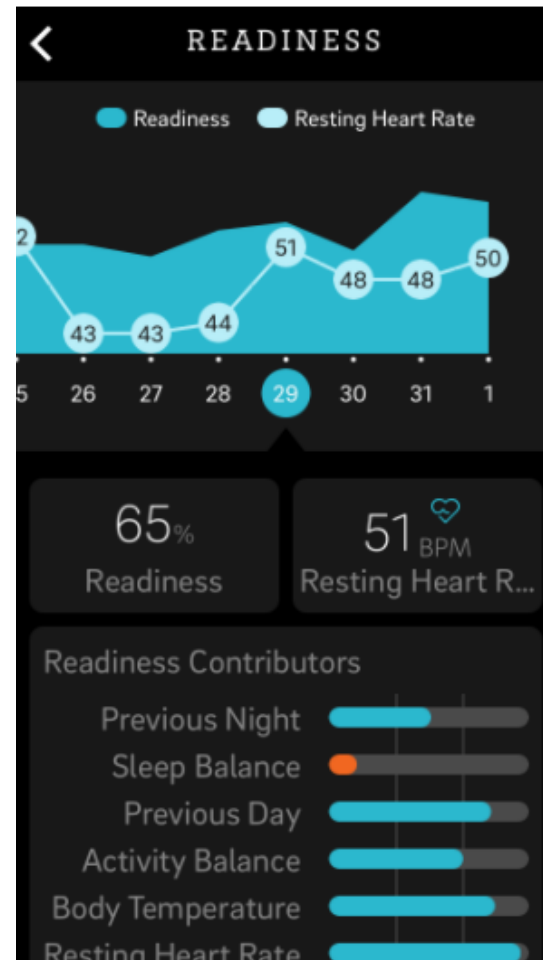


*A snapshot of Kokoon EEG signal alongside clinical polysomnograph traces*



# Trackers/Wearables: Coaching

- Physiological data
- Analysis
- Motivation
- Putting it all together



# Smart Home



# Smart Home: Sound

## ■ Nightingale Sound Blanket

- Cambridge Sound Management sound-masking systems were developed to increase employees' power to concentrate and sense of privacy in companies with open floor plans
- Can counteract snoring in an adjacent room, and adapt to hardwood, floors, carpeting, etc.
- Integrates with Alexa

[www.bostonglobe.com/magazine/2017/03/28/can-this-new-device-provide-better-night-sleep/O8OTGnvPTtAftjN1EF](http://www.bostonglobe.com/magazine/2017/03/28/can-this-new-device-provide-better-night-sleep/O8OTGnvPTtAftjN1EF)

noise.



LINDSEY ELTINGI

An illustration of how the Nightingale Smart Home Sleep System blankets a bedroom.

By **Brian Bergstein** MARCH 28, 2017

# Smart Home: Sound

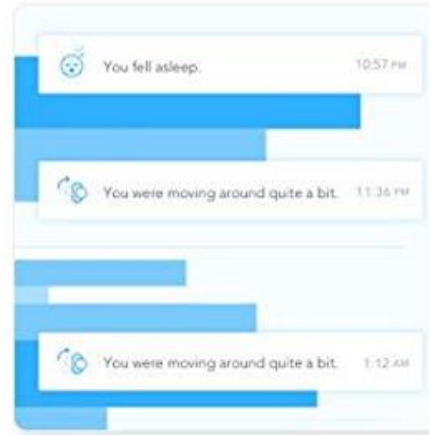
- Sense by Hello
  - Bedside orb
  - Alarm, sound machine



[View larger](#)

## Wake up energized

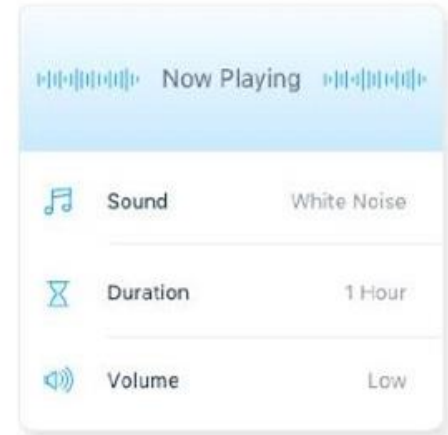
Being woken up from deep sleep leaves you feeling groggy and tired. Smart Alarm can wake you up during the lightest phase of your sleep, leaving you feeling refreshed and ready to take on your day.



[View larger](#)

## Improve your sleep

Get the most out of your sleep with personalized Insights tailored to your sleep patterns. Find your optimal sleeping environment, and learn how your daily routine impacts the quality of your sleep.



[View larger](#)

## Sleep soundly

Ambient sounds can mask disruptive noise, helping you fall asleep and stay slumbering through the night. Drift off to sleep with a selection of calming Sleep Sounds like White Noise, Fireside, and more.

# Smart Home: Lighting

## ■ Division of Sleep and Circadian Disorders, at Brigham and Women's Hospital + Lighting Science Group

- Proprietary, biological LED spectrums, GoodDay® - to enhance your natural alertness, energy and focus - and GoodNight® - to promote a healthy and restful sleep.



SLEEPY BABY®  
BIOLOGICAL LED LAMP  
\$ 16.99



GOOD NIGHT®  
BIOLOGICAL LED LAMP  
\$ 19.99



GOODDAY®  
BIOLOGICAL LED LAMP  
\$ 19.99



The effects of spectral tuning of evening ambient light on melatonin suppression, alertness and sleep

Shadab A. Rahman, Melissa A. St. Hilaire, Steven W. Lockley

Physiol Behav. Author manuscript; available in PMC 2018 Aug 1. Published in final edited form as: Physiol Behav. 2017 Aug 1; 177: 221–229. Published online 2017 May

# Smart Home: Sound+Light+Temp

## ■ Withings Aura

- *Sound, light, and temperature are controlled and interact with sleep monitor to awaken you at an optimal time*

### **The Aura Alarm Clock Hacks Your Circadian Rhythm To Help You Sleep Better**

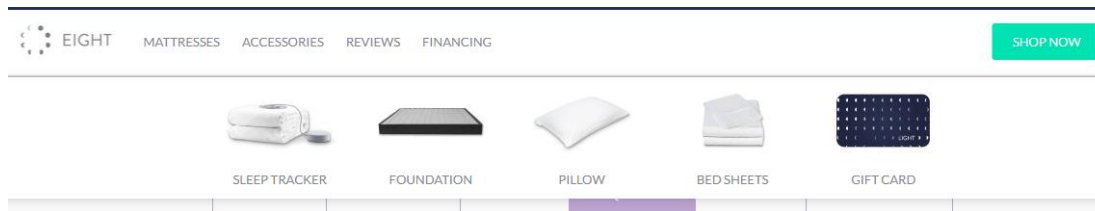
The Withings Aura reimagines the loathed alarm clock as a fully equipped sleeping assistant.



When it is time to fall asleep, Aura uses certain red wavelengths that favor the secretion of Melatonin in your body, consequently easing the onset of sleep. When it is time to wake-up, Aura gradually lights up with well-defined blue wavelengths that inhibit the secretion of Melatonin, contributing to a smooth wake-up.

# Smart Home: Mattress

- Eight: tracks sleep with cardioballistic sensor, warms bed



“What a difference a good mattress makes. I sleep much deeper - over 25% is now REM sleep!”  
- H. Logan, Eight customer

## Smart Collection

Incredible comfort with a proprietary technology that tracks your sleep, manages the temperature of your bed, connects with your smart home, and wakes you up with a smart alarm.



DAILY SLEEP REPORTS



BUILT-IN BED WARMING



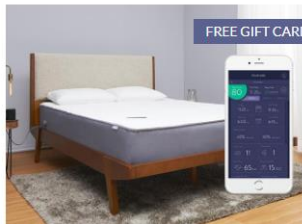
SMART ALARM



SMART HOME INTEGRATION



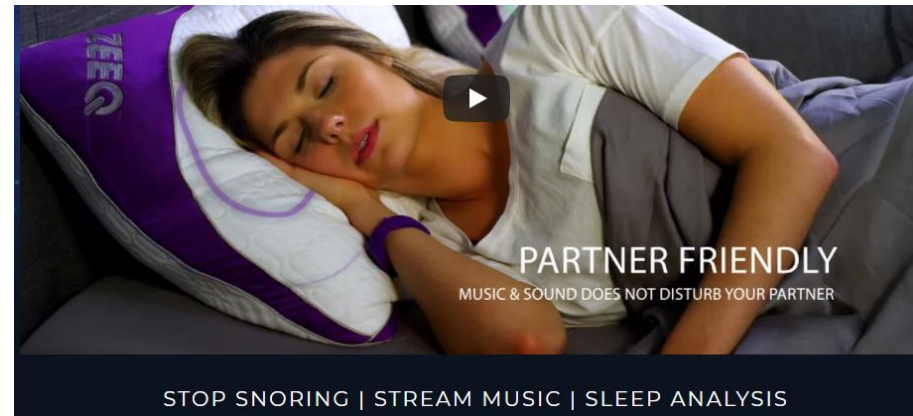
WORKS WITH AMAZON ALEXA



Hours of sleep tracked to date: **10,000,000+**  
Data points analyzed to date: **200 billion**

# Smart Home: Pillows

- Zeeq
  - Anti-snoring-vibration
  - Music streaming
  - Sleep analysis



## Measure Activity and Sleep Quality

REM-Fit's ZEEQ Smart Pillow and Active 100 Fitness & Sleep Trackers are designed to work together. Performance powers everything that you do. From your morning workout to meetings in the office, when you get the rest and recovery you need, you tap into your maximum energy. The REM-Fit Fitness & Sleep trackers work with the ZEEQ Smart Pillow and app to arm you with insightful data by measuring activity & recovery so you're at your best all day, every day.

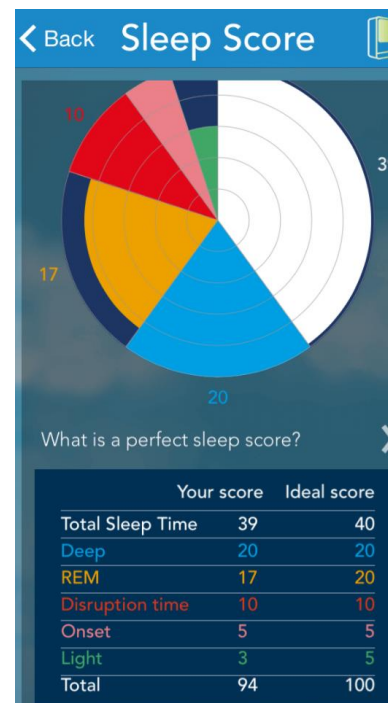




# Smart Home: Bedside

- ResMed S+

- Detailed tracking of light, deep and REM sleep stages and awakenings (BCG sensor).
- Measures **light, noise and temperature** in the bedroom.
- Questionnaire about factors like alcohol, caffeine, activity and stress
- Encourages you to leave a text or voice memo to **clear your mind** and relax before sleeping.
- **Synchronizes with your breathing** to play relaxing sounds through your phone.
- Smart **alarm** wakes you gently during a light stage of sleep.
- **Sleep coaching** advice based on your sleep pattern, bedroom environment and lifestyle.
- Detailed results and sleep graphs on a very clear phone App and website.
- **Compares your sleep score** against the average for your age and gender.
- **Printable sleep report.**



# Smart Home: Under Mattress

- Beddit (Apple)
  - Similar to S+
  - BCG sensor
  - Auto-on
  - Automatically sends data to Apple Health



# Smart Home: Architecture

- “Garden Pavilion is architectural insomnia relief”
  - Blackout shutters allow light in/out
  - Perforated acoustic ceiling panels provide sound clarity and quietening
  - heavily insulated walls and double doors with custom seals form air gaps
  - Curved footprint that refracts sound



# Family Management: Multi-trackers

- HugOne

- Sleep data, room temperature, humidity, and VOCs (volatile organic compounds) in the air
- Minimizes wireless communications in the bedroom
- Monitor family sleep patterns

## Track Your Family's Sleep

Because more informed sleep is better sleep.



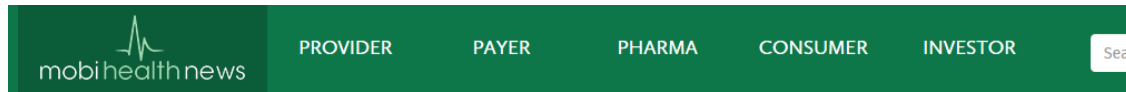
0 COMMENTS



# Family Management: Sleep Coaching

- Rest- Mimo + Nod

- Monitors breathing, sleeping temperature, body position, activity level and whether the baby is awake or asleep
- Customized sleep advice
- Clinically-validated behavioral techniques



## Johnson & Johnson, Rest Devices team up to launch connected sleep coaching system for babies

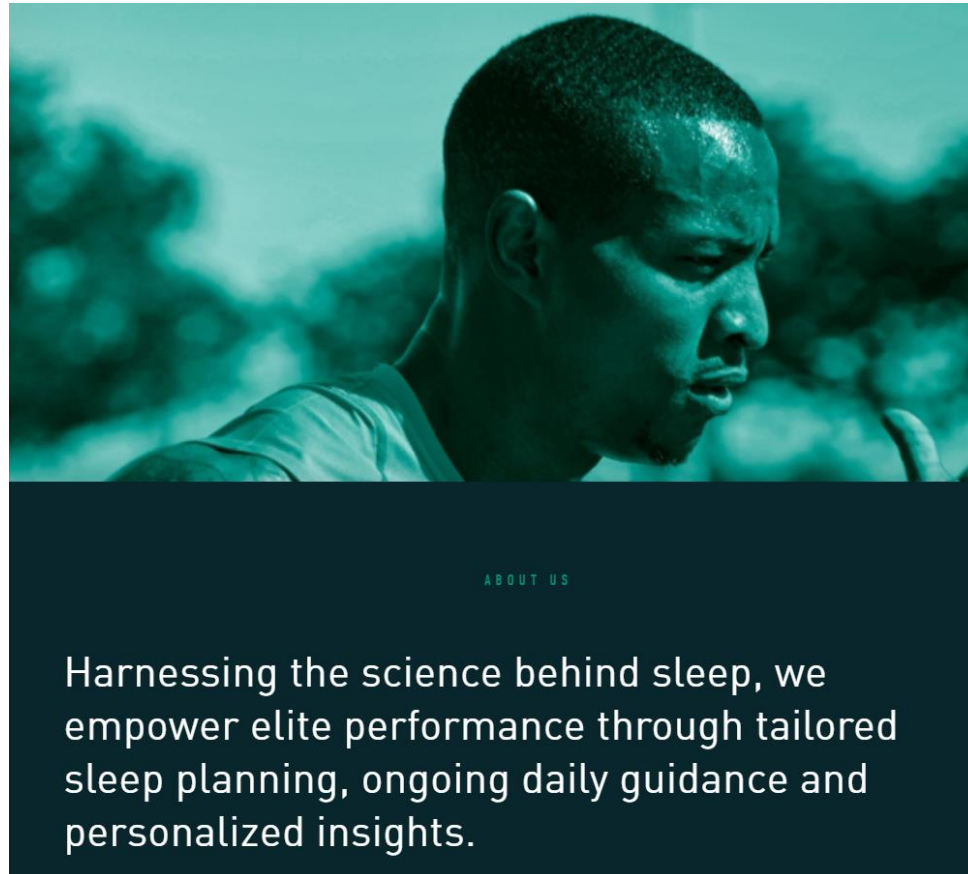
By **Heather Mack** | January 04, 2017

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# Sports Hacks: Tracker + Coach

- Rise Science (Clemson, Chicago Bulls...)
  - Under bed sleep tracker
  - FT coach



# Sports Hacks: Nap Room

- Red Sox



## 'Nap Room' is perk to keep Red Sox players perky



Zineb Curran, Boston Red Sox senior director of corporate communications, arranges bedding in a nap station near the team's clubhouse at Fenway Park in Boston. —AP Photo/Steven Senne

By JIMMY GOLEN AP, July 15, 2017

# Travel Hack: Nap Room

- Atlanta Airport

## Hartsfield-Jackson





# Sports Hacks: PJ's

- UnderArmour Athlete Recovery Sleepwear
  - Far Infrared Radiation (FIR)
  - Micro-sauna effect
  - increases blood flow without heat
  - Mechanism not fully understood

★★★★★  
"MY SLEEP IS  
MEASURABLY BETTER."

FEB 9, 2017 REVIEW



Vatanserver F, Hamblin MR. Far infrared radiation (FIR): its biological effects and medical applications. *Photonics & lasers in medicine*. 2012;4:255-266. doi:10.1515/plm-2012-0034.

# Driving safety and accident prevention

## ■ SafeCap by Ford

- Sensors and a gyroscope detect drowsiness
- Awakens driver with sound, light, and



Tech Insider 

November 6 at 4:15pm · 

Ford has created a trucker hat to wake sleepy drivers.

# Clinical Innovations

- Diagnostics
- Therapy
- Corporate Health
- Convergence



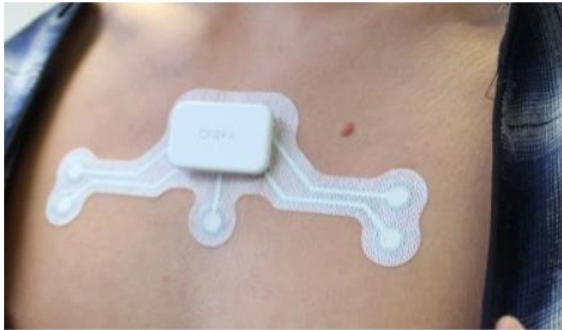
NightOwl®



NightOwl® Mini

## Diagnostic Innovations

- Disposable HST
- COVID-19 acceleration
- Multi-night monitoring
- Miniaturization
- Patches



10 February, 2020

**Onera Health: One of the most promising startups in Europe**

Onera Health has been listed as one of the most promising 11 startups of Europe

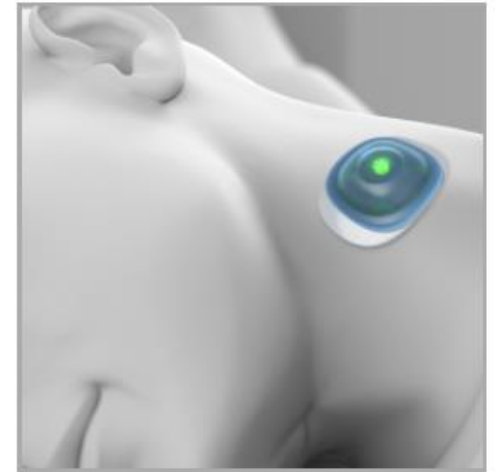
<https://www.onerahealth.com/updates>

beddr



<https://www.beddrsleap.com/sleeptuner>

**ZANSORS®**  
PERSONAL HEALTH ANALYTICS  
Know Yourself



**SLEEP APNEA**

<https://www.zansors.com/sensors-apps>

# Patches (lab on a chip)

# Snoring Hacks



**“Breakthrough Treatment for Simple Snoring”**

**“Butterfly Interface”**

# Snoring Hacks

- Activity tracker for the tongue

## Snoozeal

News

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### Snoozeal reveals work on snoring and sleep apnea device, smartphone app

By [Heather Mack](#) | December 21, 2016

While tens of millions of people live with snoring or obstructive sleep apnea, the most commonly prescribed treatment – a CPAP mask – has historically low adherence rates. So London-based Snoozeal has developed a device that aims to eliminate the need for the cumbersome masks, tubes and noise associated with CPAP machines that make them so unpopular for users. Snoozeal's product, which has a CE...

- Anti-snoring device
- CE approved

# Snoring Hacks

- Gravity
  - Smart Nora
  - Sleep Number Bed



## How Smart Nora Works

Throughout the night, Nora listens for early sounds of snoring before they become loud enough to wake the sleeping partner. Once snoring is detected, Nora starts a gentle movement in the pillow insert.





# Diagnostics: Pediatrics

IN THE JOURNALS

## Simple, affordable test may help identify sleep apnea in children

Hornero R, et al. *Am J Respir Crit Care Med*. 2017;doi:10.1164/rccm.201705-0930OC.

August 14, 2017

Automated analysis of nighttime oximetry could lead to more timely interventions and possibly enhanced outcomes in children with obstructive sleep apnea, according to findings recently published in the *American Journal of Respiratory and Clinical Care Medicine*.

- **Nocturnal Oximetry-Based Evaluation of Habitually Snoring Children.** AJRCCM Articles in Press. Published on 31-July-2017 as 10.1164/rccm.201705-0930OC

# Diagnostics: Portable Monitor

## Home Vets Close Zansors Wins NIH Grant to Advance Wearable At-Home Affordable Sleep Apnea Detection

Mon, 01/30/2017 - 4:36pm by PR Web



# Diagnostics: Sensors

**Sleep Review**  
THE JOURNAL FOR SLEEP SPECIALISTS

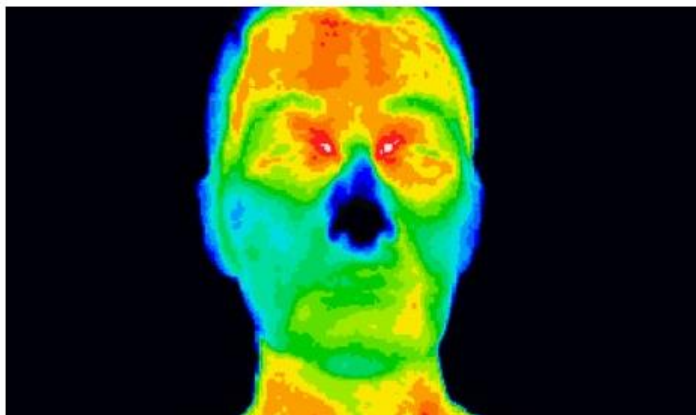
NEWS PRODUCTS BUYER'S GUIDE RESOURCES DIGITAL EDITION

CPAP Masks: You Never (Sleep Review's webinar) CF Second Chance to Make a

RESEARCH NEWS

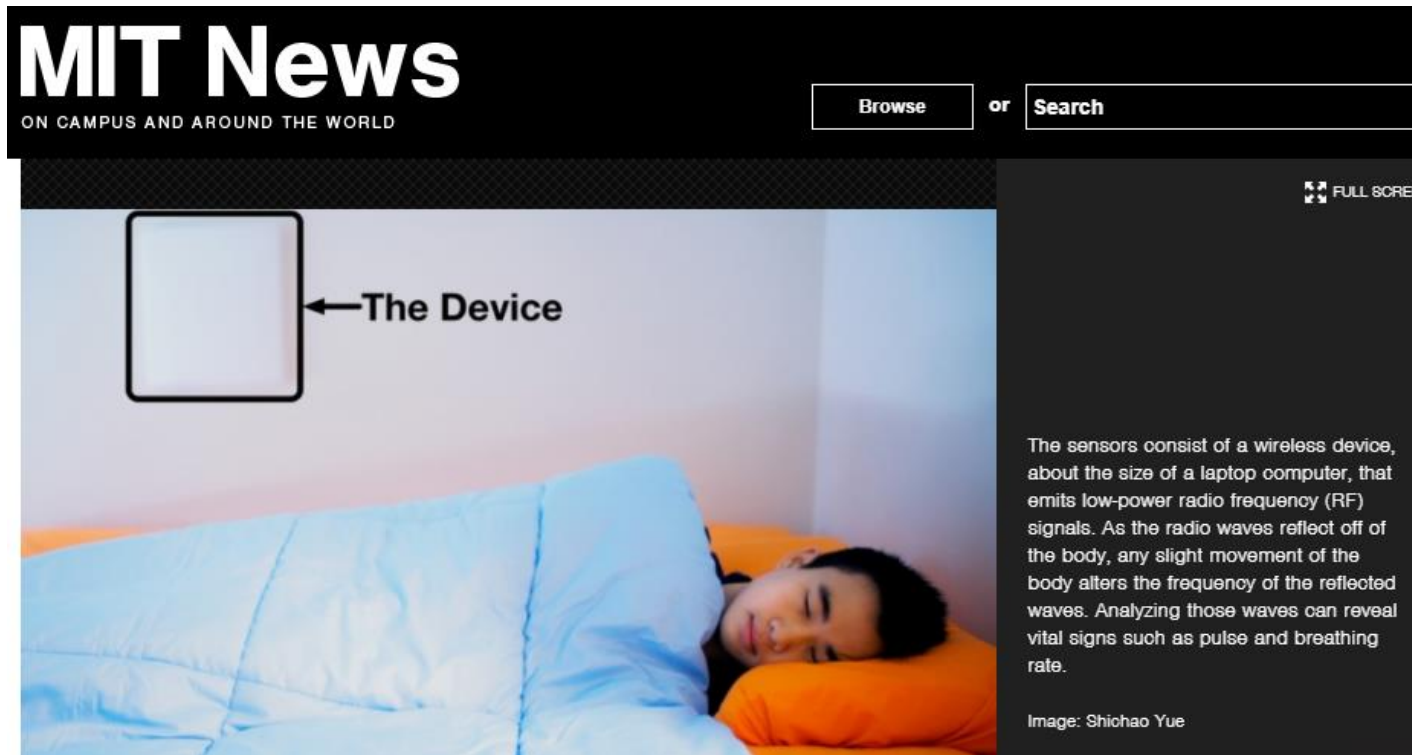
## As Thermal Cameras Shrink in Size and Price, Scientists Look to Turn Them Into Breathing Sensors

Published on September 26, 2017



Youngjun Cho, Simon J. Julier, Nicolai Marquardt, and Nadia Bianchi-Berthouze, "Robust tracking of respiratory rate in high-dynamic range scenes using mobile thermal imaging," Biomed. Opt. Express 8, 4480-4503 (2017)

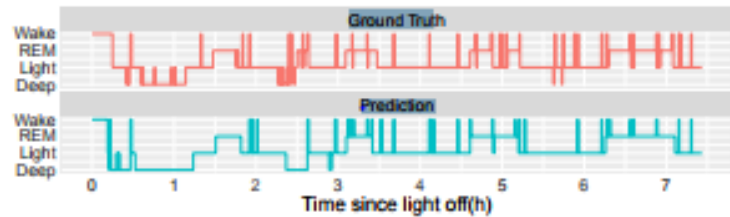
# Diagnostics: Radio Waves



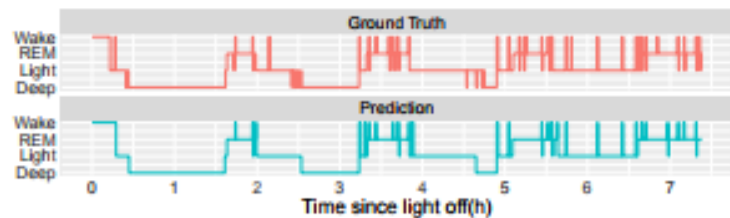
Learning Sleep Stages from Radio Signals: A Conditional Adversarial Architecture  
Mingmin Zhao, Shichao Yue, Dina Katabi, Tommi Jaakkola, Matt Bianchi  
*International Conference on Machine Learning (ICML'17)*

# Diagnostics: Radio Waves, cont.

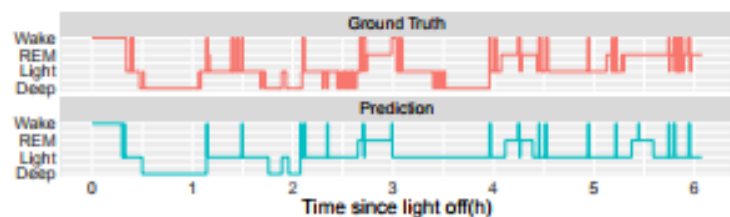
- Sleep staging accuracy equal to “sleep technologists” (80%)



(a) Average Accuracy (80.4%)



(b) Best Accuracy (91.2%)

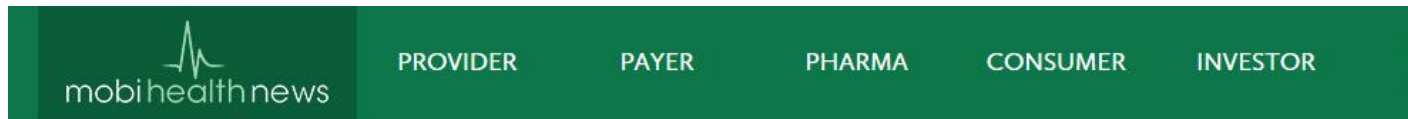


(c) Worst Accuracy (71.2%)

Figure 3. Three examples of full night predictions corresponding to the average, best and worst classification accuracy.

# Diagnostics: Scoring

- EnsoData- Auto-scoring
  - Machine learning
  - Interfacing with polysomnography systems
  - Students from University of Wisconsin Madison



## EnsoData receives FDA clearance for sleep analysis software

By **Heather Mack** | April 12, 2017

SHARE  111

Madison, Wisconsin-based **EnsoData** has received FDA clearance for its sleep analysis software called EnsoSleep, which uses machine learning to analyze sleep quality and aide in diagnosis of sleep or respiratory-related sleep disorders.



# Treatment: Insomnia

- Thim Sleep re-training device
  - Repeatedly wakes sleeper every 3 minutes for 60 minutes
  - Conditions falling asleep quickly



# Treatment: Sedation-Related Apnea

- cNEP Airway System
  - “External airway”
  - Prevents airway closure during mild to moderate sedation





# Treatment: Insomnia

- Dreem
  - EEG sensors
  - Bone conduction technology
  - Synchronize brain activity



## RESTFUL DEEP SLEEP. NOW ENHANCED

Deep sleep or slow-wave sleep is the most restorative stage of sleep. It can only be monitored with your brain activity and is involved in the process of healing, rejuvenation, memory consolidation, and preparing your body for a new day. With sound stimulations that synchronize with your brain activity, we enhance the quality of your deep sleep by up to 32% in an active, safe, and proven way possible.

# Treatment: Insomnia

- Breath training
  - Synchronize to light
  - Stimulates baroreflex
  - Target 6 bpm



parasympathetic activity.»

dodow Who is this for? Doctors? Your questions BUY 59\$ Blog About

Dr. David O'Hare  
A doctor specialized in cardiac coherence

Download

HRV  
Heart rate variability

Dodow takes you here, the optimal rhythm to stimulate the baroreceptor reflex

Breathing rhythm  
inhalation per minute

Mesure of heart rate variability according to breathing rhythm

Breathing rhythm (inhalation per minute)	HRV (Heart rate variability)
3	3500
4	4200
6	3200
8	2200
10	1300
12	800

The screenshot shows the Dodow website interface. It features a navigation bar with a 'BUY' button priced at 59\$. A section for Dr. David O'Hare, a cardiac coherence specialist, includes a 'Download' button. A bar chart illustrates the relationship between breathing rhythm and HRV, with a callout indicating that Dodow targets a breathing rhythm of 6 inhalations per minute to stimulate the baroreceptor reflex.

# Treatment: RLS

- Restiffic
  - Compressive foot wrap
  - Clinically shown to reduce RLS symptoms by nearly 70%



restiffic foot wrap for right foot



Flexor-T pad for right foot



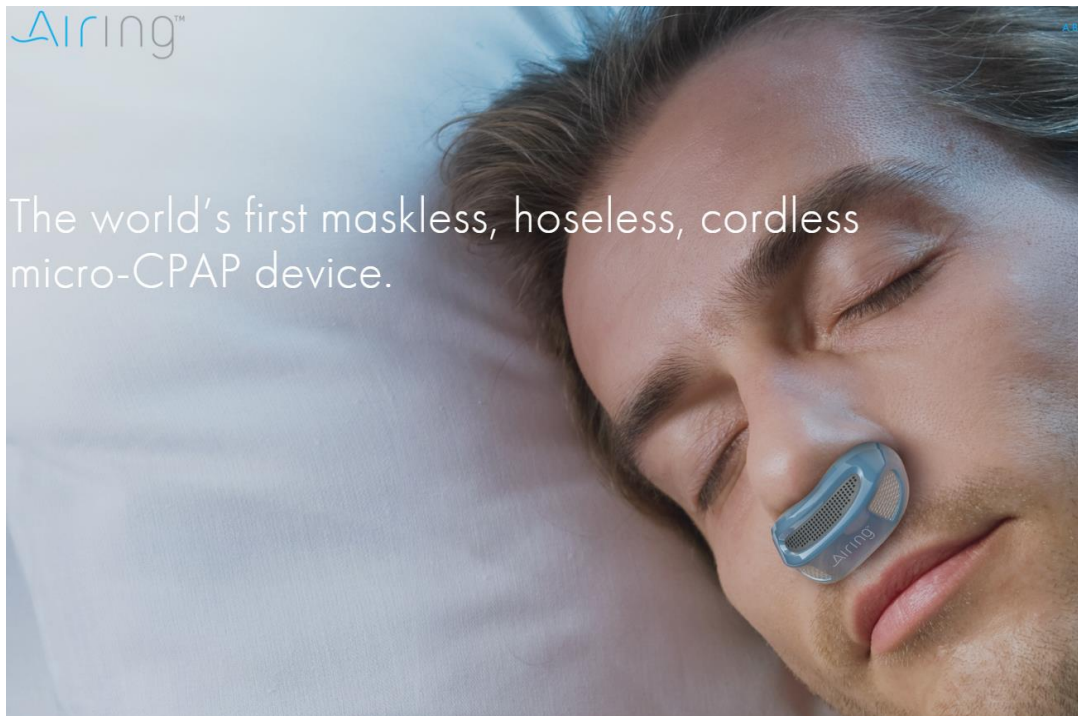
[www.restiffic.com](http://www.restiffic.com)

Targeted Pressure on Abductor Hallucis and Flexor Hallucis Brevis Muscles to Manage Moderate to Severe Primary Restless Legs Syndrome

[Phyllis J. Kuhn, MS, PhD](#); [Daniel J. Olson, DPM](#); [John P. Sullivan, MD](#) The Journal of the American Osteopathic Association, July 2016, Vol. 116, 440-450.

# Treatment: OSA/CPAP

- Airing
  - Indigogo campaign
  - Burlington, MA co.
  - **\$1,946,416** USD total funds raised



antisnoresleepaid.com

**2-IN-1 SNORING AIR PURIFIER**

- ✓ EASY TO CARRY
- ✓ MEDICINE FREE TREATMENT
- ✓ SIMPLE TO USE
- ✓ AIR PURIFIER

2-IN-1 SNORING AIR PURIFIER

**ORIGINAL ANTI SNORE DEVICE: SLEEP AID**

**\$19.99 USD** ~~\$89.99 USD~~

Anti Snore Device Sleep Aid's Post

Like Comment Share

A screenshot of an Indiegogo campaign page for the 'Airing' device. The page features a woman sleeping peacefully with the device on her nose. Below this, there are images of the device in various colors (blue, red, white) and a close-up of the device's mesh. The text highlights the product as a '2-IN-1 Snoring Air Purifier' and lists benefits like being easy to carry, medicine-free, and simple to use. The price is shown as \$19.99 USD, a significant discount from the original price of \$89.99 USD. At the bottom, there are social media sharing options for Like, Comment, and Share.

“wife tells me that they look awesome in my nose when I'm snoring at night.”

# Treatment: OSA/OAT

- An algorithm allows dentists to bypass the current unscientific, subjective, and time-consuming trial and error method of serial titration of an oral appliance.



Singh PP. Large Scale, Longitudinal Efficacy Study of Management of Obstructive Sleep Apnea (OSA) with a Mandibular Advancement Oral Appliance (MAD). Sleep. Manuscript Number:SP-00397-16.

# Corporate Wellness

- Sleepio

- "The Prof", an online persona
- Cognitive behavioral techniques
- Improve their sleep schedules.
- Daily schedule
- LinkedIn, Comcast, Boston Medical Center



## Big Health raises \$12 million for sleep-focused employee wellness app, Sleepio

# Convergence of Consumer & Clinical Applications



## Fitbit eyes sleep apnea space for next digital innovation

By [Heather Mack](#) | June 21, 2017

## Sleep expert leaves Apple for Dr. Oz JV digital health hires and departures

By [Jonah Comstock](#) | May 11, 2017

Roy J.E.M. Raymann, who, as we reported yesterday, [left Apple's sleep team a month ago](#), has moved to [SleepScore Labs](#), a joint venture between ResMed, Dr. Oz Media, and Pegasus Capital Advisors. He will serve as Vice President of Sleep Science and Scientific Affairs.

First [announced this year at CES](#), SleepScore Labs is "currently in the process of examining how people sleep by compiling and analyzing the most comprehensive and accurate collection of consumer sleep data on the planet," the group writes [on its website](#). "SleepScore Labs will use this data to deliver ultra-personalized insights, coaching, and validated solutions that enable you to make informed decisions about the behavioral and environmental factors that affect your sleep."



SHARE



Researchers

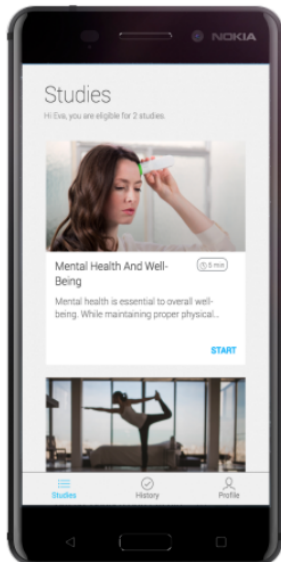
# From patient data to health solutions

Collecting real-world data from smart devices to accelerate and enrich your research.

Get started →

“As [our study participants] are so sick, traditional sleep evaluation techniques aren't an option- it's hard to get these patients to appointments, more or less to have them spend the night in a sleep clinic! We are very excited about the potential to diagnose these patients and get them help if they need it.”

Catherine Brownstein,  
Children's Hospital Boston



## Participant recruitment

Effortlessly target and enroll participants relevant to your study directly in the Nokia Health Mate app.





**IMPACT** 11/25/2017 04:30 pm ET

430



# Robots Are Coming For Our Jobs. Ways To Prepare.

Get ready for an automated world.

Amy Westervelt On assignment for HuffPost



# Connected Health Revolution



***At the Hospital***  
e.g. Capsule Tech



***In the Home***  
e.g. CliniColud



# Thank you

- [emaher6@partners.org](mailto:emaher6@partners.org)