Celebrate Freedom with Wearable Technology; Individualized Data; and Remote Monitoring

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• KardiaMobile and KardiaBand
  — Track Atrial Fib with EKG
• Hexoskin
  — HR, Resp, Activity, Position
• TempTraq
  — 48 hour stick on patch, worn on the underarm
  — Real time temp and alerts if exceeds normal range
• iTBra
  — Early detection of breast CA with bra insert-thermodynamic assessment
• Ability MyCite
  — Send signal from pill’s sensor to wearable patch
• Air Louisville
  — Asthma improvement with GPS enabled air quality sensor
• Embrace smartwatch
  — Monitor seizures and send alerts
• Dexcom G6
  — Continuous Glucose Monitors
• Google Glass and Wound Care

Quest: Improve Human Function

• Balance Technology and Hands on Care

• Allow for living independently

• Increase or Maintain Function
  — One of top reasons a person ‘moves’ to institutional setting (NH)
  1. Incontinence
  2. Function
  3. Safety/Memory
  4. Fall/Severe Injury
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Presented at Pennsylvania VOICE ACCORD 2018 11/14/2018

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Quest: Improve Human Function

• Wearable Tech and Remote Patient Monitoring (RPM)
• Leading Age Presentation in 2017
  – J Patrick Bewley, Big Cloud Analytics
  – Function is one of primary reasons for rehospitalization
• Function:
  – Gait Speed
  – Activity
  – HR at night >150 bpm
  – Sleep pattern

➢ When to intervene to improve

Three Topics: One Focus—Improve Human Function

1. Technology
  – Exponential advances
  – Sensors

2. Data
  – When is a step…a step
  – Benchmarks and Trendlines
  – Data Security

3. Remote Monitoring
  – Individualized Care
  – Case Studies

Exponential Rate of Change in Technology

Moore’s Law 1965 - Exponential

• The number of transistors on an affordable CPU doubles every two years

➢ More transistors=more calculating power
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Rate of Change in Technology

Linear
- 30 linear steps...
~30 meters

Rate of Change in Technology

Exponential
- 30 exponential steps...
More than 13 times around the earth!
536,870,912 meters

Exponential Changes

1976 – First Digital Camera
0.01MP 8 lbs/ $10,000

2014 – Digital Camera
>10MP 0.03 lbs/ $10

~ 1 Billion Times Better
1,000x Resolution & 1,000x lighter & 1,000x cheaper
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Exponential Changes Technology: Sensors

- Smaller, More accurate, Lower costs
- New types of sensors
  - Chemical, Protein
- Signal Processing and Pattern Recognition
  - New algorithms for analysis and feedback

Hardware: Sensors

Good sensor:
1. Sensitive to the measured property,
2. Insensitive to any other property likely to be encountered in its application, and
3. Does not influence the measured property

- More than one type of sensor into a device
  - 3d Accelerometer, Gyroscope, Altimeter, Biome impedance
  - Optical Sensor, Force, Pressure, Stretch, Temperature thermistor
  - Piezoelectric (HR Monitoring),
  - Photoplethysmography (Detection of blood volume)
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When is a step... counted

<table>
<thead>
<tr>
<th>Device</th>
<th>Test 1 = 2 hours</th>
<th>Test 2 = 500 steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple Watch (1)</td>
<td>1,199</td>
<td>511</td>
</tr>
<tr>
<td>Apple Watch (2)</td>
<td>2,387</td>
<td>513</td>
</tr>
<tr>
<td>Fitbit Charge HR</td>
<td>1,949</td>
<td>505</td>
</tr>
<tr>
<td>Fitbit Flex</td>
<td>1,962</td>
<td>486</td>
</tr>
<tr>
<td>Garmin vivosmart HR</td>
<td>2,818</td>
<td>513</td>
</tr>
<tr>
<td>Jawbone UP3</td>
<td>2,099</td>
<td>479</td>
</tr>
<tr>
<td>Misfit Flash</td>
<td>1,872</td>
<td>446</td>
</tr>
<tr>
<td>Polar A360</td>
<td>2,127</td>
<td>513</td>
</tr>
<tr>
<td>Withings Pulse O2</td>
<td>1,592</td>
<td>507</td>
</tr>
</tbody>
</table>

Source: Big Data research, note: not a scientific study.

Which wearable?

- Phone collects number of steps
  - Wear in hip pocket vs carry in hand vs 'arm pocket'
- Watch more consistent than phone
  - Dominant vs Non-Dominant
  - Change settings in device/app
- StepWatch Activity Monitor
  - 99% accurate at slow and irregular speeds
  - 99% accurate in people with COPD
  - 98% (unaffected) and 92% (affected) accurate in people with stroke
- Harder to use
- Consistent data, Battery life, Easy

Benchmarks and Trendlines

Instructions to the patient:
1. Sit in the middle of the chair.
2. Place your hands on the opposite shoulder crossed at the wrists.
3. Keep your feet flat on the floor.
4. Keep your back straight and keep your arms against your chest.
5. On “Go,” rise to a full standing position and then sit back down again.
6. Repeat this for 30 seconds.
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Benchmark

Chair Stand—Below Average Scores

<table>
<thead>
<tr>
<th>Age</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-64</td>
<td>&lt; 14</td>
<td>&lt; 12</td>
</tr>
<tr>
<td>65-69</td>
<td>&lt; 12</td>
<td>&lt; 11</td>
</tr>
<tr>
<td>70-74</td>
<td>&lt; 12</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>75-79</td>
<td>&lt; 11</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>80-84</td>
<td>&lt; 10</td>
<td>&lt; 9</td>
</tr>
<tr>
<td>85-89</td>
<td>&lt; 8</td>
<td>&lt; 8</td>
</tr>
<tr>
<td>90-94</td>
<td>&lt; 7</td>
<td>&lt; 4</td>
</tr>
</tbody>
</table>

How do we get the data?

- Data stored on device
  - Show
  - Synch process (Push)

- Data immediately sent to phone and then to database
  - Continuous data transfer (Bluetooth or Wi-Fi) (Pull)

- Auto-Share/Push or Push/Pull
  - Multiple
  - EHR
Issue: Data privacy is everyone’s responsibility

- **US FTC testing**
  - 12 mHealth and fitness apps
  - 76 different 3rd party companies
  - Phone unique device identifier; owners running route, dietary habits, and sleep patterns

- **Similar analysis of 43 fitness apps**
  - 40% collecting ‘high risk data’ (address, financial info, full name, health info, location, DOB, zip code)
  - 55% sharing data with 3rd party analytical services

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TeleHealth, TeleMedicine, Tele...

- Telephone-Video Calls
- Synchronous
  - Real Time
  - Interactive Services

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TeleHealth... Not

- Asynchronous
  - Store and Forward
  = Remote Monitoring
    - Interpretation of Data
    - Similar to Interpreting ECG or X-ray

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CMS and RPM Payment

- RPM is separate from Telehealth
  - Can be from home
- Jan 1, 2018: Remote Patient Monitoring
  - CPT 99091 Collection and interpretation of physiologic data...requiring a minimum of 30 minutes of time...per 30 day period
- Jan 1, 2019: Chronic Care Remote Physiologic Monitoring
  - CPT 99453 Set-up and patient education on use of equipment
  - CPT 99454 Device(s) supply with daily recording(s) or programmed alert(s) transmission, each 30 days
  - CPT 99457 20 minutes or more of clinical staff/physician/other qualified healthcare professional time a calendar month requiring interactive communication with the patient/caregiver during the month
- Jan 1, 2019 Home Health
  - Allow costs on HH Cost Reports
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Clinical Use of FitBit
Data: Possible Sub-Optimal Recovery Trajectory

Hospital D/C
Declining mobility

<2280 steps/day represents higher risk for readmission

Multiple days with mobility below high-risk cutoff

Clinical Use of FitBit

Clinical Use of FitBits

Large gaps with little activity in patients' day—possibly indicating high sedentary time, fatigue, etc.
Case Study 1

- 71yo female, hosp admit d/t Resp infection
- Fitbit provided prior to DC and instruction to pt and family
- Pt seen by a PT 1 days post DC and 7 days post DC. Fitbit data synch to tablet. Progressing with rehab. Reported no other concerns
- Manager reviewed the activity data. Noticed downward trend in amount and intensity of activity.
  - Called pt to ask her if she had been wearing her device

Case Study 1

- Pt reports
  - Feeling a little unsteady when walking
  - Some mild abdominal pain, so she hadn’t been as active. She attributed decreased activity to being tired from the PT sessions.
- Manager requested the PT schedule next visit early and re-evaluate these complaints
- PT notes decline in function and cognition
  - Calls MD who ordered lab testing
  - Dx of UTI

Case Study 1

- Unrecognized UTI may have led to a fall, ER visit, or unnecessary Hosp Adm
- Tracking physical activity level provided valuable clinical information

References:

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Case Study 2

- 68 yo male, retired teacher
- Elevated lipids, HTN, obesity, CVD
- Sedentary lifestyle
- Type 2 Diabetic
- 5’7” and 268#
- Recommendation: Increase activity, monitor calorie intake, monitor sleep, work with RD, and diabetes educator
- Agreed to wear Fitbit and work with RD


- 2 week
  - Reports tracking steps as a motivator
  - Walking less than 1 mile/day (<1,000); Activity = 14 min/day; Calories =NA
- 12 weeks
  - Walking 1.39 miles/day (2991 steps); Activity = 23 min/day; Calories = 1,571
  - Sleep avg 6 hr 5 min
- 36 week
  - Walking 4.15 miles/day (8931 steps); Activity = 64 min/day; Calories = 2,758
  - Sleep avg 8 hr 8 min
  - 22# wt loss
- Most underestimate caloric intake and overestimate physical activity

Technology

- Alexa, Echo, Siri, etc
- Devices to measure BP (24x7) and movement too
- Device that measures HR and respiration of everyone in the room —from across the room
- Sensor pads under mattress to measure sleep, HR, Location
- SensFloor. Install below all kinds of flooring—Capacitive sensor floor
  - Measure number of people, direction, gait speed, detect falls, & control music+
Quest: Improve Human Function

- Balance Technology and Hands on Care

- Wearables and Remote Monitoring
  - Function
    - Gait speed
    - Activity level
    - High HR at night
    - Sleep pattern

- When to intervene to improve function

This is why...

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