

MINDFUL HEALTH

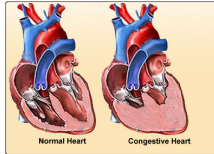
Simplifying outpatient management with wireless pulse oximetry, fluid web tools, and big data health insights

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Scientific & Clinical Background

Congestive Heart Failure (CHF)

- Congestive heart failure occurs when the heart is unable to pump blood efficiently throughout the body and thus is unable to deliver sufficient amounts of oxygen and nutrients that the body needs
- Around 670,000 people are diagnosed each year
- 6 million people are affected by heart failure in the U.S.
- Heart failure is the **leading** cause of hospitalizations in people older than 65, with an average life expectancy of 5 years post-diagnosis
- Pulse oximetry is a leading indicator of heart failure decompensations



Design Motivation

Affordable Care Act (ACA) Readmission Reduction Program

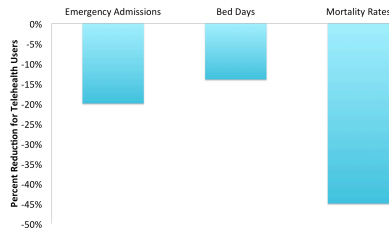
- Before: more patients in the hospital meant greater revenue for doctors and hospitals
- Now: incentive to keep patients out of the hospital with better outpatient care
- Center for Medicare & Medicaid Services will not pay for hospital readmissions within 30 days of departure
- In 2013 alone, Medicare levied **\$227 million in fines** for these avoidable readmissions in 2,225 hospitals across the country



Current Processes

- There is a "black box" when the patients leave the hospital.
- Current at home care methods are ineffective due to a significant issue with patient compliance
- *Readmissions could be avoided* with efficient telehealth monitoring in the home setting

Telehealth



- One of the largest telehealth studies to date was conducted by the UK department of health over two years with more than 6000 patients with CHF, COPD and diabetes. The results of this study showed a substantial reduction in a variety of clinical admissions, as well as a **45% reduction in mortality rates** for telehealth equipped patients
- Telehealth remote monitoring has yet to be highly adopted in the U.S. due to the tedious process of electronic health record (EHR) entry that accompanies current remote monitoring processes

pulseMobile Device & Cloud Application

Cloud Application Design Features

- Responsive alerts and notifications when patients cross pre-determined vital thresholds
- Actionable vital and trend data visualizations and analytics
- Automated patient severity categorization based on the most recent patient vitals
- Platform agnostic design enables access through any web enabled computer, tablet, or smartphone device
- High level of data, network, and system security

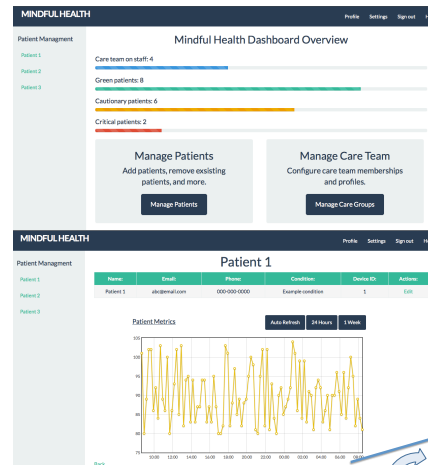


Figure A: A critical care dashboard and individual patient page displaying data

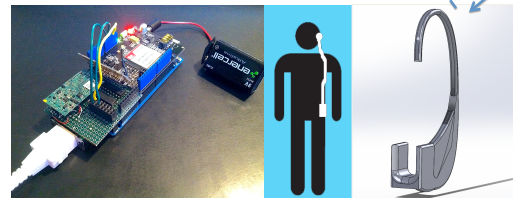


Figure B: The prototype pulseMobile (left), its typical use case (middle), and the next generation concept model (right)

Device Design Features

- Clinical grade, high profusion ear oximeter
- Automatically collects and transmits pulse oximetry data through the 2G/3G cellular network
- Smith's Medical FDA approved OEM pulse oximetry processor
- Integrates the signal and a GSM shield sends the collected data through the cellular network to the cloud
- Current prototype is the size of a pager but the next iteration will be miniaturized into the same form factor as a hearing aid

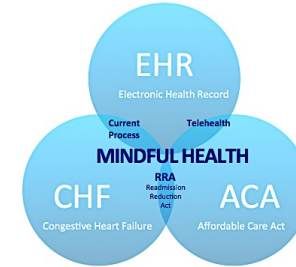
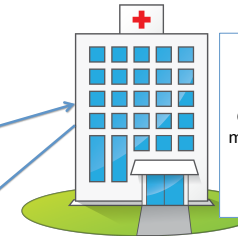


Figure C: Mindful Health seeks to simplify care processes, integrate telehealth into standard EHRs, and improve patient outcomes.

Testing

- Test driven development of cloud application using Rspec and Cucumber: Design system based on failed tests first, then rewrite code to pass them → ensures robust testing suite
- Device to cloud application connectivity: 100% data fidelity was observed in a near real-time update trial consisting of 10 updates, 1 per 10 seconds
- Power consumption



Continuous outpatient monitoring with pulseMobile will serve as a responsive, data driven clinical decision support tool for care team members, enabling focused, strategic preventative interventions and reducing avoidable hospital readmissions

Future Work

- Miniaturize electronics to hearing aid form factor
- Improve web application structure and functionality
- Launch pilot study to validate value proposition
- Continue customer development and user testing
- Configure an data archival system using Hadoop
- Migrate from Heroku to Amazon Web Services for HIPAA

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