Team Bre.ai

AI for Healthcare Hackathon

Challenge #2 - Enabling Pulmonary/Respiratory Medicine with AI

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costs estimated for COPD in the US by 2020

$49.0 B

costs incurred by asthma in the US each year

$56.0 B

AI in Respiratory Medicine

1. AI for the inhaler

To help with medical adherence solutions like Respiro Sense technology, Adherium's Hailie*TM* solution for reminders, and monitoring inhaler usage, using solutions like CareTRx

2. AI early indication/warning systems

Propeller spirometer and app use analytics to help patients using Propeller Air (an open API using machine learning and environmental sources to predict how asthma may be affected by local environment)

3. AI aided diagnostics

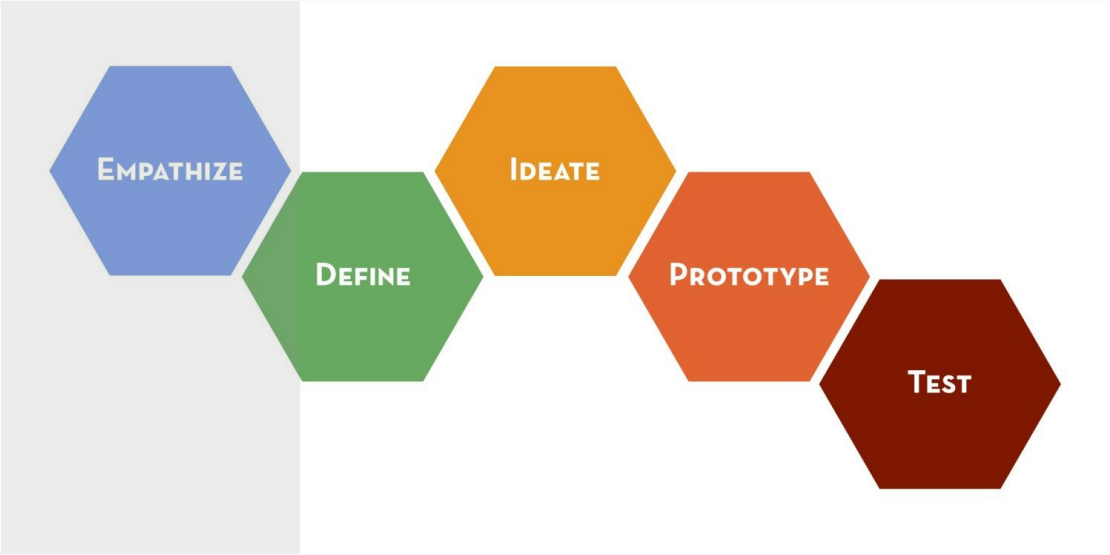
Smart spirometer like NUVOair's Air Next for pre/post bronchodilator analysis and automated data interpretation (Cohero Health's FDA approved mSpirometer sensory and BreatheSmart App)

4. AI aided lung imaging

Fluidda using AI to combine CT scan images with advanced computational fluid dynamics (CFD) to help pulmonologists visualize both structural and functional parameters of the lungs.

Product Development

Building a high fidelity mechanism to circumvent hospital visits for high risk patients with pulmonary disease



User Insurance providers & patients in the US
Need A way to detect and prevent factors contributing to COPD and asthma using wearable devices aggregated with protected patient data
Problem Statement How might we create a significant technological advancement to improve the accuracy of predicting a patient's risk to either obtain a new COPD/asthma or incur the cost of a hospitalization from a pre-existing pulmonary condition? How might we enable preventative health solutions with our tech in the future?

Explanation of Datasets Used

BIDMC DataSet

- 53 patients (19-90+) selected from a larger cohort
- Critically-ill patients, ICU
- ECG, PPG, thoracic impedance signals
- 8-minute recordings
- Sampling frequency: 125 Hz
- Manual annotation of breathing cycles

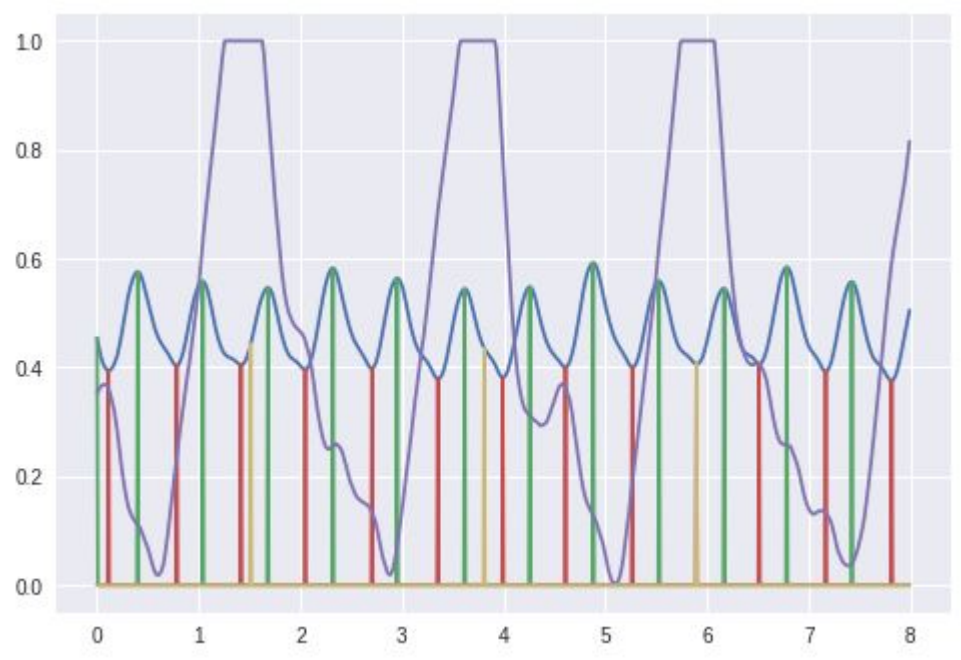
- PPG and/or ECG data can be analyzed and compared with the thoracic impedance signals which is the direct measurement data for respiratory rate (RR)
- Example: Auto-Regressive model based on this set of data [Ref: M. Pimentel et. al.]
- Use of the model to estimate RR using only PPG and/or ECG data

http://peterhcharlton.github.io/RRest/background.html

https://github.com/peterhcharlton/RRest/wiki

Data Analysis and Model Selected

- Pneumograph
- Photoplethysmogram (PPG)
- Annotated Breath
- PPG Local Minimum
- PPG Local Maximum



Hypothesis:
The variation in the PPG Local Maximum (“RIIV” - Respiration-Induced Intensity Variations) is a key feature in determining the respiration rate based only on the PPG.

Potential Application of BreAI in Early Detection

Pulmonary diseases where BreAI can help predict and prevent patient hospitalization

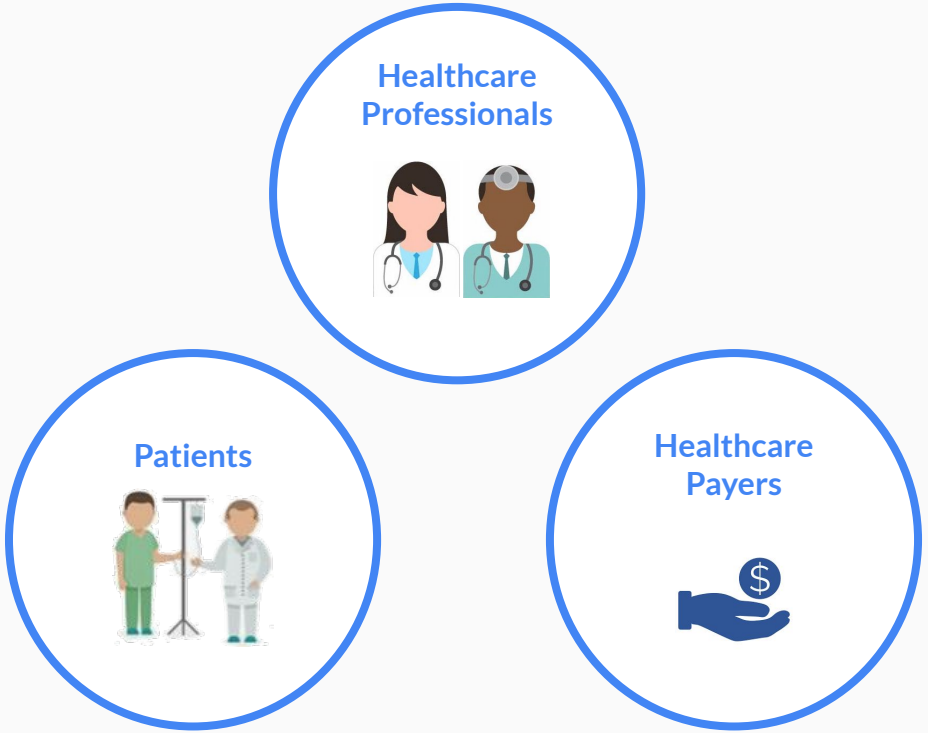
- Early detection enables interventions to avoid deterioration of patients conditions
- Avoid the need for hospitalization and associated high cost

- **Phase 1**
  - Asthma
  - COPD
  - Pneumonia
  - Sleep apnea
  - Chronic bronchitis

- **Phase 2**
  - Cardiac arrest
  - Correlating respiratory data to heart health
  - Requires more complex data aggregation and detail analysis

Product Value

For patients, professionals, and healthcare payers



Product Value

For patients, professionals, and healthcare payers

Healthcare Professionals

Patients

Healthcare Payers

Increase Speed of Acute Issue Recognition
Decrease hospital visits
Reduce % likelihood of chronic pulmonary illness

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Decrease Nurse/PA time spent measuring RR
Enable time for more complex tasks

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Healthcare Payers

Increase premium costs for high risk patients
Decrease large unanticipated costs that patients are not prepared to pay for acute care

Information for Phase I & II

Phase I

Phase II

Patient Data

- Medical History
- Medications
- Recent Procedures

- Vitals, including:
- $C0_2$ concentration and partial pressure from capnography
- SpO_2: Blood oxygen saturation level
- Photoplethysmogram from Pulse oximeter (PPG)
- Heart Rate
- Heart Rate variation
- ECG

Hospital Data

- Number of hospital acquired infections (Ventilator Associated Pneumonia) in respiratory patients

- Billing (patient & insurance)

- Hospital Mgmt- Employee'sTime & Compensation

- Sepsis
- ICU
- Length of hospital stays

Healthcare Payer / Insurance Data

Mean RR rates from patient historical data to show when patients of certain age/ethnicity/medical history were hospitalized due to pulmonary disease

- Cost of hospitalization & medication
- Hospital admission reason and treatment
- Hospital duration of stay
- Visits to providers pre-hospitalization
- Disease progression
- Medication adherence pre and post hospitalization

Sources

Pulmonary Disease + AI Data Sources

- Data sets:
- CDC Data (Slides 2-5): https://www.cdc.gov/copd/infographics/copd-costs.html, https://www.cdc.gov/asthma/impacts_nation/asthmafactsheet.pdf
- Current pulmonary disease interventions
- https://www.caretrx.com/
- Datasets:
- http://peterhcharlton.github.io/RRest/background.html
- https://github.com/peterhcharlton/RRest/wiki

Image sources:
https://www.providertech.com/for-payers/ (icon)
https://blog.rackspace.com/design-thinking-transforming-businesses-through-technology (icon)

Appendix

Pulmonary disease detection - Normal methods only

Disease	Symptoms	Doctor's protocol	Tests ordered	RR can help?
Pneumonia	Cough with phlegm (a slimy substance), fever, chills, and trouble breathing, confusion, chest pain when breathing or coughing, fatigue, lower body temp, nausea, vomiting, diarrhea Look out for systolic blood pressure below 90 millimeters of mercury (mm Hg) or your diastolic blood pressure is <= 60 mm Hg Rapid breathing HR below 50 or above 100	Physical exam **?s regarding:** ●Exposure to sick people ●Animals ●recent traveling ●Hobbies ●past and current medical conditions ●Medications ●Smoker? ●whether or not you've had the flu ●Swelling ●cyanosis (blue color of the skin indicating low O2 saturation levels) ●veins in neck **Vitals:** Breaths/min Temperature	**Blood tests.** Blood tests are used to confirm an infection and to try to identify the type of organism causing the infection. However, precise identification isn't always possible.(CBC or complete blood count) **Pulse oximetry.** This measures the oxygen level in your blood. Pneumonia can prevent your lungs from moving enough oxygen into your bloodstream. **Sputum test.** A sample of fluid from your lungs (sputum) is taken after a deep cough and analyzed to help pinpoint the cause of the infection. **CT scan.** If your pneumonia isn't clearing as quickly as expected, your doctor may recommend a chest CT scan to obtain a more detailed image of your lungs. **Chest Xray.** See if fighting an infection. **Pleural fluid culture.** A fluid sample is taken by putting a needle between your ribs from the pleural area and analyzed to help determine the type of infection.	Assumption: Yes

Generic Business Value

Why make the investment?

Emphasize **cost reduction** or **efficiency** to initiate the project

Free up **employee time** for more **complex** and severe cases

Introduce new technology for **broader patient populations**, esp. those who otherwise have **limited access to health services**

Reducing overall cost of care for **both payers and providers** - good for hospitals & health insurance

Total costs that could be reduced by lowering rates of asthma by X% and COPD by Y%

$58x + 65y B