DeepPneumo: A global platform to eradicate childhood pneumonia in low-resource settings

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Yemaya

She lives in a **small village.**

Income: **3 $** per day

Uganda **30** years old

Self-supporters: house and cultivated fields are her most valued possessions.

Five, 6 months, 2, 4, 5 and 7 years old, children

Maria

She lives in a **hilly suburbs.**

Income: **4 $** per day for whole family.

Peru **30** years old

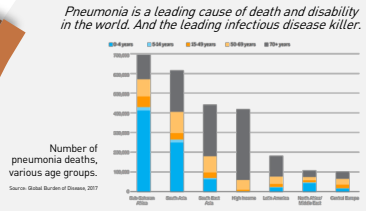
Second-hand **Nokia phone** is her most valuable possession.

Three children, one is 3 years old

Delay of treatment has been reported in Peru due to lack of knowledge and trust in healthcare system by parents.

Identified Problems

Pneumonia is a leading cause of death and disability in the world. And the leading infectious disease killer.



1 **Low specificity:** Most of the systems just detect one symptom (e.g. Respiratory Rate, Oximetry, temperature, etc.). One symptom is not enough to properly diagnose pneumonia.

2 **Poor distinction between bacterial and viral pneumonia:** This is key for the treatment. Improving it will decrease the overuse of antibiotics as well as improving the efficacy of the overall treatment.

3 Devices do not give **automatic diagnosis** and suggestion of **treatment** option.

4 **Additional sensors** such as pulse oximetry, automatic RR counter and temperature, **make the device less affordable.** However, they are important to accurately diagnose pneumonia.

5 Generally **low acceptability** of new devices by locals.

Current Technologies

Philips Charm

- Cheap and durable.
- Just measures respiratory rate.
- Belt-accelerometer sensor, not very comfortable.

Lifebox

- Accurate and easy to use Pulse Oximeter.
- Business model based on using other's technologies.
- Too many consumables.

FebriDX

- Can accurately discern between viral and Bacterial Pneumonia.
- The machine is expensive as well as its cost/test.

Children at **vulnerable age & Health workers** are **not well trained**, thus are not able to give the right diagnosis nor treatment.

Fatima

She lives in a **refugee camp** in Jordan managed by WHO.

38 years old **Syria**

Income: **3 $** per day

Passport and **mobile phone** are her most valuable possessions.

Two children, 5 and 6 year old

Primary health care:
- Some **mental health & gender violence** support.
- Ambulances for **Secondary & Tertiary** health care.

Dytia

38 years old **Nepal**

She lives in **rural area** in high altitude

Income: **10 $** per day for whole family

3 grandchildren: 8 months, 2 and 5 years

Next Health Post is **one hour** away

Prevalence of pneumonia in Nepal **reduced** over last decades as result of Community-Based Integrated Management of Childhood Illness program

*The system consists of two parts: **The device**, which holds a Respiratory Rate sensor and a Pulse Oximetry probe. And the **mobile App.**, which is wireless connected to the device and gathers information from the device, health workers, and other devices.*

Respiratory Rate

Automated breathing rate monitor sensor that converts chest movements detected by accelerometers into breathing count.

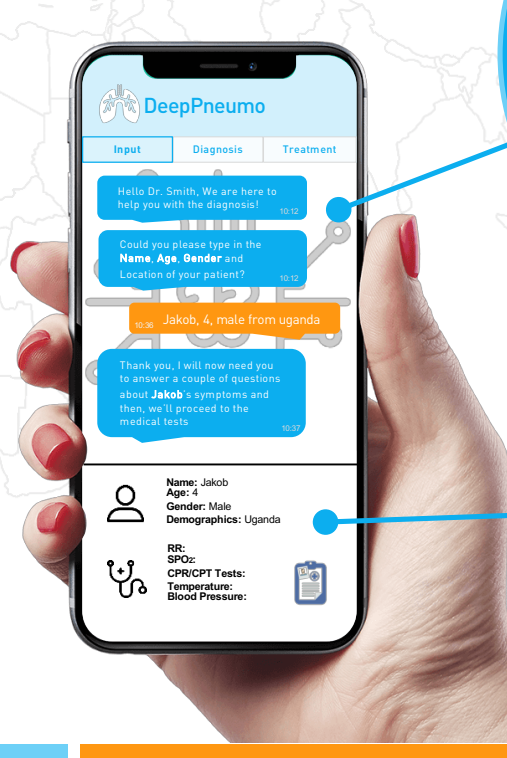
Age	Fast breathing
0 – 2 months	≥ 60 breaths/min
2 – 12 months	≥ 50 breaths/min
1 – 5 years	≥ 40 breaths/min

According to IMCI fast breathing is one of the key vital signs to diagnose pneumonia in children.

Pulse oximeter

Pulse oximeter sensor to detect the levels of Oxygen Saturation. The probe can be attached to the body of the device.

Recommended by WHO for detecting hypoxemia. A potential fatal complication of pneumonia



Mobile health

An App. that gathers information about the patient and their symptoms in a user friendly chatbot. The App. then predicts the diagnosis and gives further indications about the treatment

GENERAL INPUTS
Patient information: Age, Gender, Ethnicity and Demographics
Clinical History: When did the symptoms start? Any other episodes of pneumonia ? etc.

SENSOR INPUTS
Respiratory Rate from the sensor or from an integrated RR counter in the App..
Oxygen Saturation from the Pulse oximeter.

OTHER INPUTS
Gathered from any other health systems:
- **Lab tests (CRP, PCT),** to differentiate between Virat or Bacterial pneumonia.
- Cough / Auscultation
- Other Vital signs **(Temp & Blood Pressure)**

Prediction Model

The data gathered by the App. is sent to a Server. In the short run, the App. will give **recommendations** about the **diagnosis** & **treatment** based on current Medical Standards. Meanwhile, a model based on Machine Learning algorithms will be built. In the Long Run, the App. will give more accurate diagnosis as well as **personalized** guidelines for the treatment

PERFORMANCE

- ⊕ Minimize human error.
- ⊕ Improved specificity.
- ⊕ Allow integration of other sensors.
- ⊕ No safety concern.

"Promising other health apps e.g. ADA Machine learning as promising area."

- ⊖ Misdiagnosis: false-positive.
- ⊖ Possible misleading recommendation.
- ⊖ Does not work with too few inputs.

"Validation of the algorithm in LMIC shall be tested to increase the evidence of the performance."

USAGE

- ⊕ Intuitive and user-friendly App. interface
- ⊕ Easy to understand outcome measures.
- ⊕ No internet is required for usage.

"Ease of use on devices is one of the main component to introduce new technologies in low resources settings."

- ⊖ A smartphone is required.
- ⊖ Data privacy concerns.
- ⊖ Internet connection is required to upload the data to improve the model

"It is critical to improve the model for the application to truly support the health workers."

COST

- ⊕ No additional cost for using the App..
- ⊕ Reduce the cost of follow-up treatment.
- ⊕ No cost of maintenance and access.

"Reduce the burden of healthcare cost in low resources country is one of the main objectives."

- ⊖ Misdiagnosis could lead to increased costs.
- ⊖ Funding is required for the App., i.e. development and improvement.
- ⊖ Hard and expensive to get approval of the whole application system.

"For the application to provide treatment related information, approval from regulatory institute(s) is important and costly."

DURABILITY

- ⊕ Less dependence on the device.
- ⊕ Data is stored and will not get lost.
- ⊕ The App. lasts forever.
- ⊕ The App. can be updated at anytime, any place, where there is internet connection.

"A physical repair or recycle station is not required for fixing the application."

- ⊖ Smartphone battery might be an issue.
- ⊖ Hard to maintain due to attached sensors.
- ⊖ Hard to incorporate culture differences into the application, incl. function which allows varies local language setting.