

# Automated Contact-Free Cough Monitoring in Hospitalized Covid-19 Patients

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Project start: March 2020. Planned project duration: 6 months.

## Project Goal

One of the most prominent symptoms of Covid-19 pneumonia is cough. Due to a **lack of contact-free cough monitoring technology**, prior research had to treat **cough as a qualitative symptom instead of the quantitative symptom it is**.

Our goal was to **develop a cough monitoring system** and to **evaluate it with hospitalized (Covid-19) pneumonia patients**.

A second study stage, which examines the **utility of cough as a prognostic/predictive biomarker**, is currently ongoing.

## Key Findings

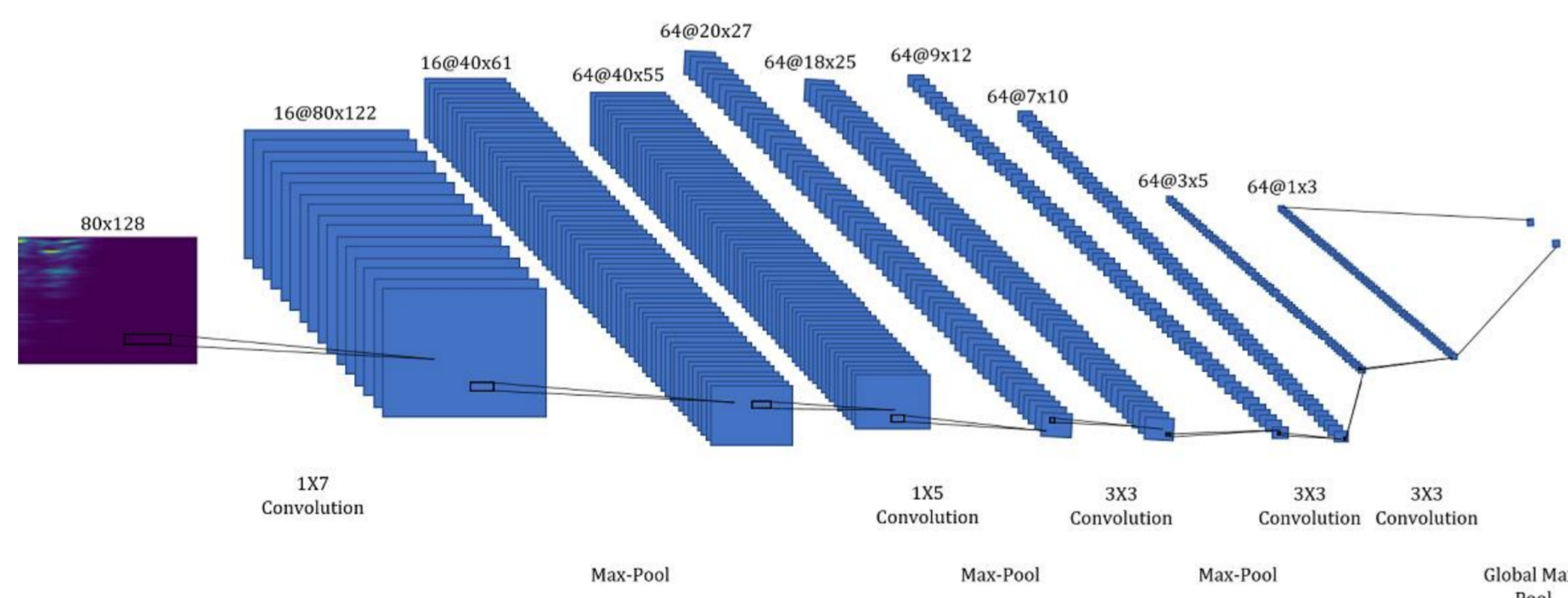
Our cough quantification system achieved a **positive predictive value (precision) of 95%** despite the challenging 24/7 hospital study setting. A **coverage rate of 100%** indicates the robustness of our system.

Of the first 10 included pneumonia patients, five were nCoV-positive.

Preliminary insights	nCoV-negative	nCoV-positive	p-value
Coughs per day	M = 113 (SD = 52)	M = 240 (SD = 147)	$p < .1$
Length of hospitalization	M = 5 days (SD = 5.4)	M = 4.5 days (SD = 1.9)	ns

## Scientific Innovation

We developed a **smartphone application** that imports our **proprietary acoustic deep learning (DL) model<sup>1</sup>** (i.e., an ensemble of five convolutional neural nets trained on data from 94 asthma patients<sup>2</sup>) and adapts it to the hospital use case: The app runs **fully automatically 24/7 without requiring any user input**. We equipped **hospital beds** with our study smartphones. Cough frequencies are **uploaded in real-time to a website** that physicians can access at anytime. Our evaluation reveals that our **DL models distinguished cough very well from non-cough**.



<sup>1</sup> Barata et al. (2020). Automatic Recognition, Segmentation, and Sex Assignment of Nocturnal Asthmatic Coughs and Cough Epochs in Smartphone Audio Recordings. *JMIR*, 22(7), e18082.

<sup>2</sup> Tinschert et al. (2019). Nocturnal cough and its potential as a marker for asthma: protocol of a smartphone-based, multicenter, longitudinal observational study with two stages. *BMJ open*, 9(1).

## Business Potential

Our preliminary results suggest a **positive correlation between cough count on the first day and the length of the hospital stay**. Thus, there seems to be value in **quantifying cough** for hospitalized pneumonia patients. Prior research also indicates the **utility of (nocturnal) cough as a monitoring and prognostic biomarker for asthma and COPD**.

*It is our mission to bring this biomarker from bench to a patient's bedside:*

With our solution, **nocturnal cough can be quantified objectively and accurately without patient effort**. A biomarker, which can be measured passively by a patient's smartphone at night, would represent a **paradigm shift in the disease management of chronic respiratory conditions** from active and often subjective to convenient and objective monitoring. By facilitating disease monitoring for patients and making it compatible with their everyday lives, we strive to **prevent costly and dangerous disease escalations** (e.g. asthma attacks; table below lists estimations of yearly preventable emergency costs for asthma).

Estimations	Preventable asthma emergency costs p.a.
Switzerland	CHF 38M (population: 8.6M, asthma prevalence: 5.1%)
Germany	CHF 362M (population: 83.2M, asthma prevalence: 7.6%)
United Kingdom	CHF 512M (population: 66.7M, asthma prevalence: 17.6%)

