

A pilot study of daily telemonitoring to predict acute exacerbation in chronic obstructive pulmonary disease

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ABSTRACT

Background: Exacerbations of COPD (ECOPD) are important events in the course of COPD and they accelerate the rate of decline of lung function, and exacerbations requiring hospitalization are associated with significant mortality. Therefore, developing approaches of prevention and early treatment of ECOPDs are of special clinical interests. One of such approaches is telecare, including home telemonitoring.

Material and methods: Daily telemonitoring of HR, BP, SpO₂ and spirometry was performed. Variables were compared using the bootstrap-boosted inference tests: the paired *t*-test or Wilcoxon signed rank test, depending on data normality, and categorical variables were compared using exact McNemar's test.

Results: Nineteen patients were included to the study. We observed significant decrease in SpO₂ 7 days preceding ECOPD ($P = 0.007$; $P_{bootstrap-boosted} = 0.005$) and increase in number of events of day-to-day decrease in oxygen saturation > 4% in the period of 7 days preceding ECOPD versus reference period ($P = 0.02$).

Conclusions: Oxygen saturation telemonitoring would be successfully used in predicting ECOPD. Recording of day-to-day decrease in oxygen saturation > 4% as alarming events would be effective approach which would be easily implemented in telemonitoring devices, however this outcome should be further validated in larger size samples.

1. Introduction

Chronic Obstructive Pulmonary Disease (COPD) is one of the major global health problems with more than 3 million people died in 2005, and the estimations predict that it will become the third leading cause of death worldwide in 2030 [1]. COPD is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases [2].

Exacerbations of COPD (ECOPD) are important events in the course of COPD and they accelerate the rate of decline of lung function [2–4]. Exacerbations requiring hospitalization are associated with significant mortality. Exacerbation, with hypercapnia (elevated level of carbon dioxide in blood) is burdened with approximately 10% of in-hospital mortality [5]. Long-term prognosis following hospitalization for ECOPD is also poor – according to metaanalysis by Hoogendoorn et al. the average in-hospital mortality rate was 6.7%, the average mortality rates at 3 and 6 months were 18% and 26%, respectively, and 51% at 5 years [6]. This is why there is a strong need to elaborate approaches to

prevent from ECOPDs and, as the effect, ameliorate prognoses.

Telemedicine is the use of telecommunication and information technology to provide clinical health care from a distance. It has been used to overcome distance barriers and to improve access to medical services that would often not be consistently available in distant communities [7]. Telemedicine might be also one of the tool that help to predict ECOPD, delayed hospitalizations and can fulfill an important role in enabling patients with COPD to better manage their condition and remain out of hospital [8].

The aim of the study was to assess the usefulness of pulse oximetry (SpO₂), heart rate (HR), blood pressure (BP), and spirometry in telemonitoring as the approach for early prevention of ECOPD.

2. Materials and methods

Patients with COPD in category D according to GOLD guidelines (the most severe category of COPD patients, those symptomatic and with high risk of death) were enrolled to the study from July 2014 to August 2017. Patients were enrolled in the Outpatient Clinic and

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Fig. 1. Equipment used for telemonitoring: A. Mobile phone as a reporting device, B. sphygmomanometer, C. spirometer and pulse oximeter.

Department of Pneumology and Allergy of Medical University of Lodz. The main criterion was ≥ 1 exacerbation requiring hospitalization within last 12 months and/or ≥ 2 exacerbations not requiring hospitalization with the need for systemic steroid therapy and/or antibiotic therapy. All patients had to obtain positive result in Mini Mental Test and training with the use of telemedicine equipments. Informed consent was obtained from all subjects. Study was approved by the Institutional Ethical Committee and informed consent was obtained from all patients.

Daily telemonitoring of following parameters was performed: HR, BP, SpO₂ and spirometry (Spirotek[®], MIR Company, Rome, Italy), using equipment presented in Fig. 1. Measurements should have been made every day, in sitting position, after 5-min rest. Those subjects who required long term oxygen therapy (LTOT) were asked to use it during the measurements. The results were reported using telemetric system entirely designed and produced for the purpose of this study (Mediguard[®]) – Fig. 2. This software enables clinical data storage and analysis in real time. Monitoring staff have access to the data via protected internet website, compatible with all types of browsers, 24 h a day.

As the exacerbation we recognized an event characterized by a worsening of the patient’s respiratory symptoms that is beyond normal

day-to-day variations and which leads to a change in medication. All the events were confirmed by physician. Each patient was monitored until the first recorded exacerbation. The telemonitoring was terminated 19th December 2017.

Continuous data was presented as the mean with standard deviation (SD) or median with interquartile range (IQR), depending of distribution of data. Data were stratified using two periods: reference period (7 days within stable period of COPD) and period of 7 days preceding ECOPD. These time periods were based on previous evidence, which has suggested that symptoms tend to worsen during the 7 days immediately before an exacerbation episode [9,10]. The “stable” period was defined as a next time window of 7 days before this time.

Variables were compared using the bootstrap-boosted inference tests: the paired *t*-test or Wilcoxon signed rank test, depending on data normality. Categorical variables were compared using exact McNemar’s test. *P*-value < 0.05 was considered as statistically significant. Statistical analyses were performed using R software for MacOS.

3. Results

29 patients were enrolled in the study, of whom 22 had ECOPD.

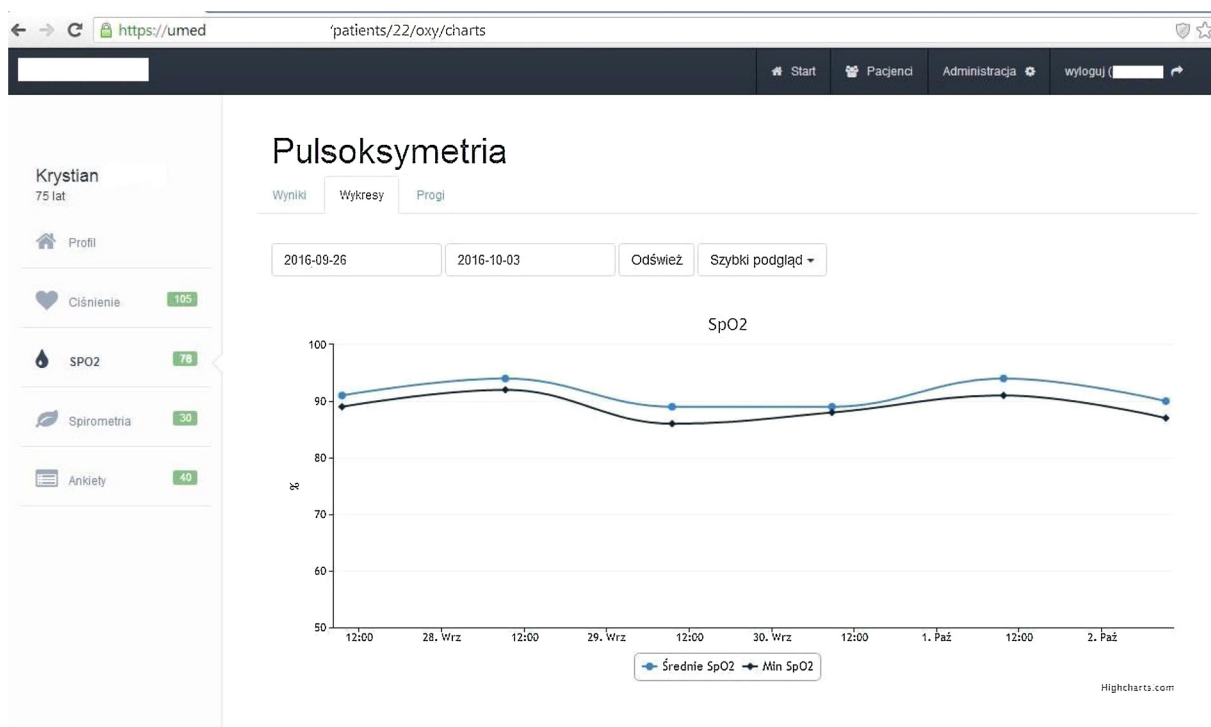


Fig. 2. Mediguard[®] software interface, presenting day-to-day SpO₂ in one of the patients (from 5 days of observation).

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