



## Early identification and treatment of COPD exacerbation using remote respiratory monitoring

Michael B. Polsky<sup>\*</sup>, Neema Moraveji

*Pulmonary Associates of Richmond, Spire Health, USA*

### ARTICLE INFO

#### Keywords:

COPD  
Remote patient monitoring  
RPM  
Respiration rate  
Prediction  
Exacerbation

### ABSTRACT

Remote patient monitoring (RPM) is increasingly more accessible and accurate. The optimal utilization of RPM requires medical conditions which have predictive physiologic changes and effective outpatient therapies. Respiratory rate elevation has been shown to be predictive of impending chronic obstructive pulmonary disease (COPD) exacerbation and treatment often focuses on home-based medical therapies. In this case, we report the successful treatment of a patient with an exacerbation of COPD based on pre-identification via respiratory RPM.

### 1. Introduction

Remote patient monitoring (RPM) is seeing an expanded role as a result of the improvements in technology and changes in care delivery due to the COVID-19 pandemic [1,2]. RPM entails electronically captured patient physiologic data that is automatically transmitted to clinical care team. The goal of RPM is to improve patient engagement as well as identify physiologic changes earlier than otherwise feasible, in order to allow for proactive interventions resulting in improved patient outcomes. The success of RPM in achieving these goals is dependent on the existence of effective and accessible medical interventions.

Chronic obstructive pulmonary disease (COPD) has an estimated global prevalence of 11.7% resulting in significant worldwide morbidity [3]. Exacerbations, COPD's most significant burden to patients and healthcare systems, are an acute worsening in a patient's respiratory symptoms requiring a change in medical therapy [3]. Exacerbations are associated with significant rates of hospitalization and an acceleration of disease progression [3]. The majority of COPD exacerbations can be managed on an outpatient basis with the use of bronchodilators, antibiotics and oral steroids, making it a promising candidate for early intervention using RPM technology.

Unfortunately, COPD exacerbations are underreported by patients which leads to worse outcomes [4]. Conversely, when early therapies for exacerbations are instituted, patients have shorter symptom duration, improved quality of life as well as decreased hospitalizations [5]. The reasons for patient delays in care for exacerbations is multifactorial and

a patient's inability to recognize symptoms as significant is likely a major factor [4].

Seemungal et al. reported a 7-day prodrome prior to diagnosis of exacerbation [6]. With this in mind, the use of respiratory RPM has the potential to reduce COPD treatment delays leading to improved care. Increased respiratory rate has demonstrated predictive ability for exacerbations of COPD [7,8]. Shah et al. observed an increased respiratory rate in the 5 days preceding hospitalization for COPD exacerbations, highlighting the window of opportunity for intervention [7].

Here, we present a case of COPD exacerbation detected using RPM in a clinical setting. The RPM system (Spire Health, 2021) has been validated for use with chronic respiratory disease patients [9,10] and is comprised of: (1) Health Tags, undergarment waistband-adhered physiologic monitors which include photoplethysmography, activity, and respiratory force sensors, (2) an in-home stationary device to collect and upload sensor data, and (3) a web dashboard to display patient data and notifications to clinicians. Changes in physiologic parameters were monitored by respiratory therapists 7-days per week and patients were contacted by phone in the event of significant deviations from the patient's baseline in device adherence, respiratory rate (RR), pulse rate (PR), or activity level. In these cases, a standardized, telephonic risk assessment was performed and, if confirmative, the patient was escalated to their pulmonologist. Subsequent clinical visits were done in-person or via telehealth.

<sup>\*</sup> Corresponding author.

E-mail addresses: [mpolsky@paraccess.com](mailto:mpolsky@paraccess.com) (M.B. Polsky), [neema@spirehealth.com](mailto:neema@spirehealth.com) (N. Moraveji).

<https://doi.org/10.1016/j.rmcr.2021.101475>

Received 16 June 2021; Accepted 6 July 2021

Available online 21 July 2021

2213-0071/© 2021 The Authors.

Published by Elsevier Ltd.

This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

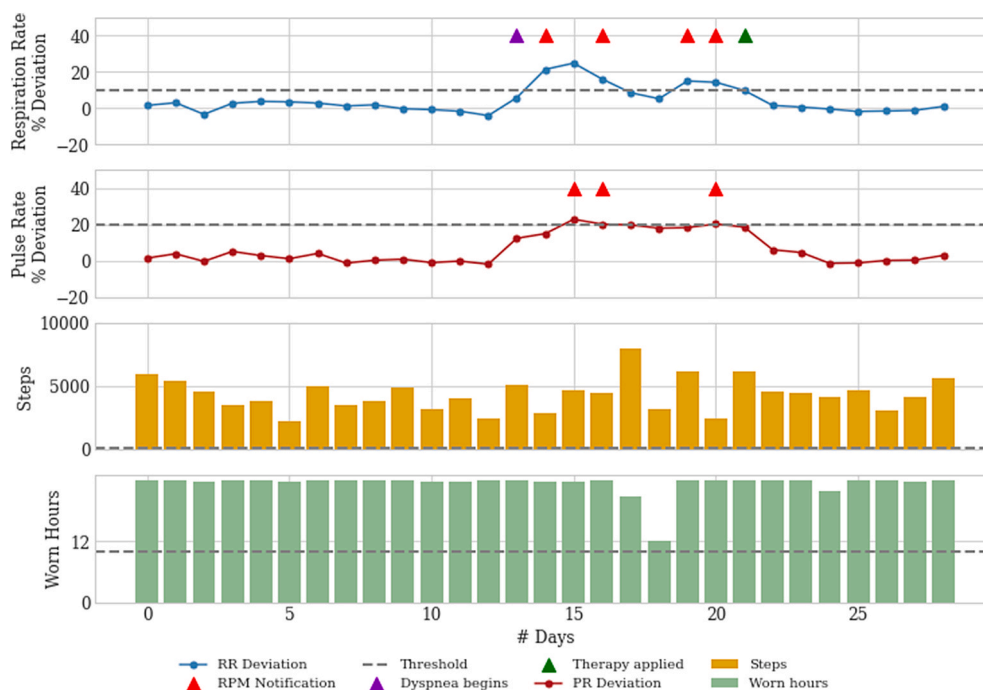


Fig. 1. Patient with mild COPD exhibiting significant deviation in respiratory and pulse rates during a 30-day period, collected by RPM. PR=Pulse Rate. RR = Respiratory Rate.

## 2. Case

The patient is an 84-year-old male with mild COPD and cardiomyopathy. The initial physiologic notification was a daily RR of  $\geq 10\%$  above the patient's daily RR baseline (see Fig. 1). The patient was contacted by the clinical team regarding these changes and he reported intermittently increased dyspnea and a change in sputum color. He attributed some of his symptoms to increased physical work at his home. The patient opted against seeing the physician and his RR transiently improved. Five days later, the patient was recontacted due to recurrent elevation in daily RR and PR. The patient then reported increased cough, sputum with persistent color change, and shortness of breath. The patient agreed to a telemedicine visit with his pulmonologist. He was diagnosed with, and treated for, a COPD exacerbation with doxycycline and a prednisone taper. Shortly after the initiation of therapy, the patient's physiologic parameters returned to normal. At follow-up a week later, the patient reported resolution of his acute symptoms.

## 3. Discussion

This case demonstrates the successful utilization of RPM for COPD. Physiologic changes were flagged to the clinical care team. The patient was proactively engaged and clinically assessed. While the patient initially declined a physician visit, the recurrent respiratory rate elevation prompted reengagement with the patient, eventually leading to successful pharmacologic therapy for a COPD exacerbation.

COPD represents a promising disease for the employment of RPM [11]. Until recently, home monitoring of cardiorespiratory parameters was limited due to technical limitations, patient burden, and cost. For RPM utilization to be successful, monitored physiologic variables need to be predictive of future clinical deterioration and rapid home-based therapies must exist. COPD exacerbations have a known prodrome which provides a window of time to provide medical management and improve outcome<sup>6,7,8</sup>. Additionally, standard treatment for COPD exacerbations typically includes oral and inhaled medications making it ideal for early, outpatient management [3].

Opportunity exists for RPM to improve care in ambulatory COPD

patients. Delay in medical therapy for exacerbations has significant consequences including hospitalization risk and enhancing disease progression [3]. Early identification of exacerbation using RPM is possible and now accessible to physicians and patients.

## Declaration of competing interest

Dr. Polsky is a paid consultant to Spire Health. Dr. Moraveji is a paid employee of Spire Health.

## References

- [1] F.A.C. Farias, C.M. Dagostini, Y.A. Bicca, V.F. Falavigna, A. Falavigna, Remote patient monitoring: a systematic review, *Telemed. J. e Health* 26 (5) (2020 May) 576–583, <https://doi.org/10.1089/tmj.2019.0066>. Epub 2019 Jul 17. PMID: 31314689.
- [2] C. Massaroni, A. Nicolò, E. Schena, M. Sacchetti, Remote respiratory monitoring in the time of COVID-19, *Front. Physiol.* 11 (2020 May 29) 635, <https://doi.org/10.3389/fphys.2020.00635>. PMID: 32574240; PMCID: PMC7274133.
- [3] Global initiative for chronic obstructive lung disease. <https://goldcopd.org/2021-gold-reports/>, 2021. (Accessed February 2021).
- [4] L. Langsetmo, R.W. Platt, P. Ernst, J. Bourbeau, Underreporting exacerbation of chronic obstructive pulmonary disease in a longitudinal cohort, *Am. J. Respir. Crit. Care Med.* 177 (4) (2008 Feb 15) 396–401, <https://doi.org/10.1164/rccm.200708-1290OC>. Epub 2007 Nov 29. PMID: 18048806.
- [5] T.M. Wilkinson, G.C. Donaldson, J.R. Hurst, T.A. Seemungal, J.A. Wedzicha, Early therapy improves outcomes of exacerbations of chronic obstructive pulmonary disease, *Am. J. Respir. Crit. Care Med.* 169 (12) (2004 Jun 15) 1298–1303, <https://doi.org/10.1164/rccm.200310-1443OC>. Epub 2004 Feb 27. PMID: 14990395.
- [6] T.A. Seemungal, G.C. Donaldson, A. Bhowmik, D.J. Jeffries, J.A. Wedzicha, Time course and recovery of exacerbations in patients with chronic obstructive pulmonary disease, *Am. J. Respir. Crit. Care Med.* 161 (5) (2000 May) 1608–1613, <https://doi.org/10.1164/ajrcm.161.5.9908022>. PMID: 10806163.
- [7] S.A. Shah, C. Velardo, A. Farmer, L. Tarassenko, Exacerbations in chronic obstructive pulmonary disease: identification and prediction using a digital Health system, *J. Med. Internet Res.* 19 (3) (2017) e69, <https://doi.org/10.2196/jmir.7207>. Published 2017 Mar 7.
- [8] A.M. Yañez, D. Guerrero, R. Pérez de Alejo, F. García-Río, J.L. Alvarez-Sala, M. Calle-Rubio, R.M. de Molina, M. Valle Falcones, P. Ussetti, J. Sauleda, E. Z. García, J.M. Rodríguez-González-Moro, M. Franco Gay, M. Torrent, A. Agustí, Monitoring breathing rate at home allows early identification of COPD exacerbations, *Chest* 142 (6) (2012) 1524–1529.

- [9] Mark Holt, et al., Ambulatory monitoring of respiratory effort using a clothing-adhered biosensor, in: IEEE International Symposium on Medical Measurements and Applications (MeMeA), IEEE, 2018.
- [10] Neema Moraveji, et al., Long-term, ambulatory respiratory monitoring of COPD patients using garment-adhered sensors, in: IEEE International Symposium on Medical Measurements and Applications (MeMeA), IEEE, 2019.
- [11] I. Tomasic, N. Tomasic, R. Trobec, et al., Continuous remote monitoring of COPD patients—justification and explanation of the requirements and a survey of the available technologies, *Med. Biol. Eng. Comput.* 56 (2018) 547–569, <https://doi.org/10.1007/s11517-018-1798-z>.