

Vital Signs Remote Patient Monitoring In Real-life For Early Detection Of AECOPD

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Introduction

The early detection of acute exacerbations of chronic obstructive pulmonary disease (AECOPD) is key to deliver early treatments to prevent hospital (re-)admission, reduce exacerbation severity and improve quality of life. Patient self-reported symptoms on digital apps provide moderate ability in predicting exacerbation events and patients may be reluctant to complete symptom scores for months. Real-time algorithms based on remote patient monitoring (RPM) with wearables sensors appear to be more serious candidates to achieve high performance in early detection of AECOPD in real life.

The Meuse Departmental Council, experiments a 6-month personalized and integrated homecare project that combines vital signs and activity remote monitoring with therapeutic education to improve the quality of life of patients with COPD.

Methods

In this study, 85 COPD patients benefited from a 6-months integrated care at home using the BORA Care® remote monitoring solution (Manufacturer : Biosency).



The BORA Band® wristband automatically and regularly measures patients' oxygen saturation (SpO2), respiratory rate (RR), heart rate (HR), and physical activity (step count, activity duration). The wristband is connected to the BORA Connect® remote monitoring platform via the BORA Box gateway. The Pulmonology Department of the Verdun Hospital monitored patient's vital signs and activity on Bora Connect on a daily basis and took therapeutic actions if needed when vital signs were deteriorating. AECOPD dates and severities were collected.

A patient-specific risk score (BVS³) based on the deviation to the mean of SpO2, HR and RR was designed. The performance of the BVS³ in the early detection of AECOPD was tested retrospectively on collected data.

Population

85 patients have been monitored at the Verdun hospital. The population is composed by 62% of men, with a mean age of 63.8 years (standard deviation of 8.3 years), a mean BMI of 28.2 (standard deviation of 6.6). All GOLD groups are represented in the study population: 8% of patients are GOLD group A, 45% group B, 47% group E (24% group C, 23% group D). The univariate analysis of all quantitative of qualitative data is presented below.

	TOTAL	Non exacerbating patients	Exacerbating patients			
			TOTAL	Severe	Moderate	Mild
Number of patients	85	63 (74%)	22 (26%)	5 (6%)	14 (16%)	6 (7%)
Age	63.8 (8.3)	64.8 (8.0)	60.8 (8.5)	54.2 (12.4)	63.7 (6.5)	61.2 (3.0)
Sex (Men)	53 (62%)	40 (63%)	13 (59%)	3 (60%)	7 (50%)	4 (67%)
BMI	28.3 (6.5)	28.7 (6.4)	27.0 (7.0%)	26.1 (0.7)	27.2 (8.0)	32.4 (6.8)
GOLD A	7 (8%)	7 (11%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
GOLD B	38 (45%)	30 (48%)	9 (43%)	3 (60%)	3 (23%)	3 (60%)
GOLD C	20 (24%)	14 (22%)	6 (29%)	1 (20%)	5 (38%)	2 (40%)
GOLD D	19 (23%)	12 (19%)	7 (33%)	2 (40%)	5 (38%)	0 (0%)
Emphysema	55 (67%)	39 (63%)	16 (76%)	5 (100%)	10 (77%)	3 (75%)
Oxygen-therapy	21 (25%)	11 (17%)	10 (48%)	3 (60%)	6 (46%)	1 (20%)
OSAS	40 (48%)	35 (56%)	5 (23%)	2 (40%)	5 (36%)	1 (17%)
Comorbidities	60 (71%)	45 (71%)	14 (64%)	4 (80%)	9 (64%)	3 (50%)
Hypertension	40 (47%)	33 (52%)	7 (32%)	1 (20%)	6 (43%)	2 (33%)
Obesity	26 (31%)	22 (35%)	4 (18%)	0 (0%)	3 (21%)	1 (17%)

Dataset

The total number of remote patient monitoring days in the dataset is 12 444. The average number of data collected per day was 32.5 spO2 measures (SD 10.7), 44 HR measures (SD 10) and 35.6 BR measures (SD 9.6).

Patients had an excellent acceptance of Bora band® : The patients wore the wristband 90% (mean, 95% confidence interval : 88% - 91%) of the time during the remote patient monitoring session.

Clinical entries in the dataset are 21 AECOPD (5 mild, 13 moderate, 3 severe) that has been recorded during the monitoring sessions.

Performance in the early detection of AECOPD

The maximal value of the VS3 score over 10 days windows is significantly different (p-value = 2x10⁻⁴) between all windows of non exacerbating patient and windows preceding AECOPD.

The risk score algorithm predicted exacerbations 3.0 days before the AECOPD (SD 2.7) on average with a sensitivity of 85.7% and a specificity of 90.9%. The Receiver Operating Curve (ROC) is displayed in Figure 1. The overall performance of this alert is described by an Area Under the Curve (AUC) of the ROC of 0.94.

The time separating true alerts from the actual AECOPD date is shown in figure 1. When the alert threshold has been set to reach a sensitivity of 85.7% and a specificity of 90.9%.

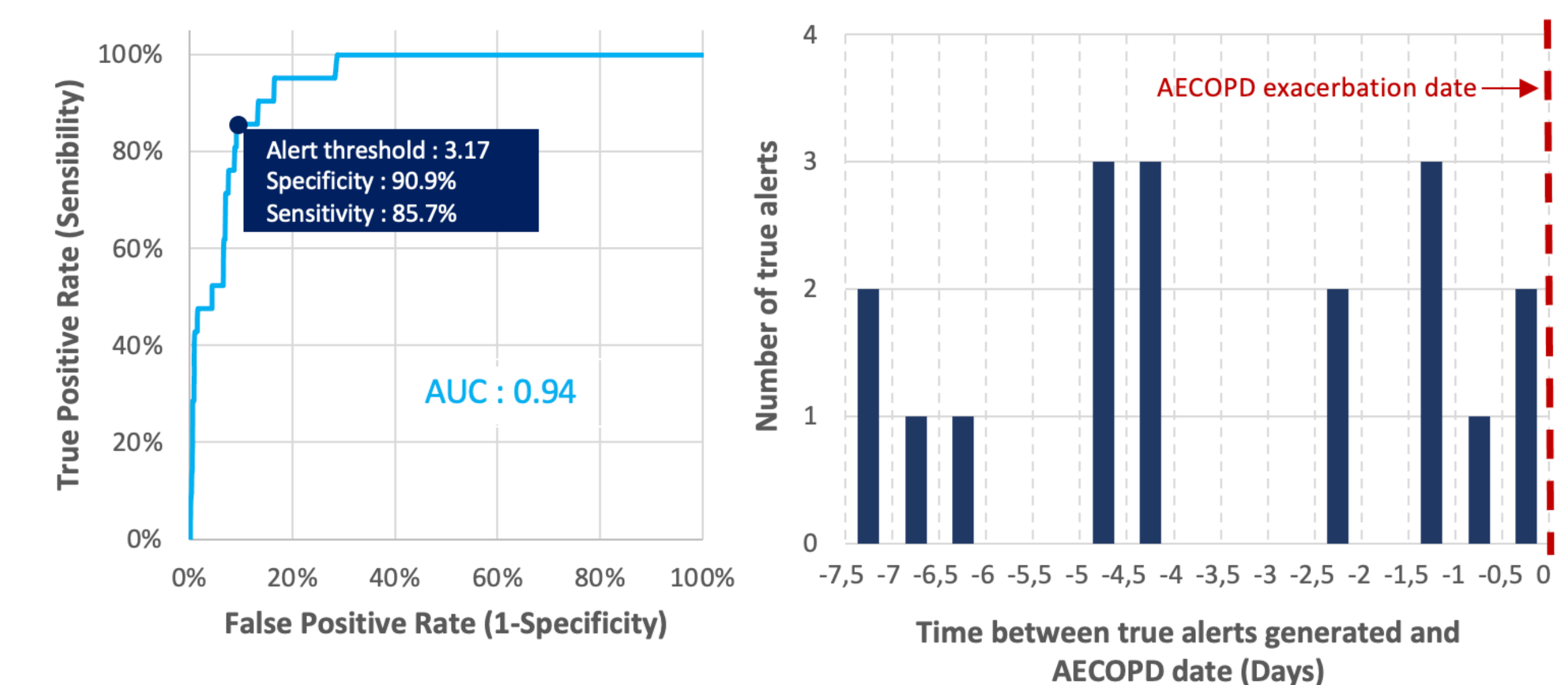


Figure : Left: ROC curve for the detection of AECOPD by the risk score algorithm (AUC=0.94); Right: Number of days separating true alerts (risk score exceeding a threshold before an actual AECOPD) from the AECOPD date registered during a pulmonology consultation. The threshold has been set to have 85.7% of sensitivity and 90.9% of specificity.

Conclusion

Patients had an excellent acceptance of Bora band® leading to an average of more than 110 daily vital signs measurements.

The BVS³ risk-score threshold can be set to raise an alert to warn medical personnel when the state of monitored patient's health deteriorates by a significant amount.

The performances of the BVS³ have been estimated to give a TPR of 85.7% for a FPR of 9.1% for alerts set up to prevent acute exacerbations of COPD. Overall, the AUC has been estimated to 0.94 for AECOPD based on the actual dataset.

The state-of-the art specificity and sensitivity of the patient-specific AECOPD early detect algorithm designed demonstrates that high-rate vital signs remote patient monitoring measurements is very promising for real-life prevention of hospital (re-)admission and reduction of AECOPD severity leading to a better quality of life for COPD patients.

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