7.1 Introduction

Chronic obstructive pulmonary disease (COPD) is currently the third leading cause of death worldwide [10]. It is caused, among others, by smoking and air pollution and it is characterized by chronic inflammation of the lung airways, and degradation of lung tissue which result in airflow limitation [12]. COPD is a global health problem because of its high prevalence, increasing incidence, and associated socio-economic costs [9]. However, COPD is severely underdiagnosed and therefore undertreated [144]. Spirometry is compulsory for the diagnosis of COPD [9]. Spirometry is now cheap and widely available, but time availability and quality control are often said to limit its implementation, particularly in primary care where there is a great deal of controversy regarding the quality of the tests performed by non-expert professionals [145]. Although detecting the disease at an early stage can increase the survival rate [146], obtaining spirometry for each smoker with or without symptoms of dyspnoea, cough, or sputum production is not a feasible solution. With the advent of health-sensor technologies and advanced data analysis methods there is a gradual permeation of these technologies into actual health care and patients' homes enabling new care services and their use as supportive systems[7].

In this work we show that the use of multimodal sensor modalities acquired during night-time only provides a good predictor of the presence of the disease in patients with COPD. In particular, we 1) used data coming from a single activity monitor worn on the upper arm to define new sleep modalities using a data driven methodology, and 2) we showed that these sleep modalities are valid constructs to assess sleep of patients with COPD in relation to their pathological condition. The defined sleep modalities were able to differentiate between nights of patients with COPD vs. nights of healthy subjects and, more in detail, predict the level of the disease and dyspnoea severity. It is worth mentioning that, for the best of our knowledge, to date, this is the first study that introduces the use of night-time data only derived from a single activity monitor for diagnosis of COPD. The objective is to reduce the uncertainty of predictions by fusing multimodal information and the use of data mining techniques.

7.2 Related works

Pervasive healthcare may enable a paradigm shift from the established centralized healthcare model to a pervasive, user-centred and preventive health management [147]. Wearable and unobtrusive technologies make more health-related data available than ever before enabling caregivers to make decisions on a broader basis of information. In clinical settings, data analytics and decision support systems have been established in several data-rich environments [7], among which COPD management.

7.2.1 Automatic classification of patients with COPD

Different machine learning techniques, such as artificial neural networks [148], and multiple instance learning [149] have been used for automatic recognition of COPD based on high resolution computed tomography scanning, which enables the direct evaluation of the lungs and airways. In [150] the authors proposed a method to predict the condition of a patient with COPD