'I'm useless after a bad night's sleep, doctor': could sleep be the key to improving physical activity in people with COPD?

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Physical activity is defined as any body movement made by skeletal muscles that results in energy expenditure, including leisure time, domestic and work-related activities. Patients with COPD are less physically active when compared with people without COPD, including age-matched controls[1] and individuals with other chronic illnesses such as heart disease, diabetes and arthritis.[2] In fact, physical activity drops off 10 years earlier in patients with COPD than in sedentary healthy people, and before the onset of breathlessness.[3] This lack of physical activity is associated with worse health outcomes. Patients with COPD with the lowest levels of physical activity are at increased risk of hospitalisation due to exacerbations[4] and of death due to any cause.[5] Increasing physical activity therefore has potential to improve health and prolong survival in people with COPD. Furthermore, patients say that an increase in activity is an important goal for them,[6] more important than prolonging survival.[7]

Increasing physical activity however is surprisingly difficult. Pulmonary rehabilitation—a physical and behavioural intervention—improves exercise performance in patients with COPD, but is not always accompanied by increased physical activity in daily life.[8] Beyond pulmonary rehabilitation, alternative therapeutic strategies to improve physical activity include counselling, nutritional supplementation, respiratory support and bronchodilators. Recent systematic reviews of such interventions in COPD found that evidence in this field was often low quality and heterogeneous.[9 10] While interventions targeted at specific patient subgroups appear successful, such as dietary supplementation in cachectic patients and nocturnal non-invasive ventilation with exercise training in hypercapnic patients, they are applicable to relatively few patients. With this lack of high-quality, generalisable long-lasting interventions in mind, new approaches to improve physical activity in patients with COPD are required.

Spina and colleagues identify an association between sleep measures and next day physical activity that could provide a new approach to improve active living in people with COPD.[11] Spina and colleagues performed a retrospective secondary analysis of actigraphic data collected during diverse observational and interventional COPD studies across 10 countries. They optimised homogeneity of data by including only studies that used SenseWear Armband monitors and only measurements from stable patients with COPD at baseline before any planned intervention. SenseWear Armband monitors include an accelerometer, which can measure motion and body position, and temperature and heat flux sensors, which measure energy expenditure. The data are captured continuously and reported in 1 min portions throughout the monitoring period. A particular strength of this study is the 'big data' generated by minute-to-minute actigraphy over 5646 monitored days assessed as valid for inclusion in the analysis.

To derive useful information from this massive dataset, the authors used set definitions and pattern recognition algorithms to derive sleep measures. For each minute, the monitor defines metabolic activity, posture (lying down vs not lying down) and sleeping status (sleep vs wakefulness). The authors developed a custom-made algorithm to remove noise and random motion artefacts and to derive measures of sleep quantity and quality. Although this method only provides an indirect estimate of sleep, it has the advantages of being an objective measure that can be performed in a large number of people in their natural sleeping environment. Reassuringly, actigraphic measures in this study identified a similar disruption in sleep quality in patients with COPD to that described in other studies using polysomnography[12] or sleep questionnaires.[13]

The study results suggest that sleep quality, more than sleep quantity, was strongly related to next day physical activity. Measures of poor sleep quality were increasing numbers of nocturnal sleeping bouts, indicating fragmented sleep, and increasing time awake after sleep onset. These measures showed a significant inverse relationship with daily step count and time spent in light or moderate-to-vigorous physical activity on the next waking day. Notably very light activity increased with worsening sleep quality, perhaps indicating conversion of more vigorous to less vigorous activity after a poor night's sleep. Measures of good sleep quality were increasing duration of nocturnal sleeping bouts and increased sleep efficiency (proportion of the time in bed spent asleep). Reassuringly these showed a significant positive relationship with daily step count and time spent in light or moderate-to-vigorous physical activity on the next waking day, with a parallel reduction in very light activity. The increase in physical activity associated with better sleep quality was clinically significant, with those with the best sleep quality walking 600 steps per day further and spending 9 min more in light intensity activities and 8 min more in moderate-to-vigorous activities per day.

Although the authors have identified a sequential relationship between sleep quality and next day physical activity in COPD, it is not possible to infer direction of association from this study. Poor sleep quality could impair physical activity by reducing capacity for exercise. Patients with COPD with subjectively poor sleep quality had reduced quadriceps muscle strength, higher exercise heart rate[14] and reduced 6 min walk distance.[15] Conversely, reduced physical activity could impair sleep through multiple mechanisms, including effects on body temperature, cardiac, autonomic, metabolic and endocrine functions and immunity/inflammation. The effect of confounders on the association between sleep quality and physical activity is likely to be considerable. Spina and colleagues found both reduced activity and impaired sleep quality in people with more severe lung disease, in those who were more breathlessness and in men. Although they accounted for these and age, body mass index, smoking status and parts of the week in their linear mixed-effect model, other factors not included in their analysis could play a role (figure 1). Sleep disorders such as obstructive sleep apnoea, restless legs, nocturnal hypoxia and

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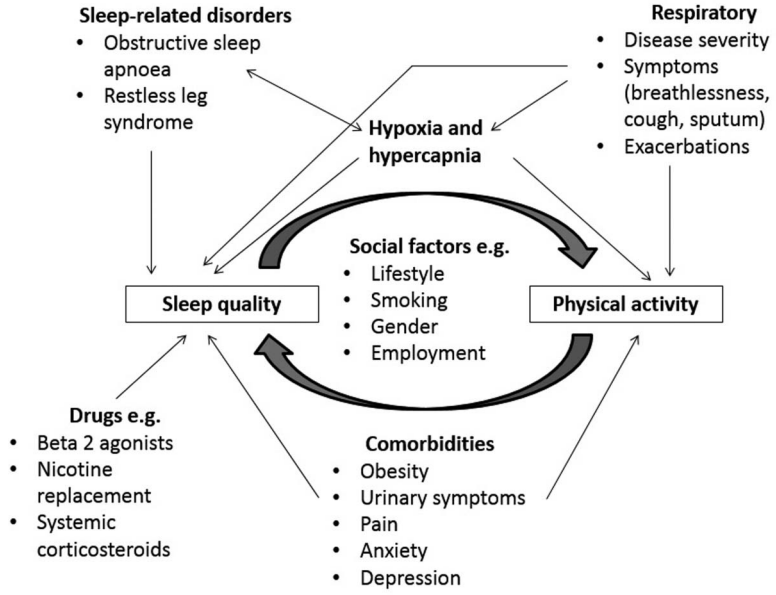

Figure 1 Schematic diagram of the interaction between physical activity, sleep quality and potential confounders.

hypercapnia are common in patients with COPD. Patients who produce sputum experience increased sleep disruption and are at increased risk of COPD exacerbations which impair activity. Common comorbidities such as anxiety and depression, urinary symptoms and pain can disrupt both sleep and physical activity. Drugs used to treat COPD, exacerbations and comorbidities, such as β2 adrenoceptor agonists, nicotine replacement, systemic corticosteroids and antidepressants, may also contribute.

The next step in unravelling the association between poor sleep quality and impaired physical activity is to determine the effect of intervention. Two small studies found that increasing physical activity with pulmonary rehabilitation improved subjective sleep quality over the 8–12 weeks of the programmes,[16 17] although a third study showed no effect.[18] Long-acting bronchodilators, nocturnal oxygen therapy, treatment of associated sleep disorders, non-invasive ventilation, melatonin and non-benzodiazepine hypnotics ('Z' drugs) have all been shown to improve sleep quality for patients with COPD.[19] However, we were unable to identify published studies that investigated the effect of interventions to improve sleep quality on physical activity.

So what message should we clinicians take away from Spina's paper? Disrupted sleep is common in COPD, and may have a hangover/knock-on effect on the ability of patients to achieve beneficial levels of physical activity. However, the relationship between sleep and physical activity is likely to be more complex than this, and the influence of confounders remains unclear. As clinicians, this study acts as a reminder to enquire about sleep quality in our patients with COPD and consider investigation and treatment for potentially treatable causes. As a wider research community, this work should encourage us to consider novel and much-needed approaches to improving physical activity in COPD, which could include investigation of the impact of interventions that improve sleep quality. Such approaches could prove useful add-ons to pulmonary rehabilitation, converting improvements in exercise capacity into increased physical activity.

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