The use of remote monitoring technologies in managing chronic obstructive pulmonary disease

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Summary

Chronic obstructive pulmonary disease (COPD) is a common cause of disability and a leading cause of admissions to hospital because of exacerbations of the condition. Early intervention with antibiotics and steroids can prevent admissions, but it can be difficult for patients to recognize the early signs of exacerbation and to access timely clinical care. One solution to these barriers to early management is the use of telemonitoring of symptoms and physiological signs. Patients regularly record these and they are made available to clinicians, by the Internet, who based on scoring algorithms are alerted and may then be able to detect early signs of deterioration and intervene.

However, the evidence to date for the effectiveness and cost-effectiveness of this approach has not been strong. While early research shows promise, most interventions have been complex and involved additional clinical support rendering interpretation of the impact of telemonitoring alone difficult. The results of larger well-designed trials are awaited.

Key to the success of future telemonitoring interventions will be establishment of the utility of different physiological measures and the construction of accurate predictive algorithms which can take into account individuals’ risk factors, patterns of symptom and physiological parameters and recent therapy changes.
identified at an early stage and treatment instituted to prevent serious deterioration and hospital admission.

Throughout the world, governments and policy makers have started to promote telemonitoring as a way of detecting, and responding to, COPD exacerbations in a timely manner, largely with a view to reducing resource use.\(^9,10\)

The evidence that telemonitoring may improve outcomes and reduce costs, however, is not strong. Despite calls for robust effectiveness trials,\(^11\) the evidence base, until recently, has largely relied on small feasibility studies and non-randomized studies. There have been three recent systematic reviews in the area.\(^12–14\) The reviews all suggest beneficial effects with reduction in hospital admissions (between 20% and 40%) and emergency room visits (between 20–50%) and to a lesser extent on quality of life with little effect on mortality. However, all have concluded that there is insufficient evidence to draw firm conclusions as to whether the interventions are effective or cost-effective. Systematic review has been hampered by the heterogeneity of the interventions which vary from simple telephone follow-up to sophisticated daily monitoring of symptoms and physiological measurements. Indeed, possibly the biggest challenge to interpreting the effects of the interventions is that most provided additional support over and above the telemonitoring which were not available to the usual care groups, for example in the form of specialist respiratory nurse services. One systematic review concluded that the most effective interventions were those that had the most additional support making it difficult to be sure what role telemonitoring per se played in the improved outcomes.\(^12\) Since these reviews, The Whole System Demonstrator\(^15\) (WSD), the world’s largest telehealth randomized controlled trial, recently reported and showed a significant reduction in deaths and significant, but modest, improvements in other outcomes including reduced hospital admissions for a combined group of people with a variety of long-term illnesses including diabetes, COPD and heart failure. However, it too provided additional clinical support to the intervention group alone. The authors were circumspect about the size of the effect and its likely cost-effectiveness. The effect on clinical outcomes specifically for people with COPD participating in the WSD is shortly to be published. In addition, the Telescot trial\(^16\) in Scotland has recently completed and publication is awaited. Unlike others, this latter study did provide similar clinical support to both intervention and control group and will provide information on the impact of telemonitoring alone.

Qualitative work with patients shows that in general they are very positive about telehealth interventions for COPD. They find using the technology both educative and empowering\(^17\) although some have rejected telehealth because they see it as challenging their perception of being self-reliant.\(^18\)

Meta-analysis of studies measuring quality of life show an insignificant trend towards improved health-related quality of life with telehealth use.\(^12\) Clinical staff, providing the telehealth service however, have concerns about increased workload and the utility of some of the physiological measures.\(^8\) They report multiple occasions when alerts have been generated and required investigation but did not require clinical intervention.

### Discussion and future research

The relatively inconclusive results for studies exploring the effectiveness and cost-effectiveness in telehealth in COPD beg the question as to why the intervention, which on the face of it should logically improve care, has not been more effective. Partly this may be down to the ability of existing systems to predict exacerbations from symptom and physiological data in a group of people who are characteristically persistently symptomatic and who show wide day-to-day variation pulse rate, FEV1 (Forced Expiratory Volume in one second) and oxygen saturation.

Current algorithms for detecting exacerbations were derived from studies of paper-based symptom diaries\(^7\) based on international definitions of exacerbations. Although new symptom-based algorithms are being developed and have improved positive predictive values, these values still remain low.\(^19\)

Similarly, physiological measures such as spirometry, oxygen saturation and heart rate have poorly understood day-to-day variation, may provoke unnecessary alerts and, alone, have limited predictive validity for COPD admissions.\(^20\) Spirometry in particular, in our research, proved challenging for patients to perform correctly and hard to interpret. There is some evidence from relatively small studies that there may be some value in creating a composite measure that combines pulse oximetry with symptoms in predicting a deterioration requiring treatment with antibiotics or steroids, but it is not clear how best these should be combined.

It is thus not clear which changes in symptoms and physiological measurements appear consistently and early enough to predict serious deteriorations and hospital admissions. This limitation is reducing the potential of telehealth to have an impact on hospital admissions. There is therefore a pressing need to develop new, more sophisticated algorithms to help identify early significant deteriorations that require intervention.
algorithms could apply appropriate weight to different symptoms and physiological signs, take into account features such as self-medication, variation over time and individual patient characteristics such as baseline severity of the condition, age, sex and previous hospital admission, and possibly other characteristics such as anxiety and depression scores or social isolation.

In addition, physiological measures such as respiratory rate and general activity, both known to change with COPD exacerbations, but which until recently have been inconvenient to measure accurately, are about to become available. Further research is required to determine the utility of such measures in predicting and monitoring recovery from COPD exacerbations.

In conclusion, although telemonitoring for COPD shows great promise, the evidence for its effectiveness and cost-effectiveness is as yet not strong. Further research is required to identify the types of patients most likely to benefit from the technology and to develop more sensitive algorithms and physiological methods for detecting exacerbations.

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**References**


