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A RCT of telehealth for COPD patient's Quality of life: the Whole System Demonstrator Evaluation

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Declaration of Interest

All authors have completed the Unified Competing Interest form at http://www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work."

Abstract

Introduction/Objectives:
Despite some concerns that the introduction of telehealth (TH) may lead to reductions in quality of life (QoL), lower mood and increased anxiety in response to using assistive technologies to reduce health care utilisation and manage long term conditions, this research focuses on the extent to which providing people with tools to monitor their condition can improve QoL.

Methods:
The Chronic Obstructive Pulmonary Disease cohort of the Whole Systems Demonstrator Trial is a pragmatic General Practitioner (GP) clustered RCT evaluating TH in the UK from three regions in England. All patients at a participating GP practice were deemed eligible for inclusion in the study if they were diagnosed with COPD.

Results:
447 participants completed baseline and either a short (4 months) or long term (12 months) follow up. There was a trend of improved QoL and mood in the TH group at longer-term follow up, but not short term follow up. Emotional functioning (g= 0.280 95% CI, 0.051- 0.510) and mastery reached (g= 2.979 95%CI, 0- 0.46) significance at $P<0.05$ (all Hedges g <0.3).

Conclusions:
TH showed minimal benefit to QoL in COPD patients who were not preselected to be at increased risk of acute exacerbations. Benefits were more likely in disease specific measures at longer term follow up. TH is a complex intervention and should be embedded in a service that is evidenced based. Outcome measures must be sensitive enough to detect changes in the target population for the specific intervention.

Keywords: Telehealth, self-monitoring, self-management, Quality of life, Patient Reported Outcomes (PRO), COPD

Introduction

Chronic obstructive pulmonary disease (COPD) leads to a number of disabling and distressing symptoms with patients' quality of life (QoL) showing declines over time (1). COPD is associated with a greater risk of anxiety (2) and depression (3) and in turn higher anxiety is associated with a greater risk of exacerbations, (2) while depression is associated with a greater incidence of hospitalisation (3).

Despite some concerns that Telehealth (TH) may lead to social isolation and reductions in QoL the focus of work has been on examining whether TH leads to improvements in QoL. In COPD there is limited available evidence on the impact of TH on QoL. Systematic reviews have found a limited number of randomised controlled trials (RCTs) that examined the effectiveness of TH on QoL in patients with COPD(4) and those that have identified evidence have found mixed results on various QoL measures,(5) as well as other outcomes such as healthcare utilisation (6, 7).

A Cochrane review (8) reported on two RCTs measuring QoL. (9, 10) These studies included 254 patients with COPD and indicated minimally clinically significant improvement in symptoms, activity levels, and impact on patient's QoL. However, the confidence intervals were wide and 2 studies were insufficient for sub-group analysis, or meta-regression to examine what factors might influence the effect of TH on patient outcomes.

A more recent RCT of TH on 256 COPD patients reported no benefits at 12-months on the QoL, mood or self-efficacy regarding management of their condition. Sub-group analysis indicated that the effect of TH on hospital admission was not affected by demographic factors or mood, but was less effective for participants with mild or moderate COPD (11).

The current aim of the investigation focuses on the COPD cohort of the Whole System Demonstrator (WSD), (12) for which there are still relatively few methodologically robust trials evaluating the effectiveness of TH.

Methods

Design

WSD is one of the largest pragmatic cluster randomised controlled trials evaluating TH in the

UK (13). Patients with COPD from Cornwall, Kent and Newham were recruited from 121 General Practices. Cluster randomisation was performed by the Trial statistician, balancing for region, practice size, deprivation index, ethnicity and prevalence of COPD to receive either standard care or the TH intervention. The study was approved by Liverpool Research Ethics Committee (ref: 08/H1005/4). Recruitment took place between May 2008 and December 2009, final 12-month follow-ups were conducted in December 2010. (Figure 1).

Participants

All patients at a participating GP practice were deemed eligible for inclusion in the study if they were diagnosed with COPD. Diagnosis could either be by inclusion on the relevant Quality Outcomes Framework (QOF) register in primary care, had a confirmed medical diagnosis as indicated by GP Read Codes or ICD-10 codes, or a confirmed diagnosis by the patients local clinician (i.e. GP, community matron or hospital consultant). Eligible participants also needed to have a landline telephone and broadband internet connection, and in Newham a digital television, as well as sufficient cognitive capacity and English language skills to complete a self-reported questionnaire. Five-hundred and seventy-eight patients with COPD completed questionnaires assessing a range of patient reported outcomes.

TH Intervention

Participants in the trial arm received a pulse oximeter ± blood pressure monitor, weight scales, and additional peripherals depending on clinical need. For example, a glucometer for patients who also suffered with diabetes. The peripheral devices were attached to a home monitoring system comprising a base unit with an LCD screen to allow questions about health and educational messages to be transmitted to participants, or set-top box that connected to a television allowing symptom questions, educational videos and a graphical history of clinical readings. Data was transmitted by participants to a monitoring centre, where it was reviewed by healthcare professionals. This would then trigger an appropriate response such as doing nothing; requesting a repeat reading, contacting the participant or

their named informal carer, arranging a home visit by their community matron or referring on to another healthcare service (please see (14) for further details).

Standard Care (control group)

The standard care group were told they would be offered TH services at the end of the trial, providing they were still eligible.

Outcome measures

Patient reported outcome measures included three QoL instruments. The Chronic Respiratory Questionnaire (CRQ) (15) measured perceived mastery of disease, fatigue, emotional impact of the disease and dyspnoea. The SF12- general health status comprised of two subscales, Physical Component Summary score (PCS) & the Mental Component Summary score (MCS) (1). The EQ-5D (16) a measure of health status with questions pertaining to mobility, self-care, usual activates, pain/discomfort and anxiety/depression. Additionally, anxiety and depression were measured by the Brief State Trait Anxiety Inventory STAI-6 (17) and the Center for Epidemiologic Studies Depression Scale CESD-10 (18).

Sample size calculation

550 participants were required to detect a clinically meaningful difference of 0.3 (standard deviation of 1.0) on the CRQ (small effect size), (19) allowing for an intra-cluster correlation coefficient of 0.05, power of 80% and an alpha of $p \leq 0.05$, with the addition of a 10% inflation to allow for the maximum possible increase in sample size due to variable cluster size (20).

Procedure

Following agreement from the GP practices, eligible patients were sent a data sharing consent form giving the researchers access to their medical records. A consecutive sample was invited to consent to participate in the study. Baseline questionnaires were completed with a trained interviewer. Participants allocated to the TH intervention had equipment installed into their homes by the local WSD teams. The control group continued with standard care for the duration of the trial. Follow-up questionnaire assessments were

conducted at 4-months (short-term follow-up) and 12-Months (long-term follow-up). Two reminders to complete the postal questionnaires were made, unless they withdrew.

Statistical methods

Missing data were imputed 10 times for variables where participants had provided at least 50% of the responses using the SPSS Markov Chain Monte Carlo imputation function. Multi-level modelling analysis using linear mixed model procedures in SPSS were conducted on all 10 imputed datasets. To account for differences between GP practices, the outcomes measure at different time points (time) were nested within participants (cases), which in turn were nested within GP practices (unit of randomisation). Random intercepts were used at the GP practice level, and trial arm and time were entered as fixed effects along with a trial arm x time interaction, with the addition of covariates. The covariates included were age, gender, ethnicity, educational attainment, postcode determined Index of Multiple Deprivation score (21), number of co-morbidities recorded from hospital records, the WSD region (Cornwall, Kent, and Newham), the number of days between TH installation and questionnaire completion and the baseline measure of the dependent variable.

Standard multiple imputation procedures were used to combine the multiple outputs (22-24) using SPSS (v.19) and NORM. (25) Analysis were repeated for each of the outcome variables and for (i) those who completed both short and long-term follow-up questionnaires (Complete Case Cohort CCC) and (ii) a larger dataset utilising anyone who completed either a short or long-term follow-up (Available Case Cohort ACC). This process was then repeated on a dataset excluding all cases where there had been a protocol violation (per-protocol analysis) to examine whether the results were sensitive to change depending on the analysis.

Results

The participant flow from GP clusters into intervention and control groups are shown in Figure 1. Socio-demographic characteristics are displayed in Table 1, for the baseline, ACC and CCC. The effect of TH on healthcare utilisation has been reported elsewhere (26), but in

the baseline COPD cohort, ACC and CCC, the frequency of emergency hospitalisation was marginally higher in the usual care in both ACC and CCC (chi-square P>0.05).

There were 447 participants completing baseline and either a short or long term follow-up and 314 completing all three questionnaire assessments.

Emotional functioning significantly improved in the TH intervention group (mean 3·344 to 4·964) compared to the control group (mean 3·776 to 3·871) over time in the available case cohort (F= 4·341, P<0·040) and the complete case cohort (mean 2·7079 to 5·504 in the intervention group and 3·139 to 3·267 in the control group, F = 10·572, P<0·001). In the complete case analysis cohort emotional functioning was significantly higher in the TH group compared to the control group (5·504 compared to 3·267, F = 6·696, P<0·010, g =0.280, 95% CI 0.051- 0.510), but did not reach significance in the available case cohort (4·964 compared to 3·871, F = 1·117, P<0·293, g = 0.11, 95% CI -0.08-0.30) (tables 2 and 3).

Mastery over managing COPD significantly improved over time in the TH intervention group (3·290 to 5·795) compared to the control group (3·600 to 3·640) in the complete case cohort (F = 5·981, P<0·041), but not the available case (4·308 to 5·335 in the intervention group and 4·490 to 4·512 in the control group, (F = 1·346, P<0·248). Mastery was significantly higher in the TH intervention group compared to the control group (5·795 compared to 3·640, F = 4·323, P<0·038, g = 2.979, 95% CI 0-0.46), but again this was only for participants completing all three questionnaire assessments and was not observed in the available case cohort (5·335 compared to 4·512, F = 1·003, P<0·318, g = 0.074, 95% CI-0.116- 0.264). It is of note that those who completed all 3 assessments compared to those who completed the baseline assessment and then either the short or long term follow-up, had significantly better scores on the SF12-MCS, EQ5D and CESD (table 2). There were no other significant effects observed for any other measures of QoL or psychological distress, although there were trends in improvements in the TH intervention group. Despite the fact that emotional functioning and mastery indicated some significant improvements in the intervention group, and change over time in the intervention group compared to the control group, the

observed effects did not reach the clinically meaningful magnitudes proposed (all less than g= 0·3).

There were no significant effects for trial arm or time in the per protocol analysis (see tables 5 and 6). Those excluded from the per-protocol analysis were significantly more anxious compared those included. Reasons for exclusion included not receiving a pulse oximeter (N = 1, having TH installed before completing their baseline assessment (N = 3), completing assessments >30 days after scheduled (N=51), not receiving a questionnaire for COPD (N = 32).

Discussion

Despite some early concerns that TH may result in reduced QoL this study found no evidence for any reduction in patients' QoL, in the longer term. The significant trial arm and time interaction effects indicated that those who received TH had better emotional functioning and mastery, which improved over time compared to the control group. Although these effects were small, there was a consistent trend towards participants reporting an improvement in their HRQoL in the intention to treat analysis.

There were no significant improvements in short term HRQoL or psychological distress. Patients needed to have had experience of self-monitoring using TH for approximately 12-months to show any significant improvements in emotional functioning or mastery. This may partly explain the significant differences observed in the ITT analysis, but not the PP analysis because participants were more likely to be excluded from the PP analysis due to completing the follow-up assessments later than specified in the protocol. This resulted in the ITT group having more experience of using TH compared to those included in the PP analysis. Another possible factor in the lack of statistically significant findings in the PP analysis may have related to the reduced power due to the smaller sample size.

The significant trial arm effects in the CCC were not robust in the ACC. The ACC had poorer mental health, QoL and greater depression compared to the CCC. Therefore those with better QoL and psychological functioning might be able to gain better control over their COPD with continued use of TH compared to those with poorer QoL and greater distress, who are more likely to attrite before gaining any significant improvements from TH.

Finally, the results for the COPD cohort of the WSD trial indicated that TH did not improve patients generic QoL or psychological distress. These findings are consistent with the combined WSD analysis of the effectiveness of TH on QoL and psychological distress (14). This suggests that generic measures are less sensitive to change in response to TH.

Apart from emotional functioning and mastery there were no significant improvements in any of the other measures. These findings are in contrast to other studies reporting improvements at 12-months in symptoms, activity levels, and impact (27), but consistent with a more recent trial showing TH was not effective in demonstrating improvements in QoL (11). Improvements in disease specific emotional functioning and mastery were only apparent at 12-months, but not evident in the short term. These findings together with the ITT compared to PP analysis suggest that any potential, albeit small benefits from TH are not immediately apparent and patients need to have experience of using TH before they are able to derive any benefits in gaining better mastery and emotional functioning.

In addition to timing of effects, the data suggest that even though the CRQ is more responsive to change compared to the SGRQ (28), there were only two sub-scales that were significantly improved in the TH arm. Therefore, the specific outcome measures used needs to be considered in reviewing the findings of studies. It is also not advisable to aggregate the psychological response to TH with measures of physical symptoms and dyspnoea, as the TH intervention may only be effective at changing extra-pulmonary manifestations of COPD surrounding control and emotional wellbeing.

In order to tease out the components of complex TH interventions that are effective, TH interventions need to be adequately described so that they can be replicated. It cannot be assumed that 'TH', telehealthcare and telemonitoring are the same interventions across different studies. Until TH interventions have better descriptions of their content and fidelity, there is unlikely to be any clear conclusions regarding effectiveness. It is

noteworthy that the two trials that have found significant effects (9, 10), both included weekly telephone calls. This study taken together with Pinnock and colleagues (13) might suggest that active monitoring in the absence of weekly telephone contact from clinical staff is insufficient to lead to improved outcomes for patients.

The mediating and moderating variables predicting the heterogeneity in effectiveness need to be examined. Possible moderating variables of TH effectiveness are acute exacerbations and recent hospitalisations versus stable disease (27), as well as severity of COPD (11). These results have implications for widespread deployment of TH in patients with COPD.

Strengths and limitations

Previous research investigating the effects of TH have tended to lack statistical power, have weaker methodological designs and unknown generalisability to the NHS in the UK. (4) The current clustered RCT addresses many of these methodological limitations. Although the samples size achieved were larger than previous trials, following attrition and protocol violation the sample was still not quite large enough to reach adequate power. However, this is unlikely to change the reported results given that the effect sizes were all less than the planned 0.3.

Future research and implications

Future research is required to establish what components of TH interventions are effective and which are not (e.g. telephone support versus self-monitoring). In order to achieve this greater level of understanding, fuller descriptions of TH interventions are required. The content of the TH intervention should be designed for the specific outcome measures they are targeting. For example, more telephone support may be effective for symptom management, whereas self-monitoring may be more effective in improving mastery over COPD. Future work is required to examine immediate versus longer term effectiveness in order to determine the optimum duration of TH, as well as the moderating and mediating mechanisms of complex TH interventions.

Conclusions

This is one of the largest pragmatic trials of TH for patients with COPD to date. Providing patients with TH tools to monitor and manage their condition remotely was insufficient to improve QoL and well-being. However, TH did not reduce QoL nor increase psychological distress either. Instead there were small effects for improved emotional functioning and mastery over COPD at longer-term follow-up, which were observed in cohorts of patients who had the equipment for longer.

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Ethical approval

The study was approved by Liverpool Research Ethics Committee (ref: 08/H1005/4).

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