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Telehealth interventions: remote monitoring and consultations for people with chronic obstructive pulmonary disease (COPD) (Review)

Janjua S, Carter D, Threapleton CJD, Prigmore S, Disler RT

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[Intervention Review]

Telehealth interventions: remote monitoring and consultations for people with chronic obstructive pulmonary disease (COPD)

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ABSTRACT

Background

Chronic obstructive pulmonary disease (COPD, including bronchitis and emphysema) is a chronic condition causing shortness of breath, cough, and exacerbations leading to poor health outcomes. Face-to-face visits with health professionals can be hindered by severity of COPD or frailty, and by people living at a distance from their healthcare provider and having limited access to services. Telehealth technologies aimed at providing health care remotely through monitoring and consultations could help to improve health outcomes of people with COPD.

Objectives

To assess the effectiveness of telehealth interventions that allow remote monitoring and consultation and multi-component interventions for reducing exacerbations and improving quality of life, while reducing dyspnoea symptoms, hospital service utilisation, and death among people with COPD.

Search methods

We identified studies from the Cochrane Airways Trials Register. Additional sources searched included the US National Institutes of Health Ongoing Trials Register, the World Health Organization International Clinical Trials Registry Platform, and the IEEEX Xplore Digital Library. The latest search was conducted in April 2020. We used the GRADE approach to judge the certainty of evidence for outcomes.

Selection criteria

Eligible randomised controlled trials (RCTs) included adults with diagnosed COPD. Asthma, cystic fibrosis, bronchiectasis, and other respiratory conditions were excluded. Interventions included remote monitoring or consultation plus usual care, remote monitoring or consultation alone, and mult-component interventions from all care settings. Quality of life scales included St George's Respiratory Questionnaire (SGRQ) and the COPD Assessment Test (CAT). The dyspnoea symptom scale used was the Chronic Respiratory Disease Questionnaire Self-Administered Standardized Scale (CRQ-SAS).

Data collection and analysis

We used standard Cochrane methodological procedures. We assessed confidence in the evidence for each primary outcome using the GRADE method. Primary outcomes were exacerbations, quality of life, dyspnoea symptoms, hospital service utilisation, and mortality; a secondary outcome consisted of adverse events.

Main results

We included 29 studies in the review (5654 participants; male proportion 36% to 96%; female proportion 4% to 61%). Most remote monitoring interventions required participants to transfer measurements using a remote device and later health professional review (asynchronous). Only five interventions transferred data and allowed review by health professionals in real time (synchronous). Studies were at high risk of bias due to lack of blinding, and certainty of evidence ranged from moderate to very low. We found no evidence on comparison of remote consultations with or without usual care.

Remote monitoring plus usual care (8 studies, 1033 participants)

Very uncertain evidence suggests that remote monitoring plus usual care may have little to no effect on the number of people experiencing exacerbations at 26 weeks or 52 weeks. There may be little to no difference in effect on quality of life (SGRQ) at 26 weeks (very low to low certainty) or on hospitalisation (all-cause or COPD-related; very low certainty). COPD-related hospital re-admissions are probably reduced at 26 weeks (hazard ratio 0.42, 95% confidence interval (CI) 0.19 to 0.93; 106 participants; moderate certainty). There may be little to no difference in deaths between intervention and usual care (very low certainty). We found no evidence for dyspnoea symptoms or adverse events.

Remote monitoring alone (10 studies, 2456 participants)

Very uncertain evidence suggests that remote monitoring may result in little to no effect on the number of people experiencing exacerbations at 41 weeks (odds ratio 1.02, 95% CI 0.67 to 1.55). There may be little to no effect on quality of life (SGRQ total at 17 weeks, or CAT at 38 and 52 weeks; very low certainty). There may be little to no effect on dyspnoea symptoms on the CRQ-SAS at 26 weeks (low certainty). There may be no difference in effects on the number of people admitted to hospital (very low certainty) or on deaths (very low certainty). We found no evidence for adverse events.

Multi-component interventions with remote monitoring or consultation component (11 studies, 2165 participants)

Very uncertain evidence suggests that multi-component interventions may have little to no effect on the number of people experiencing exacerbations at 52 weeks. Quality of life at 13 weeks may improve as seen in SGRQ total score (mean difference -9.70, 95% CI -18.32 to -1.08; 38 participants; low certainty) but not at 26 or 52 weeks (very low certainty). COPD assessment test (CAT) scores may improve at a mean of 38 weeks, but evidence is very uncertain and interventions are varied.

There may be little to no effect on the number of people admitted to hospital at 33 weeks (low certainty). Multi-component interventions are likely to result in fewer people re-admitted to hospital at a mean of 39 weeks (OR 0.50, 95% CI 0.31 to 0.81; 344 participants, 3 studies; moderate certainty). There may be little to no difference in death at a mean of 40 weeks (very low certainty). There may be little to no effect on people experiencing adverse events (very low certainty). We found no evidence for dyspnoea symptoms.

Authors' conclusions

Remote monitoring plus usual care provided asynchronously may not be beneficial overall compared to usual care alone. Some benefit is seen in reduction of COPD-related hospital re-admissions, but moderate-certainty evidence is based on one study. We have not found any evidence for dyspnoea symptoms nor harms, and there is no difference in fatalities when remote monitoring is provided in addition to usual care.

Remote monitoring interventions alone are no better than usual care overall for health outcomes.

Multi-component interventions with asynchronous remote monitoring are no better than usual care but may provide short-term benefit for quality of life and may result in fewer re-admissions to hospital for any cause. We are uncertain whether remote monitoring is responsible for the positive impact on re-admissions, and we are unable to discern the long-term benefits of receiving remote monitoring as part of patient care.

Owing to paucity of evidence, it is unclear which COPD severity subgroups would benefit from telehealth interventions. Given there is no evidence of harm, telehealth interventions may be beneficial as an additional health resource depending on individual needs based on professional assessment. Larger studies can determine long-term effects of these interventions.

PLAIN LANGUAGE SUMMARY

Telehealth technologies for people with chronic obstructive pulmonary disease (COPD)

Review question

Do telehealth technologies help improve the health of people who have COPD?

Background

Chronic obstructive pulmonary disease (COPD) includes a group of lung conditions that cause breathing difficulties. Symptoms include shortness of breath (dyspnoea), coughing, and increased mucus. COPD causes limited airflow in the lungs when breathing out; this can be measured by spirometry (a measure to assess how well the lungs function). The spirometer takes two measurements: volume of air when breathing out forcefully in one second, and total amount of air breathed out. When COPD gets worse over time, this leads to greater symptom severity and can reduce quality of life. Disease progression and sudden flare-ups (exacerbations) of symptoms can increase someone's risks of hospitalisation and death. Telehealth technologies could improve delivery of health care for people with COPD, which could reduce exacerbations, improve quality of life, and lower rates of hospitalisation. However, it is unclear whether providing telehealth care improves health-related outcomes for people with COPD. We wanted to explore whether telehealth technologies were helpful for people with COPD.

What are telehealth technologies?

Study investigators used a range of telehealth technologies. Some included remote monitoring technology, which requires daily use of a laptop or a tablet with monitoring equipment, with results received by the healthcare professional. Typical monitoring equipment included a stethoscope (to measure blood pressure and heart rate), a pulse oximeter (to measure oxygen levels in the blood), a spirometer (to measure lung function), a thermometer, and other devices. Interventions involved regular phone calls with healthcare professionals for patients to talk about their symptoms and completion of health questionnaires.

Identifying and selecting studies

We searched online databases up until April 2020. We searched for studies published worldwide, in any language, at any time. Two review authors looked at lists of studies separately, then agreed on which studies should be included.

To find the best answer to our question, we looked for studies that recruited people with COPD of any severity. To make the comparison fair, we looked for studies in which investigators compared remote monitoring, remote monitoring plus usual care, and multi-component treatments. People included in these studies had to have the same random chance (like the flip of a coin) to receive one of these teleheath technologies or usual care.

Key results

We found 29 studies (5654 people with moderate to very severe COPD) that were suitable for inclusion in our review. Duration of these studies ranged from 3 to 12 months.

We did not find any important benefits or harms for patients who were monitored with any of the telehealth technologies when we looked at number of exacerbations, improvement in quality of life, and reduction in breathing distress symptoms, hospitalisations, or death. However, people who were monitored through telehealth technology plus usual care had some reduction in risk of hospital re-admission. Thus, telehealth technologies that were part of a care package reduced COPD-related hospital re-admissions.

We could not be certain of any harms of stand-alone remote monitoring. We are also uncertain of any benefits or harms of stand-alone remote monitoring of patient experiences or reports of breathing distress.

Quality of evidence

Currently, no good quality evidence is available. We are very uncertain about evidence for exacerbations, quality of life, dyspnoea symptoms, hospitalisations, deaths, and side effects. However, we are moderately certain about our findings for hospital re-admissions.

Conclusion

We are not clear whether telehealth technologies for monitoring or consultation provide benefit, but we have not found any information on harms. Telehealth could play a role in the care and management of people with COPD. Telehealth as part of multi-component care packages may provide short-term benefit for quality of life and hospital re-admissions. Telehealth in the form of remote monitoring in addition to usual care may reduce the risk of hospital re-admission. There is little impact on exacerbations, quality of life, and death. Owing to limited information, the findings of this review should be interpreted with caution. More studies are needed to determine whether telehealth provides any long-term benefits for people with COPD of varying severity.

SUMMARY OF FINDINGS

Summary of findings 1. Remote monitoring plus usual care compared to usual care

Remote monitoring plus usual care compared to usual care

Patient or population: people with chronic obstructive pulmonary disease
Setting: primary, secondary, tertiary care; general hospital, specialist respiratory service, hospital-based respiratory care; single-centre or multi-centre
Intervention: remote monitoring plus usual care
Comparison: usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№. of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with usual care	Risk with remote monitoring plus usual care				
Exacerbations						
Number of people experiencing 1 or more exacerbations Follow-up: 26 weeks Asynchronous remote monitoring	469 per 1000	525 per 1000 (343 to 703)	OR 1.25 (0.59 to 2.67)	108 (1 RCT)	⊕⊖⊖⊖ VERY LOW[a,b]	Imprecision: does not meet OIS of 200 participants
Quality of life						
SGRQ total score Follow-up: 26 weeks Scale: 0 to 100 Lower score is better Asynchronous or synchronous remote monitoring	Mean SGRQ total was 66.8	MD 1.49 lower (9.43 lower to 6.44 higher)	-	204 (2 RCTs)	⊕⊖⊖⊖ VERY LOW[b, c, d]	MID: 4 points (Jones 2005) Control arm MD was taken from McDowell 2015
SGRQ total score Follow-up: 52 weeks	Mean SGRQ total was 67.3	MD 0.9 higher (3.71 lower to 5.51 higher)	-	205 (1 RCT)	⊕⊖⊖⊖ VERY LOW[b, e]	MID: 4 points (Jones 2005)

Scale: 0 to 100 Lower score is better						
Dyspnoea symptoms						
No evidence identified						
Hospital service utilisation						
Time to first hospitalisation after starting intervention Follow-up: 52 weeks Asynchronous remote monitoring	HR 1.08 (0.80 to 1.46)			256 (1 RCT)	⊕⊖⊖⊖ VERY LOW[b, e]	
Time to first COPD-related re-admission Follow-up: 26 weeks Asynchronous remote monitoring	HR 0.42 (0.19 to 0.93)			106 (1 RCT)	⊕⊕⊕⊖ MODERATE f	Imprecision: does not meet OIS of 200 participants
Mortality						
Mortality (all-cause) Follow-up: 44 weeks** Asynchronous or synchronous remote monitoring	93 per 1000	92 per 1000 (60 to 139)	OR 0.99 (0.62 to 1.58)	927 (7 RCTs)	⊕⊖⊖⊖ VERY LOW[b, g]	

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

**Weighted mean duration.

CI: confidence interval; **COPD:** chronic obstructive pulmonary disease; **HR:** hazard ratio; **MD:** mean difference; **MID:** minimally important difference; **OIS:** optimal information size; **OR:** odds ratio; **RCT:** randomised controlled trial; **SGRQ:** St George's Respiratory Questionnaire.

GRADE Working Group grades of evidence.
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.

Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[a]Evidence for this outcome was downgraded by 2 due to performance, detection, and selective reporting bias. Allocation concealment was unclear.
[b]Evidence for this outcome was downgraded by 1 due to wide confidence intervals.
[c] Evidence for this outcome was downgraded by 2 due to performance and detection bias. One study was at high risk of selective reporting.
[d] Evidence for this outcome was downgraded by 2 due to very high heterogeneity.
[e] Evidence was downgraded by 2 due to performance and detection bias.
[f] Evidence for this outcome was downgraded by 1 due to performance bias. Allocation concealment was unclear.
[g] Evidence for this outcome was downgraded by 2 due to allocation concealment and performance, detection, and attrition bias in one or more studies.

Summary of findings 2. Remote monitoring compared to usual care

Remote monitoring compared to usual care

Patient or population: people with chronic obstructive pulmonary disease
Setting: regional, international (university hospital; specialist respiratory outpatient clinics; community-based primary care clinics and health services), single-centre or multi-centre
Intervention: remote monitoring
Comparison: usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№. of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with usual care	Risk with remote monitoring				
Exacerbations						
Number of people experiencing 1 or more exacerbations Follow-up: 41 weeks** Asynchronous or synchronous remote monitoring	370 per 1000	375 per 1000 (283 to 477)	OR 1.02 (0.67 to 1.55)	424 (4 RCTs)	⊕⊖⊖⊖ VERY LOW[a,b]	
Quality of life						

SGRQ total score Follow-up: 17 weeks Scale: 0 to 100 Lower score is better Asychronous remote monitoring	Mean SGRQ total score was -4.5	MD 6.4 lower (18.56 lower to 5.76 higher)	-	45 (1 RCT)	⊕⊖⊖⊖ VERY LOW[b,c]	MID: 4 points (Jones 2005) Imprecision: does not meet OIS
CAT score Follow-up: 38 weeks** Scale: 0 to 40 Lower score is better Asynchronous remote monitoring	Mean CAT total score was 17.2	MD 0.06 higher (1.34 lower to 1.45 higher)	-	405 (2 RCTs)	⊕⊖⊖⊖ VERY LOW[b,d]	MID: 2 points (Kon 2014) MD in control arm taken from the study of longer duration (Walker 2018)
CAT total score Follow-up: 52 weeks Scale: 0 to 40 Lower score is better Asynchronous remote monitoring	Mean CAT total score was 21.4	MD 0.1 higher (1.42 lower to 1.62 higher)	-	229 (1 RCT)	⊕⊖⊖⊖ VERY LOW[b,e]	MID: 2 points (Kon 2014)
Symptoms of dyspnoea						
CRQ-SAS dyspnoea symptoms score Follow-up: 26 weeks Scale: 0 to 100 Higher score is better Asychronous remote monitoring	Mean dyspnoea symptoms score on the CRQ-SAS was 4.16	MD 0.44 lower (1.04 lower to 0.16 higher)	-	70 (1 RCT)	⊕⊕⊖⊖ LOW[b,f]	MID: 0.5 reflects a small change. A change of 1.0 reflects a moderate change, and a difference of 1.5 reflects a large change (Schünemann 2003) Imprecision: does not meet OIS
Hospital service utilisation						
Number of people admitted to hospital Follow-up: 36 weeks**	246 per 1000	283 per 1000 (196 to 387)	OR 1.21 (0.75 to 1.94)	357 (2 RCTs)	⊕⊖⊖⊖ VERY LOW[b,g]	

Asynchronous remote monitoring					
Mortality					
Mortality (all-cause) Follow-up: 38 weeks** Asynchronous remote monitoring	73 per 1000	51 per 1000 (28 to 89)	OR 0.68 (0.37 to 1.25)	798 (6 RCTs)	⊕⊖⊖⊖ VERY LOW[b,e]

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

**Weighted mean duration.

CAT: COPD assessment test; **CI:** confidence interval; **COPD:** chronic obstructive pulmonary disease; **CRQ-SAS:** chronic respiratory disease questionnaire self-administered; **MD:** mean difference; **MID:** minimally important difference; **OIS:** optimal information size; **OR:** odds ratio; **RCT:** randomised controlled trial; **SGRQ:** St George's Respiratory Questionnaire.

GRADE Working Group grades of evidence.
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[a]Evidence for this outcome was downgraded by 2 due to allocation concealment and performance, detection, attrition, and selective reporting bias.
[b]Evidence for this outcome was downgraded by 1 due to wide confidence intervals.
[3]Evidence was downgraded by 2 due to performance and detection bias. Selection bias (randomisation and allocation concealment) and selective reporting were unclear.
[d]Evidence for this outcome was downgraded by 2 due to performance and detection bias. One study was at high risk of selective reporting.
[e]Evidence for this outcome was downgraded by 2 due to allocation concealment and performance and detection bias.
[f]Evidence for this outcome was downgraded by 1 due to performance bias. Detection, attrition, and selective reporting were unclear.
[g]Evidence was downgraded by 2 due to performance and detection bias.

Summary of findings 3. Multi-component interventions (with telehealth as a component of care) compared to usual care

Multi-component interventions (with telehealth as a component of care) compared to usual care
Patient or population: people with chronic obstructive pulmonary disease **Setting:** primary, secondary, tertiary care; community teaching hospitals, outpatient clinics (COPD-specific (university-based), general respiratory, or physiotherapy practice); single-centre or multi-centre **Intervention:** multi-component interventions **Comparison:** usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№. of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with usual care	Risk with multi-component interventions				
Exacerbations						
Number of people experiencing at least 1 exacerbation/moderate to severe exacerbation Follow-up: 52 weeks Asynchronous or synchronous remote monitoring	347 per 1000	343 per 1000 (283 to 405)	OR 0.98 (0.74 to 1.28)	955 (3 RCTs)	⊕⊖⊖⊖ VERY LOW[a,b,c]	
Time to first exacerbation Follow-up: 52 weeks Asynchronous remote monitoring	HR 1.05 (0.67 to 1.65)			166 (1 RCT)	⊕⊖⊖⊖ VERY LOW[d,e]	Does not meet OIS
Quality of life						
SGRQ total score Follow-up: 13 weeks Scale: 0 to 100 Lower score is better Asynchronous remote monitoring	Mean SGRQ total score was -0.6	MD 9.7 lower (18.32 lower to 1.08 lower)	-	38 (1 RCT)	⊕⊕⊖⊖ LOW[f]	MID: 4 points (Jones 2005) Imprecision: does not meet OIS
SGRQ total score Follow-up: 26 weeks Scale: 0 to 100 Lower score is better Asynchronous remote monitoring and synchronous video conference	Mean SGRQ total score was 48	MD 7 higher (4.79 lower to 18.79 higher)	-	40 (1 RCT)	⊕⊖⊖⊖ VERY LOW[c,g]	MID: 4 points (Jones 2005) Imprecision: does not meet OIS
SGRQ total score Follow-up: 52 weeks	Mean SGRQ total score was 56.8	MD 1.09 lower (6.24 lower to 4.05 higher)	-	203 (2 RCTs)	⊕⊖⊖⊖ VERY LOW[c,h]	MID: 4 points (Jones 2005)

Scale: 0 to 100 Lower score is better Asynchronous remote monitoring						MD in control arm taken from Farmer 2017
CAT score Follow-up: mean 38 weeks Scale 0 to 40 Lower score is better Asynchronous remote monitoring and synchronous video consultation	Mean CAT score was 18.6	MD 3.93 lower (7.75 lower to 0.12 lower)		521 (2 RCTs)	⊕⊖⊖⊖ VERY LOW[i,j]	MID: 2 points (Kon 2014)
Dyspnoea symptoms						
No evidence identified						
Hospital service utilisation						
Number of people who had at least 1 hospital admission Follow-up: 33 weeks** Asynchronous remote monitoring alone or additional synchronous video consultation	485 per 1000	432 per 1000 (341 to 526)	OR 0.81 (0.55 to 1.18)	447 (2 RCTs)	⊕⊕⊖⊖ LOW[c,j]	
Number of people re-admitted (all-cause) Follow-up: 39 weeks** Asynchronous remote monitoring alone or additional video conference or telephone calls	476 per 1000	312 per 1000 (220 to 424)	OR 0.50 (0.31 to 0.81)	344 (3 RCTs)	⊕⊕⊕⊖ MODERATE[j]	
Mortality						
Mortality (all-cause) overall analysis Follow-up: 40 weeks** Asynchronous remote monitoring alone or additional video conference, or synchronous telephone consultations	113 per 1000	73 per 1000 (47 to 114)	OR 0.62 (0.39 to 1.01)	1886 (9 RCTs)	⊕⊖⊖⊖ VERY LOW[g,k]	

Adverse events: number of people with 1 or more (all-cause) Follow-up: 52 weeks Asynchronous remote monitoring	528 per 1000	504 per 1000 (409 to 598)	OR 0.91 (0.62 to 1.33)	485 (2 RCTs)	⊕⊖⊖⊖ VERY LOW[a,c]

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

**Weighted mean duration of follow-up.

CI: confidence interval; **COPD:** chronic obstructive pulmonary disease; **HR:** hazard ratio; **MD:** mean difference; **MID:** minimally important difference; **OIS:** optimal information size; **OR:** odds ratio; **RCT:** randomised controlled trial; **SGRQ:** St George's Respiratory Questionnaire.

GRADE Working Group grades of evidence.
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[a]Evidence for this outcome was downgraded by 2 due to performance, detection, and attrition bias.
[b]Evidence for this outcome was downgraded by 1 due to differences in multi-component interventions.
[c]Evidence for this outcome was downgraded by 1 due to wide confidence intervals.
[d]Evidence for this outcome was downgraded by 2 due to performance and detection bias. Allocation concealment and attrition were unclear.
[e]There was no difference between intervention and control. Confidence intervals crossed the line of no effect.
[f]Evidence for this outcome was downgraded by 2 due to performance and detection bias. Randomisation method and selective reporting were unclear.
[g]Evidence was downgraded by 2 due to performance and detection bias.
[h]Evidence for this outcome was downgraded by 2 due to performance and detection bias. Randomisation method, detection, attrition, and selective reporting were unclear in one or more studies.
[i]Evidence for this outcome was downgraded by 2 due to very high heterogeneity.
[j]Evidence was downgraded by 1 due to performance bias.
[k]Evidence for this outcome was downgraded by 1 due to moderate heterogeneity.

BACKGROUND

Description of the condition

The Global Burden of Disease (GBD) analysis from 1990 to 2017 shows that more than 500 million people worldwide are living with a chronic respiratory condition that is a large contributor to premature death (GBD 2015; Soriano 2020). Moreover, the World Health Organization has predicted that chronic obstructive pulmonary disease (COPD) will be among the top causes of death by the year 2030 (WHO 2018). Although most information about COPD death comes from high-income countries, it is known that 90% of COPD deaths occur in low- to middle-income countries (WHO 2018). COPD represents 3.9% of the entire global burden of disease (Soriano 2020); it is a growing global public health problem that remains under-recognised, under-diagnosed, and under-treated (Quaderi 2018).

Although the burden of COPD in high-income countries is significant, this is compounded in low- to middle-income countries by poverty and greater exposure to smoking and environmental factors such as outside and household air pollution (Quaderi 2018). It is expected that continued exposure to risk factors, population growth, and ageing will further increase the burden of this disease (Lopez-Campos 2016). Disease severity, symptoms (e.g. frequent exacerbations leading to hospitalisation), and common comorbidities (e.g. cardiovascular disease) (in approximately 30% to 57% of people with COPD) increase the burden for patients and their carers, while exerting an economic burden for healthcare systems (Udsen 2017a). Respiratory diseases account for approximately 6% of the total healthcare budget in the EU, and more than half of this cost is attributed to COPD (ATS 2014). There is a direct correlation between severity of COPD, number of coexisting conditions, and increasing costs of care (GOLD 2021a).

COPD is a chronic lung disease that is characterised by persistent respiratory symptoms and limited airflow due to airway or alveolar abnormalities (or both) resulting from significant exposure to noxious particles or gases (including tobacco smoking and environmental factors such as exposure to biomass fuel and air pollution) (WHO 2018). Diagnosis of COPD is considered when a person has symptoms such as dyspnoea, cough, sputum production, or a combination of these, and when spirometry (presence of post-bronchodilator forced expiratory volume in one second (FEV_1)/forced vital capacity (FVC) < 70%) confirms the presence of persistent airflow limitation (GOLD 2021). Exacerbations occur with increasing frequency as the disease progresses, leading to increased risk of hospitalisation or mortality (or both) (BLF 2018a; GOLD 2021a). Despite optimised treatment, people with COPD experience debilitating symptoms (e.g. frequent exacerbations, lung infection, reduced self-care capability, limited physical function, anxiety, depression, cognitive deterioration), which can have an impact on their functional status, access to health services, and quality of life. 'Informal' carers play a key role in supporting people with COPD, particularly as the disease progresses. Physical, emotional, and financial impact on carers can be substantial (Andrianopoulos 2017; Farquhar 2018).

Description of the intervention

Telehealth is a broad term referring to "delivery of health care services where patients and providers are separated by distance" (WHO 2010).

Health care delivered through telehealth technologies can be received remotely by patients in many ways, including telephone, email, computer, monitoring, or video consultation.

Remote monitoring can facilitate the timely transfer of patient data, such as physiological parameters (e.g. oxygen saturation, blood pressure), through digital devices (e.g. telephone line, web-based devices) to health professionals (Annandale 2011).

Remote monitoring has the potential to alert healthcare professionals to changes in a person's symptoms early in deterioration (McLean 2011), allowing the best opportunity for early intervention. Early intervention is known to decrease exacerbation severity, hospitalisation frequency, and disease progression in COPD (GOLD 2021a). Additionally, continuous monitoring can provide a more robust picture of a person's condition when compared with the single snapshot or retrospective symptoms recalled by the patient (or both), which clinicians commonly rely on in traditional face-to-face consultations (Breen 2015; Tomasic 2018).

Remote monitoring can be asynchronous or synchronous. Asynchronous technologies (e.g. store and forward technology) do not require live interaction with the person when data are collected. Data are collected in a file format that is sent to the necessary healthcare professional via a secured encrypted Internet connection, allowing healthcare professionals to receive and analyse these data as they would if the data were collected from the person in a usual clinic setting (McLean 2011). 'Synchronous' refers to real-time technology that facilitates monitoring of physiological parameters, live-streaming of medical images, and video consultations (AMD Global Telemedicine 2015; McLean 2011).

Real-time remote consultation consists of live interaction between patient and healthcare professional by video, telephone, or web-based application (e.g. Skype, text messaging). Remote consultations can be provided when patients are not able to have face-to-face consultation, or they can be given in addition to face-to-face home visits or clinic visits (Hernandez 2014).

Remote monitoring or remote consultation (or both) can be provided as part of an integrated package of care, which we refer to in this review as "multi-component" interventions.

How the intervention might work

Hospital admissions and re-admissions pose a significant burden for healthcare services, with respiratory disease contributing as the second most common cause of emergency hospital admissions in the UK (BLF 2018b). As populations age, and as people live longer with chronic conditions, there is a need to explore more efficient approaches to healthcare delivery that are flexible and tailored (McLean 2011), while supporting people's acquisition and strengthening of their own resources in self-management of their day-to-day activities (Luhr 2018). Remote monitoring and remote consultation (with a health professional), in addition to usual care, provide closer and more timely monitoring of patients in their own home, along with early intervention for fluctuations and exacerbations of COPD. Ongoing monitoring and management based on ongoing fluctuations in disease and symptoms are needed for people with COPD, who often have difficulty accessing face-to-face services at their time of need. Remote monitoring and consultation may allow serial collection of data over a longer

period - a benefit over traditional face-to-face healthcare settings, where the clinician often relies on a clinical snapshot provided by the patient at the time of the face-to-face consultation. Ultimately these types of interventions have the potential to optimise COPD management, consequently reducing hospitalisation and improving quality of life for people with COPD.

Why it is important to do this review

Although it may be appropriate for healthcare providers to promote remote monitoring or consultation, it is not clear whether these technologies improve outcomes for people with COPD. Mixed evidence of effectiveness is derived from published systematic reviews, and some report potential for improving health-related outcomes.

Two systematic reviews have addressed this topic (Lundell 2015; McLean 2011). Our current scoping searches suggest that more than 50 new publications of potentially relevant studies have become available since the last Cochrane Review was published.

Similarly, evidence for cost-effectiveness of telemonitoring or consultations is limited and unclear, with one such trial showing that remote monitoring plus usual care resulted in similar quality-adjusted life-years (QALYs) as usual care alone and was not cost-effective when provided with standard support and treatment (Henderson 2013).

Therefore, it is essential to determine which interventions (i.e. remote interventions for monitoring or remote consultations) are clinically effective and safe for people with COPD who are unable to have face-to-face contact with health professionals, or may live a considerable distance from healthcare facilities.

OBJECTIVES

To assess the effectiveness of telehealth interventions that allow remote monitoring and consultation and multi-component interventions for reducing exacerbations and improving quality of life, while reducing dyspnoea symptoms, hospital service utilisation, and death among people with COPD.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled trials (RCTs) only. We included cluster-randomised trials but meta-analysed data from such trials only if they were adjusted to account for clustering. We included cross-over trials but meta-analysed data from such trials only if outcome data from the pre-cross-over phase were obtainable, as the carry-over effect could not be excluded. We included studies that reported in full text, those published in abstract format only, and unpublished data. We included studies from primary care and hospital settings.

Types of participants

We included adults (aged 18 years and over) who had a diagnosis of COPD according to established criteria (e.g. Global Initiative for Chronic Obstructive Lung Disease (GOLD) staging, European Respiratory Society (ERS) or American Thoracic Society (ATS) criteria), including adults with any comorbidities. We excluded adults with diagnosed asthma, cystic fibrosis, bronchiectasis, or other respiratory conditions.

Types of interventions

We included studies that explored the following telehealth interventions and comparators.

1. Remote monitoring (linked to a healthcare professional) plus usual care versus usual care alone (as reported by trialists).
2. Remote consultation (e.g. real-time contact with a healthcare professional) plus usual care versus usual care alone (e.g. face-to-face visit for a check-up with a health professional in a health service, or as reported by trialists).
3. Remote monitoring or remote consultation versus usual care (e.g. when telehealth care has replaced an element of usual face-to-face care).

We analysed data from the above three groups separately.

We included the following telehealthcare intervention categories.

1. Wired or wireless telehealthcare systems to monitor physiological parameters that are processed or authorised by a healthcare professional with feedback provided to the patient via telephone or video.
2. Store and forward telehealthcare systems to transfer data to healthcare professionals regarding the condition of the patient for offline assessment.
3. Internet-based telecommunication with healthcare professionals via methods such as video or telephone (e.g. Skype, text messaging, email).

We excluded interventions that delivered or monitored pulmonary rehabilitation remotely.

Types of outcome measures

We analysed the following outcomes in the review, but we did not use them as a basis for including or excluding studies.

Primary outcomes

1. Exacerbations (as defined by trialists; depending on available data, we extracted numbers of participants experiencing one or more exacerbation, exacerbation rate, or both)
2. Quality of life (validated scales, such as St George's Respiratory Questionnaire (SGRQ))
3. Dyspnoea symptoms (validated scales)
4. Hospital service utilisation (e.g. emergency department presentation, hospitalisation, re-admission, length of stay, as defined by trialists; depending on available data; we extracted numbers of participants who require hospitalisation, hospitalisation utilisation rate, or both)
5. Mortality (all-cause)

We reported outcomes using the following time points.

1. Three months or longer to less than six months.
2. Six months or longer to less than 12 months.
3. 12 months or longer.

Secondary outcomes

1. Adverse effects (i.e. numbers of participants with adverse effects)
2. Anxiety and depression (validated scales, e.g. Hospital Anxiety and Depression Scale)
3. Self-efficacy (as defined by trialists, depending on available data)
4. Participant satisfaction (as defined by trialists, depending on available data)

Reporting one or more of the outcomes listed here was not an inclusion criterion for studies for this review.

Search methods for identification of studies

Electronic searches

We identified studies from the Cochrane Airways Trials Register on 28 April 2020, which was maintained by the Information Specialist for the Group. The Cochrane Airways Trials Register contains studies identified from several sources.

1. Monthly searches of the Cochrane Central Register of Controlled Trials (CENTRAL), in the Cochrane Library, through the Cochrane Register of Studies Online (crso.cochrane.org).
2. Weekly searches of MEDLINE OvidSP from 1946.
3. Weekly searches of Embase OvidSP from 1974.
4. Monthly searches of PsycINFO OvidSP from 1967.
5. Monthly searches of the Cumulcative Index to Nursing and Allied Health Literature (CINAHL) EBSCO from 1937.
6. Monthly searches of Allied and Complementary Medicine (AMED) EBSCO.
7. Handsearches of the proceedings of major respiratory conferences.

Studies contained in the Trials Register were identified through search strategies based on the scope of Cochrane Airways. Details of these strategies, along with a list of handsearched conference proceedings, are provided in Appendix 1. See Appendix 2 for the search terms we used to identify studies for this review.

We searched the following additional sources with appropriately adapted search terms.

1. US National Institutes of Health Ongoing Trials Register ClinicalTrials.gov (www.clinicaltrials.gov).
2. World Health Organization International Clinical Trials Registry Platform (apps.who.int/trialsearch).
3. IEEE Xplore Digital Library (https://ieeexplore.ieee.org/Xplore/home.jsp).

We searched the Cochrane Airways Trials Register and additional sources from inception to 28 April 2020, with no restriction on language of publication. We searched grey literature such as conference abstracts through the Cochrane Airways Trials Register.

Searching other resources

We checked the reference lists of all primary studies and review articles for additional references. We searched relevant manufacturers' websites for study information.

We searched on 17 March 2021 for errata or retractions from included studies published in full text on PubMed.

Data collection and analysis

Selection of studies

Three review authors (SJ, CT, DC) screened titles and abstracts of search results independently and coded them as 'retrieve' (eligible or potentially eligible/unclear) or 'do not retrieve'. We retrieved full-text study reports of all potentially eligible studies, and three review authors (SJ, CT, DC) independently screened them for inclusion, recording the reasons for exclusion of ineligible studies. We resolved any disagreements through discussion; if required, we consulted a fourth review author (RD). We identified and excluded duplicates, and we collated multiple reports of the same study so that each study, rather than each report, was the unit of interest in the review. We recorded the selection process in sufficient detail to complete a PRISMA flow diagram and the Characteristics of excluded studies table (Moher 2009).

Data extraction and management

We used a Microsoft Excel spreadsheet piloted on at least one study in the review to collect data for study characteristics, interventions, and outcomes. Two review authors (SJ, DC) extracted the following study characteristics from included studies.

1. Methods: study design, total duration of study, details of any 'run-in' period, number of study centres and locations, study settings, withdrawals, and dates of study.
2. Participants: number, mean age, age range, numbers of males and females recruited, severity of condition, diagnostic criteria, baseline lung function, smoking history, inclusion criteria, and exclusion criteria.
3. Interventions: intervention and comparison.
4. Outcomes: primary and secondary outcomes specified and collected and time points reported.
5. Notes: funding for studies and notable conflicts of interest of trial authors.

Three review authors (SJ, CT, DC) independently extracted outcome data from the included studies. We noted in the Characteristics of included studies table when outcome data were not reported in a usable way. We resolved disagreements by consensus or by consultation with a fourth review author (RD). One review author (SJ) transferred data into Review Manager 5 (Review Manager 2014). We double-checked that data were entered correctly by comparing data presented in the systematic review with information provided in study reports. A second review author (DC) spot-checked study characteristics for accuracy against the study report.

We produced a table summarising the key characteristics of each study, including region, baseline characteristics of participants, study size, interventions investigated, and effects reported in each study.

Assessment of risk of bias in included studies

Three review authors (SJ, CT, DC) independently assessed risk of bias for each study using the criteria outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2019). We resolved any disagreements by discussion or by consultation

with another review author (RD). We assessed risk of bias according to the following domains.

1. Random sequence generation.
2. Allocation concealment.
3. Blinding of participants and personnel.
4. Blinding of outcome assessment.
5. Incomplete outcome data.
6. Selective outcome reporting.
7. Other bias.

We judged each potential source of bias as high, low, or unclear and provided a quote from the study report together with a justification for our judgement in the 'Risk of bias' table. We summarised risk of bias judgements across different studies for each listed domain. We considered blinding separately for different key outcomes when necessary (e.g. for unblinded outcome assessment, risk of bias for all-cause mortality may be very different than for a participant-reported pain scale). It is unlikely that participants were blinded to the intervention. We took this into account in risk of bias and GRADE assessments, and we considered the potential impact of lack of blinding on a case-by-case basis (e.g. subjective outcomes were likely to be more at risk than objective outcomes). When information on risk of bias was related to unpublished data or correspondence with a trialist, we noted this in the 'Risk of bias' table.

When considering treatment effects, we took into account the risk of bias for studies that contributed to that outcome.

Assessment of bias in conducting the systematic review

We conducted this systematic review according to the published protocol and justified any deviations from it in the Differences between protocol and review section of the review.

Measures of treatment effect

We analysed dichotomous data as odds ratios (ORs) and continuous data as mean differences (MDs) when studies used the same scale, and as standardised mean differences (SMDs) when studies used different scales. For SMD analyses in which duration of treatment was varied, we calculated and reported absolute effects with 95% confidence intervals (CIs). When data from rating scales were combined in a meta-analysis, we ensured they were entered with a consistent direction of effect (e.g. lower scores always indicating improvement).

We undertook meta-analyses only when this was meaningful, that is, when treatments, participants, and the underlying clinical question were similar enough for pooling to make sense.

We presented data as forest plots when it was possible to show size and direction of effect for treatment with 95% CIs using Review Manager 5 (Review Manager 2014).

We described skewed data narratively (e.g. medians and interquartile ranges for each group).

When a single study reported multiple trial arms, we included only relevant arms. We reported details of additional arms in the Characteristics of included studies table; when two comparisons (e.g. intervention A versus usual care, intervention B versus usual care) were combined in the same meta-analysis, we combined the active arms or halved the control group to avoid double-counting.

When available, we used adjusted analyses (ANOVA or ANCOVA) as a preference in our meta-analyses. When both change from baseline and endpoint scores were available for continuous data, we used change from baseline unless there was low correlation between measurements among participants. When a study reported outcomes at multiple time points, we used the latest time point. When studies reported post-treatment follow-up, we extracted this information and reported it narratively.

We used intention-to-treat (ITT) or 'full analysis set' analyses when they were reported (i.e. when data were imputed for participants who were randomly assigned but did not complete the study) instead of completer or per-protocol analyses.

Unit of analysis issues

For dichotomous outcomes, we used participants, rather than events, as the unit of analysis (e.g. number of participants admitted to hospital rather than number of admissions per participant). However, when a study reported rate ratios, we analysed them on this basis. We meta-analysed data from cluster-RCTs only when available data were adjusted (or could be adjusted) to account for clustering.

Dealing with missing data

We contacted investigators or study sponsors to verify key study characteristics and to obtain missing numerical outcome data when possible (e.g. when a study was published as an abstract only). When this was not possible, and missing data were thought to introduce serious bias, we took this into consideration in the GRADE rating for affected outcomes.

Assessment of heterogeneity

We used the I^2 statistic to measure heterogeneity among studies in each analysis. When we identified substantial heterogeneity ($I^2 \geq 40\%$), we reported this and explored possible causes by pre-specified subgroup analysis.

Assessment of reporting biases

We were unable to pool more than 10 studies to create and examine a funnel plot to explore possible small-study and publication biases.

Data synthesis

We used a random-effects model, with the assumption that included studies may have heterogeneous, but related, intervention effect estimates (due to the clinical nature of the intervention). We performed a sensitivity analysis by using a fixed-effect model.

Subgroup analysis and investigation of heterogeneity

We planned to carry out the following subgroup analyses.

1. Recent hospitalisation (within six months) versus no hospitalisation.
2. Cognitive function (presence or absence, e.g. Mini-Mental State Examination score < 26).

3. Mean number of comorbidities (≤ 1 versus > 1; e.g. Charleston index).

We planned to include the following outcomes in subgroup analyses.

1. Exacerbations.
2. Quality of life.
3. Hospitalisation utilisation.
4. Mortality.

We planned to use the formal test for subgroup interactions in Review Manager 5 (Review Manager 2014).

Sensitivity analysis

We planned to carry out the following sensitivity analyses, removing the following from the primary analyses.

1. Studies with high risk of bias in one or more domains.

We compared results obtained with a fixed-effect model versus results obtained with a random-effects model when possible.

Summary of findings and assessment of the certainty of the evidence

We created a 'Summary of findings' table using the following outcomes: exacerbations, quality of life, dyspnoea symptoms, hospital utilisation, mortality, and adverse effects. We presented effect size with 95% CI for each outcome, as well as absolute effects (generated by GRADEpro GDT software). We used the five GRADE considerations (risk of bias, consistency of effect, imprecision, indirectness, and publication bias) to assess the overall certainty of a body of evidence (low, moderate, or high certainty) as it relates to studies that contributed data for pre-specified outcomes. We used the methods and recommendations provided in Section 8.5 and Chapter 12 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2019), using GRADEpro software (GRADEpro GDT). We justified all decisions to downgrade the quality of studies using footnotes, and we provided comments to aid the reader's understanding of the review when necessary. We applied the clinical importance of results using the published minimally important difference (MID) when available (e.g. SGRQ has well-established MIDs in the literature).

RESULTS

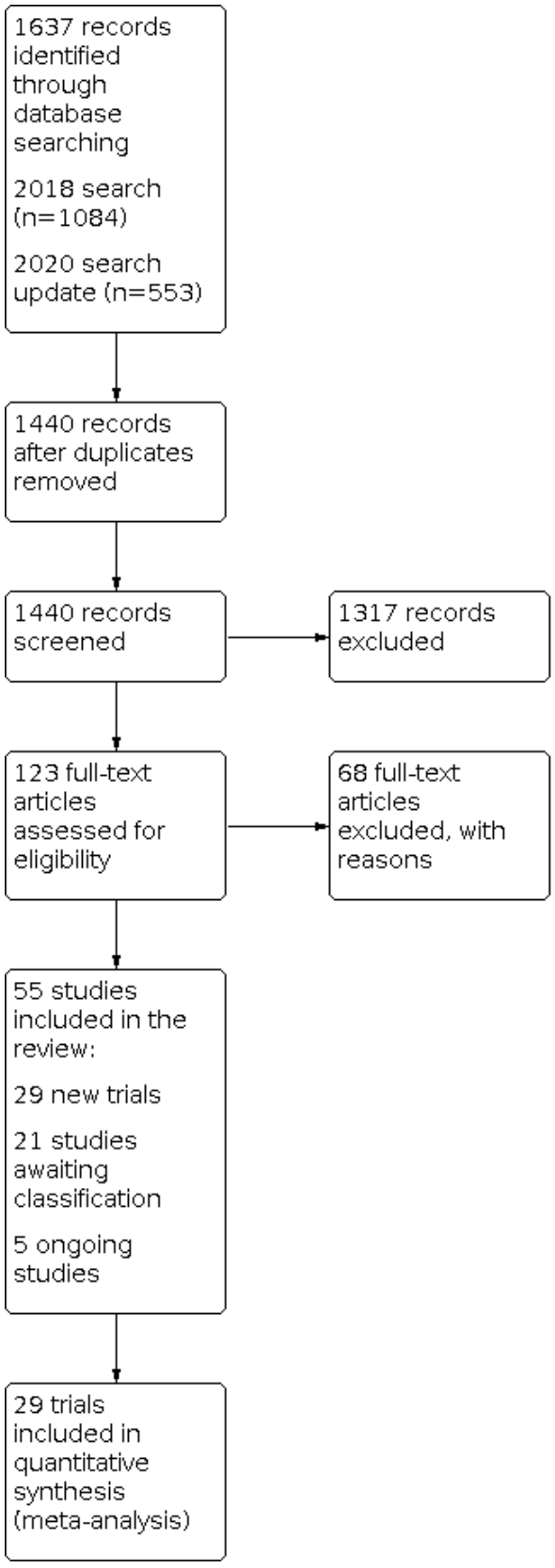
Description of studies

Details of the 29 studies are described in the Characteristics of included studies tables. Among included studies, interventions included remote monitoring in addition to usual care (Antoniades 2012; Berkhof 2015; Ho 2016; Lewis 2010; McDowell 2015; Pinnock 2013; Shany 2016; Vianello 2016), remote monitoring only compared with usual care (Calvo 2014; De San Miguel 2013; Jódar-Sanchez 2013; Minguez 2017; Pedone 2013; Sink 2020; Soriano 2018; Stamenova 2020; Udsen 2017; Walker 2018), or multi-component interventions compared with usual care (Bourbeau 2016; Casas 2006; Farmer 2017; Koff 2009; Ringbaek 2015; Ritchie 2016; Rose 2018; Jakobsen 2015; Sorknaes 2013; Tabak 2014; Yan 2018). Intervention comparisons and classifications are listed in Table 1.

Results of the search

We conducted database searches in 2018 and 2020. Through these searches we retrieved 1440 records after removing duplicates. Of the 1440 references screened, we excluded 1317 based on titles and abstracts. We assessed full texts for 123 relevant references for inclusion. Of these, we identified 55 studies that met the inclusion criteria. We included 29 studies in the quantitative analysis (Figure 1). We placed 21 studies under awaiting classification for further assessment, as we could not find information about these studies, and five were ongoing. GRADE certainty ratings of the evidence for primary outcomes are presented in Summary of findings 1, Summary of findings 2, and Summary of findings 3.

Figure 1. Study flow diagram.



Included studies

Setting, design, and duration

Fourteen studies were single-centre, and fifteen were multi-centre, parallel-assignment randomised trials. Four studies were conducted in Denmark (Jakobsen 2015; Ringbaek 2015; Sorknaes 2013; Udsen 2017), four in Spain (Calvo 2014; Jódar-Sanchez 2013; Minguez 2017; Soriano 2018); three each in the UK (Farmer 2017; Lewis 2010; Pinnock 2013), Australia (Antoniades 2012; De San Miguel 2013; Shany 2016), and the USA (Koff 2009; Ritchie 2016; Sink 2020); and two each in the Netherlands (Berkhof 2015; Tabak 2014), Canada (Rose 2018; Stamenova 2020), and Italy (Pedone 2013; Vianello 2016). One study each was conducted in China (Yan 2018), Ireland (McDowell 2015), and Taiwan (Ho 2016). Three were multi-national studies (Bourbeau 2016; Casas 2006; Walker 2018). The duration of interventions ranged from 12 weeks to 52 weeks' follow-up, and settings included primary, secondary, and tertiary care.

Baseline participant characteristics

Participant characteristics at baseline are presented in Table 2. The mean age of participants ranged from 63 to 79 years. The proportion of males recruited in these studies ranged from 36% to 96%, and the proportion of females ranged from 4% to 61% (Table 2). COPD severity ranged from mild to very severe, as diagnosed by GOLD staging criteria, and concomitant medications included long-acting beta-agonists (LABAs), long-acting muscarinic agonists (LAMAs), inhaled corticosteroids (ICSs), theophylline, phosphodiesterase-4 inhibitors (PDE-4s), and short-acting beta-agonists (SABAs). Participants in three studies were receiving home oxygen (Berkhof 2015; De San Miguel 2013), or were given long-term oxygen therapy (Jódar-Sanchez 2013); however some studies also reported participants who had received influenza or pneumonia vaccines (Casas 2006 Koff 2009 McDowell 2015 Rose 2018). Most studies did not report exacerbations in the previous 12 months; however, mean exacerbations among three studies ranged from 1 to 19 (Bourbeau 2016; Ho 2016; Stamenova 2020). Hospitalisations in the previous 12 months ranged from mean 0.55 to 2.75 across 14 studies. Comorbidities were reported by most studies (except for Antoniades 2012 Berkhof 2015 De San Miguel 2013 Jakobsen 2015 Koff 2009 Pedone 2013 Ritchie 2016 Sink 2020 Tabak 2014 and Yan 2018); these are presented in Table 2. Anxiety and depression, hypertension, cardiovascular disease, infection, and diabetes were among the comorbidities more commonly reported by studies, ranging from mean 1.9 to 3.5 comorbidities per person (Bourbeau 2016; Casas 2006; Table 2).

Description of interventions

All descriptions of interventions are presented in Table 3.

Remote monitoring plus usual care

Four studies reported interventions that consisted of a remote home monitoring system that was wired to a telephone or assessed physiological parameters (e.g. blood pressure, oxygen saturation) that were processed or authorised by a health professional, with feedback provided to the participant in addition to usual or standard care (Antoniades 2012; Lewis 2010; McDowell 2015; Pinnock 2013). Berkhof 2015, Ho 2016, Shany 2016, and Vianello 2016 used a wireless home remote monitoring system to monitor physiological parameters that were processed by a health professional, with feedback provided to participants in addition to usual care.

Participant data transfer process

Participants in four studies entered physiological parameters manually into the remote monitoring system (Ho 2016; Lewis 2010; McDowell 2015; Vianello 2016), whereas in two studies (Antoniades 2012; Shany 2016), the apparatus was connected to the remote monitoring system, allowing automatic transfer of data. Participant data in Berkhof 2015 were obtained through telephone calls made by the nurse.

Data were transmitted automatically via the linked remote system (computer-based device or device connected to a telephone line) to secure servers and were acquired by study administrators asynchronously (i.e. once the data had been transmitted) in seven studies (Antoniades 2012; Ho 2016; Lewis 2010; McDowell 2015; Pinnock 2013; Shany 2016; Vianello 2016). Participant data in Berkhof 2015 were obtained synchronously (i.e. in real time) through telephone calls.

In seven studies, symptom- or algorithm-based clinical alerts or 'red flags' were generated when readings were outside pre-set parameters on the monitoring system. At the first instance, participants were contacted by the person monitoring the alerts to either take another reading or confirm health status, and to then escalate to specialists who could decide on further intervention. No clinical alert was generated in Berkhof 2015, as the intervention was based on telephone calls.

Remote monitoring only

All ten studies consisted of a remote monitoring setup that included apparatus to measure physiological parameters at home. Five studies consisted of a wired remote monitoring device set up at home that included apparatus for participants to measure, for example, blood pressure, oxygen saturation, and heart rate (Calvo 2014; De San Miguel 2013; Jódar-Sanchez 2013; Minguez 2017; Soriano 2018). The remaining five studies included a wireless remote monitoring system with apparatus to measure physiological parameters via Bluetooth connection (Pedone 2013; Stamenova 2020; Udsen 2017), by automated telephone calls or text messaging (Sink 2020), or by a touch-screen computer (Walker 2018).

Participant data transfer process

Participants in four studies entered their physiological data manually using apparatus provided with the remote monitoring system; data were then transmitted automatically to a secure website or to a clinical health centre connected by telephone and modem or via Internet (Calvo 2014; De San Miguel 2013; Jódar-Sanchez 2013). In five studies, participants measured physiological parameters via Bluetooth equipment (Pedone 2013; Stamenova 2020), wireless equipment (Udsen 2017; Walker 2018), and automated telephone calls and texts (Sink 2020), which allowed data to be transmitted automatically. Participants in Soriano 2018 entered physiological parameters manually, but respiratory rate and oxygen use adherence data were collected automatically by a device attached to the oxygen feed from participants' main oxygen source.

In nine studies, administrators reviewed the data asynchronously once transmitted (Calvo 2014; De San Miguel 2013; Jódar-

Sanchez 2013; Minguez 2017; Sink 2020; Soriano 2018; Stamenova 2020; Udsen 2017; Walker 2018). Participant data were acquired synchronously in Pedone 2013.

Data were triaged based on whether readings were within pre-set parameters (green), or were not provided (yellow). A red alert was created if readings were outside the pre-set parameters, after which the administrator contacted the participant, or escalated to clinical staff for further intervention (Calvo 2014; Jódar-Sanchez 2013; Soriano 2018; Udsen 2017). In De San Miguel 2013; Minguez 2017, Pedone 2013, Sink 2020, Stamenova 2020, and Walker 2018, participants were contacted when a clinical alert was created because readings were outside the parameters, and were escalated to clinical staff for further investigation.

Multi-component intervention (with remote monitoring, consultation, or both, as a component of the intervention)

Eight studies were described as integrated care interventions with a remote monitoring or consultation platform set up in participants' homes (Casas 2006; Farmer 2017; Jakobsen 2015; Koff 2009; Ringbaek 2015; Rose 2018; Sorknaes 2013; Tabak 2014). Bourbeau 2016 used a telephone-based remote monitoring system, whereas Ritchie 2016 provided remote monitoring via a web-based interactive voice response system. Yan 2018 provided remote consultation via a mobile phone.

One study included a wired remote monitoring system that allowed monitoring of physiological parameters (e.g. FEV_1, oxygen saturation, steps in the 6-minute walk distance (6MWD)) transmitted by participants using apparatus provided (Koff 2009). Three studies used wireless systems (Bourbeau 2016; Farmer 2017; Ringbaek 2015). Bourbeau 2016 included a wireless remote monitoring system (web and telephone) to monitor physiological parameters and long-term oxygen therapy, whereas Farmer 2017 included a wireless tablet computer for participants to measure physiological parameters via Bluetooth connection. Ringbaek 2015 provided equipment for remote monitoring and for measurement of physiological parameters that could be transferred by the participant via a wireless tablet computer with a webcam and a microphone. Casas 2006 consisted of monitoring via an integrated platform including a web-based call centre and telephone calls from the call centre. In Ritchie 2016, participants used a web-based platform and telephone calls for remote monitoring of physiological parameters. Rose 2018 included telephone consultation for monitoring and assessment of symptoms. Similarly, Tabak 2014 provided web-based consultations and telephone calls. Jakobsen 2015 consisted of both remote monitoring and a consultation platform via a touch screen and a web cam. Sorknaes 2013 included video consultations, remote monitoring of physiological parameters, and follow-up telephone calls. Yan 2018 was based on a remote consultation mobile platform that provided care by text, voice, photo, or video.

Participant data transfer process

Data entry was manual in six studies and required participants to measure and record physiological parameters on the remote system set up at home (Bourbeau 2016; Jakobsen 2015; Koff 2009; Ringbaek 2015; Ritchie 2016; Yan 2018). In Farmer 2017, data were transmitted automatically through Bluetooth-connected apparatus, and in Sorknaes 2013, data were automatically collected through video consultations with the nurse. In Casas 2006, an integrated web-based call centre was available for participants. Participants in Rose 2018 had telephone consultations with a health professional that included monitoring and assessment of symptoms. Tabak 2014 provided remote consultations via a web portal whereby participants could communicate with health professionals about their digital diary.

Participant data were acquired asynchronously by the administrator in seven studies (Bourbeau 2016; Casas 2006; Farmer 2017; Koff 2009; Ringbaek 2015; Ritchie 2016; Tabak 2014), and they were acquired synchronously in three studies (Rose 2018; Sorknaes 2013; Yan 2018). Jakobsen 2015 used asynchronous acquisition of participant data for hospital rounds and synchronous acquisition for real-time video consultations for data review.

Clinical alerts were created by the telehealth system based on scores or symptoms (Bourbeau 2016; Yan 2018), physiological parameter thresholds (Farmer 2017; Jakobsen 2015), or algorithms based on participant data, and were then triaged via a colour code system: green for normal readings, yellow for warning or no reading, and red for readings outside pre-set thresholds (Koff 2009; Ringbaek 2015; Ritchie 2016). Clinical alerts were not generated in six studies (Casas 2006; Jakobsen 2015; Rose 2018; Sorknaes 2013; Tabak 2014; Yan 2018).

Administrators contacted participants if a red flag or clinical alert was created on the system (Bourbeau 2016; Casas 2006; Farmer 2017; Koff 2009; Ringbaek 2015; Ritchie 2016). In Rose 2018, telephone consultations included 'teach-back' sessions.

Excluded studies

We excluded 68 trials from the review, along with 19 additional references to these trials. Details of the excluded studies can be found under Characteristics of excluded studies along with exclusion reasons.

Risk of bias in included studies

An overview of the risk of bias in individual studies is provided in Figure 2; support for judgements in individual studies is shown in risk of bias tables under Characteristics of included studies.

Figure 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

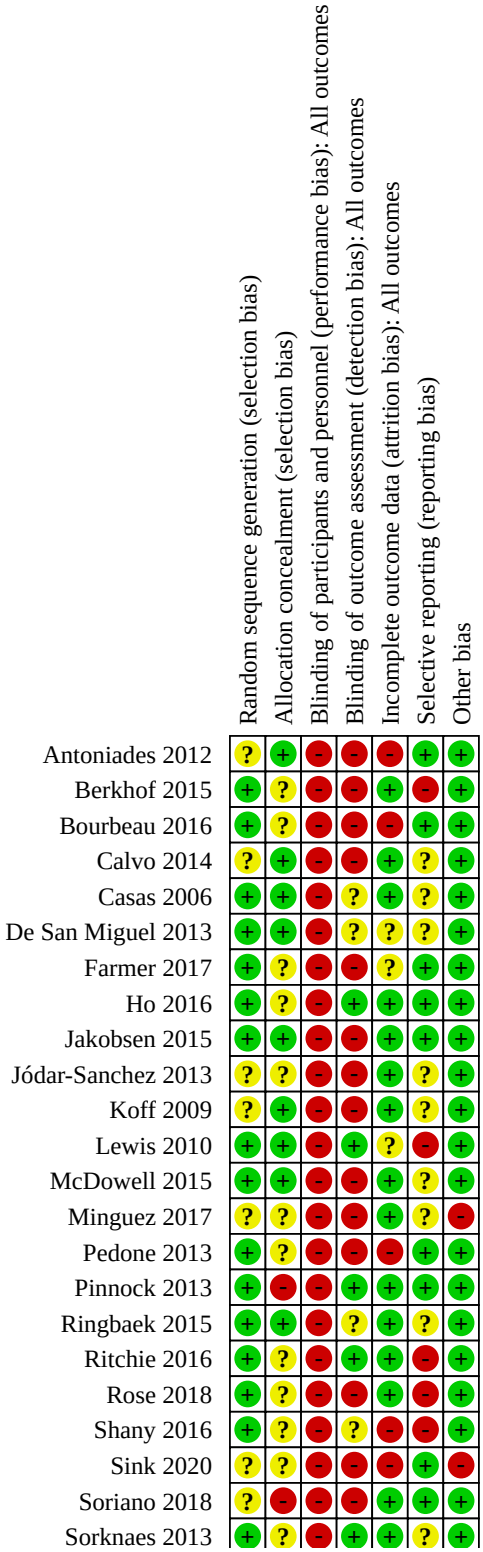
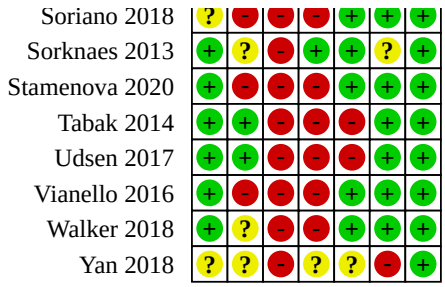


Figure 2. (Continued)



Allocation

We evaluated 21 studies as having low risk of bias for random sequence generation, and 11 studies as having low risk and 4 studies as having high risk of bias for allocation concealment. Limited information is available from publications reviewed for sequence generation and allocation concealment, but we have considered this to be a low source of bias, as studies used standard methods to minimise the risk of selection bias. We therefore determined the risk of selection bias to be low, although sequence generation and allocation concealment are unclear in several studies (Figure 2).

Blinding

Many studies reviewed were reported as open-label studies. The overall risk of performance and detection bias evaluated was high. We evaluated 29 studies as having high risk of performance bias. The structure of the study design and the nature of the intervention made it difficult to blind participants and personnel. We judged overall risk of performance and detection bias as high.

We assessed 19 studies as having high risk of bias for outcome assessment; personnel knew which participants were receiving treatment because the nature of the intervention provided in the studies made it difficult to blind.

Incomplete outcome data

The overall rate of withdrawal was similar in each study arm and was generally less than 20%; 17 arms had attrition greater than 20%, resulting in some concerns. However three studies - Shany 2016 (47.6% telehealth and 14.3% control), Tabak 2014 (33.3% telehealth and 85.7% control), and Udsen 2017 (55.4% telehealth and 51.2% control) - reported higher rates of attrition bias overall than were reported in other studies. Shany 2016 and Tabak 2014 included small sample sizes, and Udsen 2017 was lost to follow-up, so we judged these three studies to be at high risk of attrition bias. Rose 2018 had low attrition overall; however, data related to secondary outcome measures assessed by questionnaires were missing, which could have led to bias in the results.

Selective reporting

We assessed 14 studies as having low risk and 6 as having high risk of reporting bias. We found limited information available for the remaining nine studies, classified as having unclear risk of reporting bias due to no registry information found to verify outcomes reported as planned. We therefore had some concern regarding reporting bias.

Other potential sources of bias

Most of the included studies (29 studies) were assessed as having low risk for other potential source of bias. However, Minguez 2017 and Sink 2020 reported information resulting in a judgement for other potential sources of bias as high risk for these studies. Minguez 2017 reported that the selection process could not be generalised to the whole COPD population and patients were selected due to intellect and cognitive capacity. Sink 2020 reported adding 17 participants to the control group without randomisation, and differences in FEV_1/FVC values among randomised and non-randomised participants in the control group.

Effects of interventions

See: **Summary of findings 1** Remote monitoring plus usual care compared to usual care; **Summary of findings 2** Remote monitoring compared to usual care; **Summary of findings 3** Multi-component interventions (with telehealth as a component of care) compared to usual care

Interventions were classified according to comparisons outlined in the Methods. Interventions with more than two components were classed as multi-component interventions. Classification of studies according to intervention type is shown in Table 1, and details of baseline characteristics and individual interventions are listed in Table 2 and Table 3.

No studies were identified for remote consultation plus usual care or remote consultation alone versus usual care comparisons. Data for outcomes not included in the analyses are presented in Table 4 and Table 5 and are briefly described in the relevant comparison section.

Remote monitoring plus usual care versus usual care

We identified eight studies that compared a remote monitoring intervention in addition to usual care versus usual care and included them in the analyses (Antoniades 2012; Berkhof 2015; Ho 2016; Lewis 2010; McDowell 2015; Pinnock 2013; Shany 2016; Vianello 2016). We reported the main outcomes in Summary of findings 1. Outcomes that were not analysed are reported in Table 4.

Primary outcome: exacerbations

Number of people experiencing one or more exacerbations (follow-up 26 weeks)

One included study compared an asynchronous remote in-home telemonitoring intervention plus usual care versus regular

outpatient visits (Berkhof 2015). Evidence is very uncertain and suggests that in-home telemonitoring plus usual care may result in little to no difference in the number of people experiencing one or more exacerbations compared to regular outpatient visits at 26 weeks (odds ratio (OR) 1.25, 95% confidence interval (CI) 0.59 to 2.67; 108 participants, 1 study; very low-certainty evidence; Analysis 1.1; Summary of findings 1).

Mean exacerbations (follow-up 26 or 52 weeks)

Two included studies compared asynchronous home remote monitoring interventions plus usual care versus control (usual clinical care) (McDowell 2015; Pinnock 2013). Evidence suggests that a home remote monitoring intervention plus usual care may result in little to no difference in mean exacerbations compared to usual care at either 26 weeks (mean difference (MD) -0.46, 95% CI -1.19 to 0.27; 100 participants, 1 study; Analysis 1.2) or 52 weeks (MD 0.10, 95% CI -0.40 to 0.60; 189 participants, 1 study; Analysis 1.2).

Primary outcome: quality of life

St George's Respiratory Questionnaire (SGRQ total) (follow-up 26 or 52 weeks)

Included studies compared asynchronous and synchronous home remote monitoring interventions plus usual care versus usual care (Berkhof 2015; McDowell 2015; Pinnock 2013). Each study measured quality of life using St George's Respiratory Questionnaire (SGRQ), which consists of 50 items from three domains (symptoms, activities, and impact). Total scores range from 0 (no limitations) to 100 (increased limitations). Only Berkhof 2015 reported that the tool was self-reported. Evidence is very uncertain and suggests that asynchronous or synchronous home remote monitoring intervention plus usual care may result in little to no difference in quality of life improvement at 26 weeks compared to usual care (MD -1.49, 95% CI -9.43 to 6.44; 204 participants, 2 studies; I^2 = 75%; very low-certainty evidence; Analysis 1.3; Summary of findings 1). Similarly, evidence is uncertain at 52 weeks and suggests that an asynchronous home telemonitoring plus usual care intervention may result in little to no difference in quality of life improvement at 52 weeks (MD 0.90, 95% CI -3.71 to 5.51; 205 participants, 1 study; Analysis 1.3; Summary of findings 1).

Explanation of heterogeneity in SGRQ at 26 weeks

At 26 weeks, heterogeneity in the meta-analysis was very high (Analysis 1.3). We used a random-effects model based on the assumption that intervention effect estimates are different, which cannot be explained by other factors, that is, differences observed are random. Although heterogeneity is not a concern in this model, we explored the differences between Berkhof 2015 and McDowell 2015. Berkhof 2015 was a single-centre study in which participants in the remote monitoring group had worse health outcomes (Clinical Chronic Obstructive Pulmonary Disease Questionnaire (CCQ), symptoms) at baseline and increased use of home oxygen, as well as hospitalisations, compared to the control group. McDowell 2015 was a two-centre study that included participants with moderate to severe COPD. Participants in the remote monitoring group received increased ambulatory oxygen therapy compared to those in the usual care group (40% versus 33%), although long-term oxygen therapy was similar in both groups (27% versus 25%). At baseline, study participants had similar health status, which was measured by the EuroQoL Group Quality of Life Questionnaire based on 5 dimensions (EQ-5D), the EuroQoL Group Visual Analogue Scale (EQ-VAS), and SGRQ total scores. Interventions in both studies were home-based monitoring systems, but monitoring mechanisms were different. Participants in Berkhof 2015 were remotely monitored by fortnightly telephone calls with a call centre nurse, whereas those in McDowell 2015 were monitored via a home remote monitoring system that was connected to a telephone line. Measurements (heart rate, oxygen saturation, blood pressure) and symptoms (tiredness, sputum, difficulty breathing, cough) were monitored regularly through the system. If an alert was triggered, the nurse called the patient to obtain more information, to repeat monitoring, or to escalate to the community respiratory team for further advice on what action should be taken. It may be likely that differences in these intervention processes may result in the variation observed in the analysis.

Quality of life measures not included in main analyses

Quality of life measures not included in the main analyses are listed in Table 4. Antoniades 2012 reported results from the Chronic Respiratory Disease Questionnaire (CRDQ) at 26 weeks and 52 weeks. At both time points, there may be little to no effect on quality of life. The CCQ was measured in Berkhof 2015 at 26 weeks; there may be little to no effect on quality of life with a remote monitoring intervention plus usual care compared to usual care alone. The Short Form Health Survey (SF-36) was reported by Antoniades 2012. At 26 weeks and at 52 weeks, there was little to no improvement in quality of life with remote monitoring in addition to usual care compared to usual care alone. Little to no effect was seen in the SF-36 mental, physical, or general subscales (Berkhof 2015; Vianello 2016).

Primary outcome: dyspnoea symptoms

We identified no studies that reported dyspnoea symptoms.

Primary outcome: hospital service utilisation

Six studies reported data for hospital service utilisation (Antoniades 2012; Ho 2016; McDowell 2015; Pinnock 2013; Shany 2016; Vianello 2016).

Mean hospital admissions (all-cause) (follow-up 52 weeks)

Three included studies compared asynchronous remote monitoring intervention plus standard best practice (SBP) or usual care versus standard best practice or usual care alone (Antoniades 2012; Pinnock 2013; Shany 2016). Each study measured mean hospital admissions (all-cause). Evidence is very uncertain and suggests that a remote monitoring plus usual care intervention may result in little to no difference in mean hospital admissions at 52 weeks compared to usual care alone (MD 0.09, 95% CI -0.43 to 0.60; 342 participants, 3 studies; I^2 = 0%; Analysis 1.4).

Mean hospital admissions (COPD-related) (follow-up mean 45 weeks)

Three included studies compared asynchronous remote monitoring interventions plus standard best practice or usual care with standard best practice or usual care alone (Antoniades 2012; McDowell 2015; Pinnock 2013). One study had follow-up of 26 weeks (McDowell 2015), and two studies had follow-up of 52 weeks (Antoniades 2012; Pinnock 2013). We converted the analysis to standardised mean differences (SMDs) and 95% CIs to account for different follow-up times, and we assessed imprecision by calculating the absolute effect estimate. Evidence is very uncertain

and suggests that a remote monitoring intervention plus standard best practice (SBP) or usual care had little to no effect on mean hospital admissions compared to SBP or usual care alone at a mean of 45 weeks (SMD -0.01, 95% CI -0.21 to 0.18; 400 participants, 3 studies; I^2 = 0%; Analysis 1.5). The absolute effect estimate for COPD-related hospital admissions per year was -0.016 (95% CI -0.336 to 0.288).

Hospital admission rate (follow-up 52 weeks)

One included study compared an asynchronous remote monitoring intervention plus usual care versus usual care alone (Vianello 2016). Evidence is very uncertain and suggests that a remote monitoring intervention plus usual care may result in little to no difference in hospital admission rate per year compared to usual care alone (rate ratio 0.84, 95% CI 0.66 to 1.07; 334 participants; Analysis 1.6).

Time to first hospitalisation after start of intervention (all-cause or COPD-related) (follow-up 52 weeks)

One included study compared an asynchronous remote monitoring intervention plus usual care versus usual care alone (Pinnock 2013). Evidence is very uncertain and suggests that a remote monitoring intervention plus usual care may result in little to no difference in mean time to first hospitalisation compared to usual care alone at 52 weeks (hazard ratio (HR) 1.08, 95% CI 0.80 to 1.46; 256 participants; Summary of findings 1; Analysis 1.7).

In the same study (Pinnock 2013), evidence is very uncertain for risk of COPD-related hospitalisation and suggests that a remote monitoring intervention plus usual care may result in little to no difference in the risk of COPD-related hospitalisation compared to usual care alone at 52 weeks (HR 1.10, 95% CI 0.78 to 1.55; 256 participants; Analysis 1.8; Summary of findings 1).

Time to first COPD-related hospital re-admission (follow-up 26 weeks)

One included study compared an asynchronous remote monitoring intervention plus usual care versus usual care alone (Ho 2016). Moderately certain evidence shows that a remote monitoring intervention plus usual care likely results in reduced risk of COPD-related hospital re-admission at 26 weeks (HR 0.42, 95% CI 0.19 to 0.93; 106 participants; Analysis 1.9; Summary of findings 1).

Time to first COPD-related emergency department visit (follow-up 26 weeks)

One included study compared an asynchronous remote monitoring intervention plus usual care versus usual care alone (Ho 2016). Evidence is uncertain and suggests that a remote monitoring intervention plus usual care may result in little to no difference in the risk of a COPD-related emergency department visit at 26 weeks (HR 0.50, 95% CI 0.24 to 1.04; 106 participants; Analysis 1.10).

Length of stay (days, all-cause) (follow-up 52 weeks)

Four included studies compared asynchronous remote monitoring interventions plus usual care versus usual care alone (Antoniades 2012; Pinnock 2013; Shany 2016; Vianello 2016). Evidence suggests that a remote monitoring intervention plus usual care may result in little to no effect on all-cause length of stay in hospital compared to usual care alone at 52 weeks (MD -0.81 days, 95% CI -4.83 to 3.22; 604 participants, 4 studies; I^2 = 0%; Analysis 1.11).

One included study compared an asynchronous remote monitoring intervention plus usual care versus usual care alone (Pinnock 2013). Evidence is very uncertain and suggests that a remote monitoring intervention plus usual care may result in little to no effect on the risk of all-cause duration of stay in hospital (HR 1.05 days, 95% CI 0.75 to 1.47; 256 participants; Analysis 1.12).

Length of stay (days, COPD-related) (follow-up mean 47 weeks)

Three included studies compared asynchronous remote monitoring interventions plus usual care (McDowell 2015; Pinnock 2013; Vianello 2016). One study had follow-up of 26 weeks (McDowell 2015), and two studies had follow-up of 52 weeks (Pinnock 2013; Vianello 2016). We converted the analysis to standardised mean differences (SMDs) and 95% CIs to account for different follow-up times, and we assessed imprecision by calculating the absolute effect estimate. Evidence is very uncertain and suggests that a remote monitoring intervention plus usual care may result in little to no effect on COPD-related length of hospital stay compared to usual care alone at a mean of 47 weeks (SMD -0.11 days, 95% CI -0.30 to 0.09; 618 participants, 3 studies; I^2 = 28%; Analysis 1.13). This is also observed at 52 weeks, with little to no effect of asynchronous remote monitoring plus usual care compared to usual care alone on risk of length of stay (COPD-related), as evidence is very uncertain (HR 1.03 days, 95% CI 0.70 to 1.52; 256 participants; Analysis 1.14).

On further investigation of variation observed in the analysis (I^2 = 28%), by taking Vianello 2016 out of the analysis, we no longer noted any variation. This could have been due to a number of reasons. First, over time, the number of actual hospitalisations may vary across studies, and mean length of stay data may be skewed. Vianello 2016 was conducted in Italy. McDowell 2015 and Pinnock 2013 were conducted in the UK and in Northern Ireland, respectively. McDowell 2015 was the only 26-week study included in the analysis, whereas both Pinnock 2013 and Vianello 2016 were 52-week studies. Both McDowell 2015 and Vianello 2016 included participants with moderate to severe COPD, whereas Pinnock 2013 included participants with mild to very severe COPD. Intervention processes were similar across all three studies, but uptake and behaviour of the intervention could have contributed to differences observed. We were unable to perform a subgroup analysis based on our pre-specified criteria, as they were not reported by all three studies. Only two studies reported previous hospitalisations (McDowell 2015; Pinnock 2013), and participants in Pinnock 2013 had approximately two hospitalisations in the last 12 months. Participants in McDowell 2015 had approximately one hospitalisation in the last year. Cognitive impairment could not investigated, as it was not reported in any study. McDowell 2015 did not report comorbidities, but Pinnock 2013 reported that more than 70% of participants who had at least one comorbidity, and Vianello 2016 reported that more than 60% had hypertension or Ischaemic heart disease (or both).

Hospital admission measures not included in main analyses

Vianello 2016 reported COPD-related hospital admissions. At 52 weeks, remote monitoring plus usual care had little to no effect on the rate of COPD-related hospital admissions compared to usual care alone (Table 4).

Primary outcome: mortality

Seven included studies compared six asynchronous and one synchronous remote monitoring intervention plus SBP or usual care versus SBP or usual care alone (Antoniades 2012; Berkhof

2015; Lewis 2010; McDowell 2015; Pinnock 2013; Shany 2016; Vianello 2016). Evidence is very uncertain and suggests that a remote monitoring intervention plus SBP or usual care may result in little to no difference in the number of deaths compared to SBP or usual care alone at a mean of 44 weeks (OR 0.99, 95% CI 0.62 to 1.58; 927 participants, 7 studies; I^2 = 0%; Analysis 1.15; Summary of findings 1).

Secondary outcome: adverse events

We identified no studies that reported adverse events.

Secondary outcome: anxiety and depression

Hospital Anxiety & Depression Scale (HADS) anxiety score (follow-up 26 or 52 weeks)

Four included studies compared asynchronous remote monitoring interventions plus SBP or usual care versus SBP or usual care alone (Lewis 2010; McDowell 2015; Pinnock 2013; Vianello 2016). Evidence suggests that a remote monitoring intervention plus SBP or usual care does not reduce anxiety measured by the HADS-anxiety scale at 26 weeks (Analysis 1.16). At 52 weeks, evidence suggests that a remote monitoring intervention plus SBP or usual care may result in little to no effect on the HADS-anxiety score (Analysis 1.16).

HADS depression score (follow-up 26 or 52 weeks)

Three included studies compared asynchronous remote monitoring interventions plus usual care versus usual care alone (McDowell 2015; Pinnock 2013; Vianello 2016). Evidence suggests that a remote monitoring intervention plus usual care may result in little to no effect on the HADS-depression score at 26 weeks (Analysis 1.17) or at 52 weeks (Analysis 1.17).

Secondary outcome: self-efficacy

One included study compared an asynchronous remote monitoring intervention plus usual care versus usual care alone (Pinnock 2013). Evidence suggests that a remote monitoring intervention plus usual care may result in little to no effect on self-efficacy on the Self-Efficacy for Managing Chronic Disease-6 (SEMCD-6) Scale at 52 weeks compared to usual care alone (Analysis 1.18).

Secondary outcome: participant satisfaction

We identified no studies that reported participant satisfaction.

Remote monitoring versus usual care

We identified ten studies that compared a remote monitoring intervention versus usual care and were included in the analyses (Calvo 2014; De San Miguel 2013; Jódar-Sanchez 2013; Minguez 2017; Pedone 2013; Sink 2020; Soriano 2018; Stamenova 2020; Udsen 2017; Walker 2018).

Primary outcome: exacerbations

Number of people experiencing one or more exacerbations (follow-up mean 41 weeks)

Four included studies compared three asynchronous and one synchronous remote monitoring interventions versus usual care (Jódar-Sanchez 2013; Minguez 2017; Pedone 2013; Soriano 2018). Evidence is very uncertain and suggests that a remote monitoring intervention may have little to no effect on the number of people experiencing one or more exacerbations compared to usual care at a mean follow-up of 41 weeks (OR 1.02, 95% CI 0.67 to 1.55; 424 participants, 4 studies; I^2 = 0%; Analysis 2.1; Summary of findings 2).

Mean exacerbations (follow-up mean 46 weeks)

Two included studies compared asynchronous remote monitoring interventions versus usual care (Soriano 2018; Stamenova 2020). The analysis was converted to standardised mean differences (SMDs) and 95% CIs to account for different follow-up times, and we assessed imprecision by calculating the absolute effect estimate. Evidence suggests that a remote monitoring intervention may have little to no effect on mean exacerbations compared to usual care at a mean follow-up of 46 weeks (SMD 0.22, 95% CI -0.01 to 0.44; 297 participants, 2 studies; I^2 = 0%; Analysis 2.2). The absolute effect estimate was 0.22 (95% CI -0.01 to 0.45) exacerbations per year.

Time to first exacerbation (follow-up 26 weeks)

One included study compared an asynchronous remote monitoring intervention versus usual care (Minguez 2017). Evidence is very uncertain and suggests that a remote monitoring intervention may have little to no effect on risk of an exacerbation compared to usual care at 26 weeks (HR 1.29, 95% CI 0.72 to 2.31; 1 study, 116 participants; Analysis 2.3; Summary of findings 2).

Primary outcome: quality of life

SGRQ total score (follow-up 17 weeks)

One included study compared an asynchronous remote monitoring intervention versus usual care (Jódar-Sanchez 2013). Evidence is very uncertain and suggests that a remote monitoring intervention may have little to no effect on quality of life compared to usual care at 17 weeks (MD -6.40, 95% CI -18.56 to 5.76; 45 participants; Analysis 2.4; Summary of findings 2).

CAT score (follow-up mean 38 weeks or 52 weeks)

Three included studies compared effects of asynchronous remote monitoring interventions versus usual care on quality of life as measured by the CAT score (score range 0 to 40; lower scores represent better outcomes) (Minguez 2017; Soriano 2018; Walker 2018). Included studies did not report whether the tool was self-reported) (Minguez 2017; Walker 2018). Evidence is very uncertain and suggests that a remote monitoring intervention may have little to no effect on quality of life compared to usual care at a mean of 38 weeks (MD 0.06, 95% CI -1.34 to 1.45; 405 participants, 2 studies; I^2 = 0%; Analysis 2.5; Summary of findings 2). Similarly, very uncertain evidence based on one study suggests that a remote monitoring intervention may have little to no effect on quality of life compared with usual care at 52 weeks (MD 0.10, 95% CI -1.42 to 1.62; 229 participants, 1 study; Analysis 2.5; Summary of findings 2) (Soriano 2018).

Quality of life measures not included in the main analyses

Udsen 2017 showed little to no difference in effects of a remote monitoring intervention compared to usual care on the SF-36 mental composite score at 52 weeks (Table 4). Jódar-Sanchez 2013 measured quality of life using the EQ-5D scale at 17 weeks, which showed little to no difference in effects between a remote monitoring intervention and usual care (Table 4). There was no difference in quality of life improvement as measured by the Minnesota Living with Heart Failure Questionnaire (MLHFQ) at 39 weeks (Walker 2018; Table 4).

Primary outcome: dyspnoea symptoms

Chronic Respiratory Disease Questionnaire Self-Administered Standardized Scale (CRQ-SAS) (follow-up 26 weeks)

One included study compared an asynchronous remote monitoring intervention versus usual care (De San Miguel 2013). Evidence is uncertain and suggests that a remote monitoring intervention may have little to no effect in reducing dyspnoea symptoms compared to usual care at 26 weeks (MD -0.44, 95% CI -1.04 to 0.16; 70 participants; Analysis 2.6; Summary of findings 2).

Primary outcome: hospital service utilisation

Number of people admitted to hospital (all-cause) (follow-up mean 36 weeks)

Two included studies compared asynchronous remote monitoring interventions versus usual care (Jódar-Sanchez 2013; Walker 2018). Evidence is very uncertain and suggests that a remote monitoring intervention may have little to no effect in reducing the number of people admitted to hospital compared to usual care at a mean of 36 weeks (OR 1.21, 95% CI 0.75 to 1.94; 357 participants, 2 studies; I^2 = 0%; Analysis 2.7; Summary of findings 2).

Hospital admissions (all-cause) (follow-up mean 48 weeks)

Four included studies compared asynchronous remote monitoring interventions versus usual care (De San Miguel 2013; Jódar-Sanchez 2013; Stamenova 2020; Udsen 2017). The analysis was converted to standardised mean differences (SMDs) and 95% CIs to account for different follow-up times. We assessed imprecision by calculating the absolute effect estimate of -0.02 hospital admissions (95% CI -0.27 to 0.23) per year. Evidence is very uncertain and suggests that a remote monitoring intervention may have little to no effect in reducing mean hospital admissions compared to usual care at a mean of 48 weeks (SMD -0.02, 95% CI -0.22 to 0.19; 1409 participants, 4 studies; I^2 = 29%; Analysis 2.8).

Note: for Udsen 2017, the standard error (SE) for the control arm was reported as 0.49, which was calculated as a standard deviation (SD) of 12.4 with the RevMan calculator. Upon further discussion, we concluded that the reported SE should be 0.049, not 0.49, due to an error in the publication. For an SE of 0.049, this would give a pooled SD of approximately 1, which fits the standardised difference. The mean difference is 0.046, and when divided by the pooled SD from both arms, this becomes 3%, which is 0.03, so the pooled SD should be roughly 1.5.

Hospital admissions (COPD-related) (follow-up 26 weeks)

Two included studies compared asynchronous remote monitoring interventions versus usual care (De San Miguel 2013; Stamenova 2020). Evidence is very uncertain and suggests that a remote monitoring intervention may have little to no effect in reducing COPD-related hospital admissions compared to usual care at 26 weeks (MD -0.19, 95% CI -0.41 to 0.02; 129 participants, 2 studies; I^2 = 0%; Analysis 2.9).

Time to first hospitalisation (follow-up 34 weeks)

One included study compared an asynchronous remote monitoring intervention versus an active control (reported as usual care) (Sink 2020). Evidence is uncertain and suggests that a remote monitoring intervention may result in a slight reduction in the risk of hospitalisation compared to usual care at 34 weeks (HR 2.36, 95% CI 1.02 to 5.46; 168 participants; Analysis 2.10; Summary of findings 2).

Hospital re-admissions

Walker 2018 compared an asynchronous remote monitoring intervention versus usual care at 39 weeks. Hospital re-admission was reported as the incidence rate ratio (IRR 0.46, 95% CI 0.24 to 0.87). Among participants who were previously hospitalised due to a COPD exacerbation, a 53% reduction in the re-hospitalisation rate was noted in the remote monitoring group compared to the usual care group (P = 0.017).

Length of stay (all-cause) (follow-up mean 49 weeks)

Five included studies compared asynchronous remote monitoring interventions versus usual care (De San Miguel 2013; Jódar-Sanchez 2013; Soriano 2018; Stamenova 2020; Udsen 2017). The analysis was converted to standardised mean differences (SMDs) and 95% CIs to account for different follow-up times. We assessed imprecision by calculating the absolute effect estimate (MD -0.39 days, 95% CI -1.50 to 0.63). Evidence suggests that a remote monitoring intervention may have little to no effect in reducing all-cause length of stay at a mean of 49 weeks (SMD -0.05 days, 95% CI -0.19 to 0.08; 1638 participants, 5 studies; I^2 = 17%; Analysis 2.11).

Length of stay (COPD-related) (follow-up 26 weeks)

One included study compared an asynchronous remote monitoring intervention versus usual care (De San Miguel 2013). Evidence suggests that a remote monitoring intervention may result in little to no difference in COPD-related length of stay compared to usual care at 26 weeks (MD -2.20 days, 95% CI -6.02 to 1.62; 71 participants; Analysis 2.12).

Primary outcome: mortality

Six included studies compared asynchronous remote monitoring interventions versus usual care (Calvo 2014; De San Miguel 2013; Jódar-Sanchez 2013; Soriano 2018; Stamenova 2020; Walker 2018). Evidence is very uncertain and suggests neither benefit nor harm compared to usual care at a mean of 38 weeks (OR 0.68, 95% CI 0.37 to 1.25; 798 participants, 6 studies; I^2 = 0%; Analysis 2.13; Summary of findings 2).

Secondary outcome: adverse events

We identified no studies that reported adverse events.

Secondary outcome: anxiety and depression

Anxiety or depression measures not included in the main analyses

One included study compared an asynchronous remote monitoring intervention versus usual care (Soriano 2018). Evidence suggests that a remote monitoring intervention may result in little to no effect in reducing Goldberg anxiety or depression subscale scores compared to usual care at 52 weeks (Table 4).

Secondary outcome: self-efficacy

We identified no studies that reported self-efficacy.

Secondary outcome: participant satisfaction

We identified no studies that reported participant satisfaction.

Multi-component or integrated care (when remote monitoring, remote consultations, or both, are components of care) versus usual care

We identified 11 studies that compared a multi-component intervention versus usual care and were included in the analyses (Bourbeau 2016; Casas 2006; Farmer 2017; Jakobsen 2015; Koff 2009; Ringbaek 2015; Ritchie 2016; Rose 2018; Sorknaes 2013; Tabak 2014; Yan 2018).

Primary outcome: exacerbations

Number of participants experiencing at least one exacerbation or moderate to severe exacerbations (follow-up 52 weeks)

Three included studies compared multi-component interventions versus usual care (Bourbeau 2016; Farmer 2017; Rose 2018). Evidence is very uncertain and suggests that multi-component interventions with asynchronous or synchronous remote monitoring may result in little to no effect in reducing the number of people experiencing at least one exacerbation or moderate to severe exacerbations compared to usual care at 52 weeks (OR 0.98, 95% CI 0.74 to 1.28; 955 participants, 3 studies; I^2 = 0%; Analysis 3.1; Summary of findings 3).

Mean time to first exacerbation (days) (follow-up 52 weeks)

One included study compared a multi-component intervention versus usual care (Farmer 2017). Evidence is very uncertain and suggests that a multi-component intervention with asynchronous remote monitoring may result in little to no effect on risk of time to a first exacerbation compared to usual care at 52 weeks (HR 1.05, 95% CI 0.67 to 1.65; 166 participants; Analysis 3.2; Summary of findings 3).

Exacerbation measures not included in the main analyses

Rose 2018 reported mean exacerbations per person, noting little to no difference in effects of a multi-component intervention on mean exacerbations at 52 weeks (Table 5). Bourbeau 2016 reported the mean number of days to a first exacerbation, which showed little to no difference in effects on the outcome with a multi-component intervention compared to usual care (Table 5).

Primary outcome: quality of life

SGRQ total

Five included studies compared a multi-component intervention (asynchronous remote monitoring or both asynchronous and synchronous monitoring and video conferencing) versus usual care (Casas 2006; Farmer 2017; Jakobsen 2015; Koff 2009; Rose 2018). Data from these studies were not pooled and were separated by follow-up duration. At 13 weeks, one included study comparing a multi-component intervention versus usual care showed that evidence was uncertain and suggested that a multi-component intervention may result in improved quality of life (MD -9.70, 95% CI -18.32 to -1.08; 38 participants; Analysis 3.3; Summary of findings 3) (Koff 2009). However, this effect is not seen at 26 weeks (MD 7.00, 95% CI -4.79 to 18.79; 40 participants, 1 study; Analysis 3.3; Summary of findings 3) nor at 52 weeks (MD -1.09, 95% CI -6.24 to 4.05; 203 participants, 2 studies; I^2 = 0%; Analysis 3.3; Summary of findings 3). Evidence was very uncertain at 26 and 52 weeks. Rose 2018 was not pooled in the main analysis; however, there is little to no difference in effects between a multi-component intervention and usual care (Analysis 3.4).

COPD Assessment Test (CAT) score (follow-up mean 38 weeks)

Two included studies compared effects of a multi-component intervention (asynchronous or synchronous remote monitoring and remote or video consultation) versus usual care on quality of life as measured by the CAT tool (scale range 0 to 40; lower scores represent better outcomes). Only Ringbaek 2015 reported the tool as a patient-reported measure) (Ringbaek 2015; Yan 2018). Multi-component interventions may result in improved quality of life on the CAT score compared to usual care at a mean of 38 weeks; however evidence is very uncertain (MD -3.93, 95% CI -7.75 to -0.12; 521 participants, 2 studies; I^2 = 95%; Analysis 3.5; Summary of findings 3).

It should be noted that although a random-effects model was applied, a very high level of heterogeneity suggests fundamental differences between the two studies. First, Ringbaek 2015 was a 26-week study conducted in Denmark, whereas Yan 2018, a Chinese study, reported a longer duration of 52 weeks. Interventions from both studies were integrated; Ringbaek 2015 included a computer tablet for remote monitoring, whereas Yan 2018 provided a mobile platform doctor or network consultancy and change to medications through consultation with the participant if needed. As the number of studies was limited, we were unable to perform subgroup analyses.

Primary outcome: dyspnoea symptoms

We identified no studies that reported dyspnoea symptoms.

Primary outcome: hospital service utilisation

Number of people who had at least one hospitalisation (follow-up mean 33 weeks)

Two included studies compared a multi-component intervention (with asynchronous remote monitoring or additional video consultation) versus usual care (Farmer 2017; Ringbaek 2015). Evidence is uncertain and suggests that a multi-component intervention may result in little to no difference in the number of people experiencing hospitalisation compared to usual care at a mean of 33 weeks (OR 0.81, 95% CI 0.55 to 1.18; 447 participants, 2 studies; I^2 = 0%; Analysis 3.6; Summary of findings 3).

Length of stay (days) all-cause or COPD-related (follow-up 26 weeks)

Two included studies compared a multi-component intervention (with asynchronous remote monitoring or additional video consultation) versus usual care (Ringbaek 2015; Sorknaes 2013). Evidence was uncertain and suggests that a multi-component intervention may result in little to no difference in length of stay compared to usual care at 26 weeks (MD -0.66 days, 95% CI -2.40 to 1.08; 523 participants, 2 studies; I^2 = 0%; Analysis 3.7). Evidence about a multi-component intervention is uncertain (with asynchronous remote monitoring or additional video consultation) and suggests that it may have little to no effect on COPD-related length of stay compared to usual care at 26 weeks (MD -0.47 days, 95% CI -1.49 to 0.55; 523 participants, 2 studies; I^2 = 0%; Analysis 3.8).

Number of people who had a re-admission (all-cause) (follow-up mean 39 weeks)

Three included studies compared a multi-component intervention (with asynchronous remote monitoring and synchronous video conference, or telephone calls) versus usual care (Casas 2006;

Jakobsen 2015; Ritchie 2016). Overall evidence is of moderate certainty and suggests that multi-component interventions likely result in a reduction in the number of people re-admitted (all-cause) compared to usual care at a mean of 39 weeks (OR 0.50, 95% CI 0.31 to 0.81; 344 participants, 3 studies; I^2 = 0%; Analysis 3.9; Summary of findings 3). On further investigation, a greater reduction was noted in the number of people re-admitted at 52 weeks compared to 12 or 26 weeks (Analysis 3.9).

Hospital re-admissions (follow-up mean 39 weeks)

Three included studies compared a multi-component intervention (with asynchronous remote monitoring or additional video conference) versus usual care (Casas 2006; Jakobsen 2015; Ritchie 2016). Overall evidence is very uncertain and suggests that multi-component interventions may result in little to no effect in reducing risk of hospital re-admissions compared to usual care at a mean of 39 weeks (HR 0.77, 95% CI 0.38 to 1.57; 349 participants, 3 studies; Analysis 3.10; Summary of findings 3). On further investigation, a greater reduction was noted in the risk of hospital re-admissions at 52 weeks, but not at 12 or 26 weeks (Analysis 3.10).

Hospital admission measures not included in the main analyses

There was little to no difference in mean all-cause or COPD-related hospital admissions and re-admissions (Table 5). There was little to no difference in mean all-cause emergency department presentations (Table 5).

Primary outcome: mortality

Nine included studies compared a multi-component intervention (with asynchronous remote monitoring and synchronous video consultation) versus usual care (Bourbeau 2016; Casas 2006; Farmer 2017; Jakobsen 2015; Koff 2009; Ringbaek 2015; Ritchie 2016; Rose 2018; Sorknaes 2013). Overall evidence is very uncertain and suggests that multi-component interventions may result in little to no effect in reducing all-cause deaths compared to usual care at a mean of 40 weeks (OR 0.62, 95% CI 0.39 to 1.01; 1886 participants, 9 studies; I^2 = 40%; Analysis 3.11; Summary of findings 3). Intervention duration did not appear to affect all-cause deaths overall, but deaths at 52 weeks were reduced in Rose 2018.

Bourbeau 2016 reported considerably more deaths in the usual care group group compared to the multi-component group, and compared to other studies of this duration. Further investigation of Bourbeau 2016 revealed that the multi-component intervention (disease management programme) included a self-management and e-health telephone/web platform, as well as a home monitoring component (requiring daily and weekly symptom reporting; FEV_1, spirometry, and heart rate tests; oxygen saturation; diary card/symptom scoring; and monitoring and feedback regarding alerts on worsening symptoms). Among study participants, 74% receiving long-term oxygen therapy and 80% had GOLD stage C disease (high risk with fewer symptoms). Deaths in the usual care group resulted from COPD exacerbations. Reduced deaths observed in the multi-component intervention group may have occurred due to optimisation of self-management of exacerbations and home monitoring by case managers, resulting in timely treatment and prevention of complications and death.

Secondary outcome: adverse events

Two included studies compared a multi-component intervention (with asynchronous remote monitoring) versus usual care (Bourbeau 2016; Farmer 2017). Evidence suggests that a multi-component intervention may result in little to no effect on the numbers of people experiencing adverse events compared to usual care (Analysis 3.12; Summary of findings 3).

Secondary outcome: anxiety and depression

Two included studies compared a multi-component intervention (with asynchronous remote monitoring or additional synchronous video conference) versus usual care (Bourbeau 2016; Jakobsen 2015). Evidence suggests that a multi-component intervention may result in little to no effect on anxiety or depression (HADS total) at 26 or 52 weeks (Analysis 3.13). Rose 2018 reported both HADS anxiety and HADS depression scores. At 52 weeks, results show little to no difference in effects of a multi-component intervention (with synchronous telephone consultations) on HADS depression compared to usual care but a reduction in HADS anxiety scale scores (Analysis 3.14). These results should be interpreted with caution due to missing data at 52 weeks that may lead to bias in the results.

Secondary outcome: self-efficacy

We identified no studies that reported self-efficacy.

Secondary outcome: participant satisfaction

One included study compared a multi-component intervention versus usual care (Tabak 2014). Evidence suggests that a multi-component intervention (with asynchronous telephone and synchronous remote consultation) may result in little to no effect on participant satisfaction compared to usual care at 39 weeks (Analysis 3.15).

DISCUSSION

Summary of main results

The review question was a topic prioritised by our patient advisory group; we evaluated randomised trials that assessed the effectiveness of remote monitoring technologies in addition to usual care, remote monitoring technologies alone, and multi-component interventions, of which telehealth technology was a part. Primary health outcomes investigated include exacerbations, quality of life, dyspnoea symptoms, hospitalisation, and mortality.

Remote monitoring plus usual care

Based on one study (108 participants), we found that an asynchronous remote monitoring intervention in addition to usual care was no better than usual care at 26 weeks' follow-up. Similarly, additional asynchronous remote monitoring interventions were of no benefit for mean exacerbations over the short or long term.

Overall, we found no benefit of asynchronous or synchronous remote monitoring in addition to usual care for improving quality of life compared to usual care, as measured by St George's Respiratory Questionnaire (SGRQ) total score at 26 weeks (2 studies, 204 participants) and at 52 weeks (1 study, 205 participants).

We found no evidence for dyspnoea symptoms.

Remote monitoring in addition to usual care interventions was no better than usual care in reducing mean all-cause or chronic obstructive pulmonary disease (COPD)-related hospital admissions at 52 weeks and at 45 weeks, respectively. However, additional

asynchronous remote monitoring interventions likely reduced the number of people re-admitted to hospital at 26 weeks.

We did not find differences in mortality rates between remote monitoring in addition to usual care versus usual care alone.

Remote monitoring interventions only

Based on four studies (424 participants), asynchronous or synchronous remote monitoring interventions alone were no better than usual care in terms of numbers of people experiencing exacerbations at a mean of 41 weeks.

Asynchronous remote monitoring was no better than usual care for improving quality of life at 17 weeks as seen in SGRQ total score (1 study, 45 participants), nor on COPD Assessment Test (CAT) score at a mean of 38 weeks (2 studies, 413 participants) or 52 weeks (1 study, 229 participants). Asynchronous remote monitoring interventions were no better than usual care for improving dyspnoea symptoms at 26 weeks.

Asynchronous remote monitoring interventions were no better than usual care for reducing the number people admitted to hospital at 36 weeks (2 studies, 357 participants). Risk of hospitalisation may be reduced at 34 weeks, but this result is based on 1 study of 168 participants, comparing an active (usual care) control group (Analysis 2.11).

We identified 6 studies with 798 participants reporting deaths at a mean of 38 weeks. We could not determine whether asynchronous remote monitoring interventions were beneficial in reducing deaths compared to usual care. A total of 22 fewer deaths were reported in the remote monitoring group, but due to very wide upper and lower confidence intervals (28 to 89) of the absolute risk, we are very uncertain about the effects observed.

Multi-component interventions (telehealth as a component of care)

Most studies included asynchronous or synchronous remote monitoring and remote or video consultation components of multi-component care provision.

Based on two studies, we could not determine whether multi-component interventions were beneficial in terms of numbers of people experiencing moderate or severe exacerbations, or in terms of risk of exacerbation (1 study) at 52 weeks.

We found that quality of life (as measured by SGRQ total score) may improve with a multi-component intervention at 13 weeks, but this small benefit was not observed at 26 weeks nor at 52 weeks. Similarly, quality of life based on two studies may improve at a mean of 38 weeks (CAT score); however, the studies were different geographically (China and Denmark) and the care package was varied, as one intervention included a computer tablet for remote monitoring, whereas the other consisted of a mobile platform doctor or network consultancy that allowed patient and doctor to have consultations about medications (Analysis 3.5). Behaviour of patients and ease of use may contribute to uptake of these interventions.

We did not find evidence for dyspnoea symptoms.

Evidence (2 studies, 447 participants) for effects of multi-component interventions on numbers of people admitted to hospital was uncertain; these may have little to no effect compared to usual care at a mean of 33 weeks. However, we are moderately certain that multi-component interventions are likely to result in fewer people re-admitted to hospital at a mean of 39 weeks, with greater reduction at 52 weeks. In addition, the risk of hospital re-admissions is reduced at 52 weeks, but not at 12 or 26 weeks (3 studies, 349 participants; Analysis 3.10).

Among nine studies (1886 participants), multi-component interventions were no better than usual care in reducing deaths compared to usual care at a mean of 40 weeks' duration. Only one study at 52 weeks had fewer deaths compared to other studies of the same duration, probably because of the nature of the intervention and because self-management of exacerbations and monitoring were optimised by case managers. In Bourbeau 2016, more deaths occurred in the control group than in the telehealth group, probably due to a high BODE index (integrates body mass index, airflow limitation (forced expiratory volume in 1 second), dyspnoea, and 6-minute walk distance) at the end of 1-year follow-up, and due to the fact that large numbers of hospitalisation days were reported during the study (as a result of COPD exacerbations). It is possible that the multi-component intervention was successful in reducing deaths, but it is not clear which component of the intervention (self-management, home monitoring, early and prompt treatment) could have prevented deaths.

Overall completeness and applicability of evidence

We did not include digital interventions for supported self-management, as this is covered in a linked Cochrane Review (Janjua 2021). The focus of this review was to explore the effectiveness of asynchronous or synchronous interventions including remote monitoring or remote consultation interventions, in addition to usual care (with health professional involvement), remote monitoring or remote consultations alone, or multi-component interventions (of which remote monitoring or remote consultations were component(s)) compared to usual care.

Our search of the evidence led to the inclusion of 29 relevant studies. Despite the large number of studies included in our review, we could not clearly demonstrate benefit or harm of these interventions for most health outcomes among study populations, except for hospital re-admissions. We are moderately certain that a remote monitoring intervention in addition to usual care may confer some benefit for risk of re-admission at 26 weeks; however, this result was based on the findings of one study (106 participants) (Analysis 1.9). Similarly, a multi-component intervention resulted in fewer people re-admitted to hospital at 39 weeks' follow-up (344 participants, 3 studies; moderate-certainty evidence) (Analysis 3.9). We did not find any data for remote consultations in addition to usual care nor for remote consultations alone compared to usual care, and data for our primary outcomes are limited due to small numbers of study participants.

Severity of COPD among study populations ranged from mild to very severe. When conducting the review, we were interested to find out whether these interventions might help people with more severe COPD who are unable to have face-to-face appointments. People with severe COPD are often frail (Marengoni 2018), and they may have one or more long-term comorbidities such as cardiovascular disease, diabetes, and depression (Anecchino 2007; Hillas 2015; Vanfleteren 2013),

and their mobility can be compromised by COPD. On this basis, the healthcare professional may advise patients against exposure to hospital-induced exposure risk. Conversely, face-to-face appointments may be of particular benefit for this demographic because such appointments provide an opportunity for clinicians to assess people holistically: reviewing their general health, their symptom burden, and how they are managing at home. Face-to-face reviews have the potential to help people better manage their long-term conditions while maintaining their independence. Non-pharmacological interventions such as education, pulmonary rehabilitation, and smoking cessation face-to-face may be easier to deliver remotely. Unfortunately, study results were not disaggregated according to severity type, and we could not determine whether any COPD severity group would receive particular benefit from remote interventions.

Several factors may contribute to lack of effectiveness of these interventions over usual care. No model for remote monitoring of people with COPD has been established, and interventions in included studies were highly heterogeneous. Interventions varied by technological method of monitoring (e.g. telephone calls, remote monitoring systems), by health professional monitoring (e.g. nurse, respiratory therapist), and by parameters monitored (e.g. symptoms, oxygen saturation, forced expiratory volume in 1 second, and steps in 6-minute walk distance (6MWD). Such variations could impact the effectiveness of interventions.

We did not measure individual physiological parameters; however, participant ethnicity was not always well reported in trials and may be of relevance when one considers that a commonly used remote monitoring intervention - pulse oximetry - may not be as accurate for participants with darker skin, potentially leading to poorer outcomes and widened healthcare inequality (Sjoding 2020).

Of importance, we found no evidence to indicate that remote monitoring interventions are worse than usual care; such interventions may be a valid replacement for usual care for some people with COPD. This has particular relevance during the current SARS-CoV-2 pandemic, when many people with COPD may want to limit unnecessary contact to reduce their risk of contracting COViD-19. From this review, we are unable to determine which patients may be best suited to or may prefer this approach, but we have shown that most interventions follow an asynchronous approach to monitoring people's physiological parameters rather than using a continuous or real-time approach. Continuous remote care, with real-time monitoring, in which the individual does not have to enter data manually for example, may be helpful for early detection in people who have more severe COPD and may help to reduce exacerbations, hospitalisations, and deaths. The asynchronous approach may be better suited for people who have stable but less severe COPD. Nevertheless, decisions on which type of remote care should be given are likely to be dependent on the health professional's assessment of the individual and his or her needs, as well as on funding provided for the healthcare provider to run the service.

Levels of health literacy and technological literacy and beliefs about the value of an intervention can affect uptake and adherence (Hoass 2016). Individuals may have anxiety about the technology itself (preferring face-to-face interaction, forgetting to use technology, needing technical support, or finding health care to be a repetitive process) (Gorst 2014). Whilst several studies included participant satisfaction with remote monitoring as an outcome measure, we could not find any studies that compared satisfaction between remote monitoring and usual care groups. This is an important measure for inclusion in future research because satisfaction and compliance data can reveal more information on whether or not an intervention is working. Indeed, a major drawback of the included studies is lack of a patient voice. The current COVID-19 pandemic is likely to have increased the use of telehealth technologies (in single-component or multi-component format), and more data will enable investigation of their effectiveness in the future. Further quantitative research would provide valuable data on patients' thoughts about remote monitoring and the impact of disease severity, health beliefs, and technological literacy on effectiveness of these interventions. In addition, qualitative information would shed light on the issues (and benefits) that patients with COPD experience when using telehealth interventions.

Quality of the evidence

Studies that contributed evidence for key outcomes including exacerbations, quality of life, hospital service utilisation, mortality, and adverse events have high risk of bias due to lack of blinding (performance bias) overall; we judged the evidence for these outcomes to be of moderate to very low certainty (as assessed by GRADE). The GRADE assessment incorporated risk of bias assessments for outcomes, which reduced our certainty in the evidence for exacerbations and quality of life measures. Inconsistency was observed in some analyses, and this could have resulted in differences in COPD severity among populations, as well as in interventions, processes of care, uptake of interventions, settings, and countries where trials were conducted. We could not determine what may contribute to differences observed, but it is likely that collectively all factors play a role in the effectiveness of the intervention.

For most outcomes, we downgraded the certainty of evidence due to imprecision and small participant numbers; this resulted in analyses showing little to no difference in effects between intervention and usual care groups. Therefore, we could not determine benefit or harm of interventions for our pre-specified outcomes. Only evidence for hospital re-admissions is of moderate certainty, as we noted no issues with imprecision (Analysis 1.9; Summary of findings 1; Analysis 3.9; Summary of findings 3). We are unable to to investigate publication bias for each outcome because of the small number of included studies.

We noted no issues of indirectness for participants or interventions.

For mean hospitalisations (number of admissions and length of stay (LOS)), some analyses show that duration of follow-up varied among studies. To overcome issues of skewed data, we converted meta-analyses to standardised mean differences; however, we could make no robust conclusions based on these analyses.

Potential biases in the review process

We noted any deviations from the published protocol under Differences between protocol and review, and we provided reasons for the changes made. Due to heterogeneity of interventions and their components, it was difficult to categorise interventions according to inclusion criteria; however, we kept to categorisation as stated in the protocol as best as we could. This could have

introduced some subjectivity in decisions about multi-component interventions (interventions with two or more components). We could not determine effects of telehealth interventions as a component of a multi-component intervention due to the pairwise nature of the data analysis. Heterogeneity and the large numbers of tools used to assess outcomes made it difficult to compare many studies. We did not analyse data nor interpret results while taking into consideration the superiority of interventions among trials.

Screening of studies was difficult due to the complexity of interventions, which led to re-checking of studies that we had initially included. We did contact study authors directly for any information about studies that needed further clarification. We did not include data from some studies, as no further information was provided by study authors, or only data for the intervention group were available. Any non-English language papers were translated by volunteers, who used a structured table to ascertain relevance to the review.

Agreements and disagreements with other studies or reviews

In this review, we cannot clearly demonstrate that telehealth interventions overall improve exacerbations, quality of life, or deaths. This is in consensus with another Cochrane Review (McLean 2012).

McLean 2012 investigated the effectiveness of ten telehealth interventions for people with COPD in improving clinical and process outcomes. Review authors found that telehealth care did not improve quality of life but did reduce hospital emergency department admissions and hospitalisations. In our review, we included 29 studies of varying telehealth interventions and found some very limited evidence for improvement of quality of life on SGRQ and for reduced hospital re-admissions, which McLean did not report. We did not find reductions in hospital admissions in general; this does not reflect findings of the McLean review. In terms of fatalities, our review is in agreement with McLean 2012, in that mortality rates did not differ between comparison groups.

We found that remote monitoring interventions alone and multi-component interventions are likely to reduce the number of people with COPD re-admitted to hospital; however, the evidence base is small for both intervention types, and studies have limitations due to lack of blinding. Given differences in usual care setup across studies, our results suggest that telehealth interventions may be similar in effectiveness to usual care for health outcomes, and they may be acceptable as part of a management service, for example, for re-admissions. We have not investigated further the cost-effectiveness of telehealth interventions; however, one study suggests that reduced re-admissions outweigh the costs of managing telehealth system alerts (Walker 2018).

Our findings are consistent with guidance from the National Institute for Health and Care Excellence (NICE), which recommends that telehealth interventions "should not be offered as part of COPD management", specifically routine monitoring, because of lack of improvement in quality of life and lack of reduction in hospital admissions (NICE 2018). However, NICE recommend that use of telehealth monitoring for specific reasons such as short-term monitoring following discharge from hospital should not be avoided.

Guidance on telehealth interventions suggests that although no clear evidence for effectiveness of telehealth monitoring is available, these interventions are increasingly utilised and may have a role in healthcare services. Current lack of clear evidence should not change or prevent use of these interventions for the COPD population, if required for a specific reason (e.g. home monitoring after discharge from hospital) (NICE 2018). Lenferink 2017 suggests that telemedicine may be better placed as an adjunct to COPD management; however, uncertainty among studies about its effectiveness is ongoing (Ancochea 2018). Emerging evidence from pulmonary rehabilitation studies on patient preferences and barriers to implementation of virtual or digital approaches to care may shed some light on issues surrounding uptake of telehealth monitoring interventions (Bryant 2019).

AUTHORS' CONCLUSIONS

Implications for practice

Evidence of low to very low quality suggests that asynchronous or synchronous telehealth interventions in addition to usual care or provided alone, or as part of a multi-component intervention, may have little to no effect on exacerbations, quality of life, hospitalisation, or death, and may be no different from usual care. We are moderately certain that stand-alone and multi-component interventions are likely to reduce the risk of hospital re-admission (COPD-related or all-cause), but more research is required to test whether these effects are seen in larger studies examining these interventions. We cannot determine which COPD severity subgroup would benefit from telehealth due to lack of disaggregated data in studies. Outcome data from separate COPD severity groups would provide more information on effectiveness of interventions. Experiences of people with COPD and of health professionals could also provide more information on perceptions of telehealth and reasons why these interventions may or may not work in certain COPD severity groups. Training for staff and patients could facilitate use of technology associated with telehealth interventions.

Although the findings of this review do not show benefit, they also do not show harm. These interventions cannot be dismissed, particularly in light of challenges involving access to services for many individuals with COPD. It is possible that with careful consideration by the health professional, an individualised approach that involves discussion with individuals around remote monitoring or consultation as part of their management, along with support from informal carers, may be crucial for the effectiveness of remote management. Further research is warranted.

Implications for research

This Cochrane Review has highlighted the following areas for further research.

Further investigation is needed for enhanced understanding of results of this review.

- A qualitative Cochrane Review investigating why there is variation in effects observed that cannot be determined from quantitative data. Qualitative information can enhance understanding of barriers and facilitators that people with COPD may experience when using telehealth interventions, for example, participants with sensory or physical impairment may struggle to fully access telehealthcare interventions.

- Investigation of safety related to accuracy of pulse oximetry, blood pressure measurement, and spirometry in remote monitoring interventions.
- Subgroup analysis of those living alone compared to those receiving some support from informal carers, or from adult social care service workers.
- Investigation of telehealth interventions for the COPD population post COVID-19.

Future trials should include the following.

- Clear reporting of outcome data and information about protocols in trial registries.
- Participant and carer assessments of understanding of digital interventions through a teach-back technique, including technology literacy nested in the randomised trial.
- Outcomes that measure a person's behaviour towards telehealth interventions.
- Disaggreggated COPD severity group data, to gain an understanding of which group(s) would benefit from telehealth interventions.
- Reporting of hospital admission rates per year as a more accurate measure of the outcome, as mean hospitalisation data may be skewed due to variable duration.
- Well-reported standardised or validated scales, for example, for patient satisfaction. Standardised assessment mechanisms in telehealth monitoring in general so that efficacy and overall benefit can be more easily established in the future. Researchers should also include data for the control group for comparison.
- Hospital admission rates per year, as a more accurate measure of the outcome, as mean hospitalisation data may be skewed due to variable duration.
- Standardisation of terminology for telehealth interventions.
- Comparison of preference for remote consultations compared to face-to-face visits.
- Comparison of continuous and non-continuous remote monitoring, to investigate whether continuous monitoring has a greater impact on acute events such as exacerbations.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Antoniades 2012

Study characteristics	
Methods	**Study design:** single-centre, single-blinded, parallel individual randomised controlled trial in Australia
	Duration: 52 weeks
	Setting: tertiary care hospital

Antoniades 2012 *(Continued)*

Participants	**Population:** 44 adults recruited from a metropolitan tertiary care hospital **Baseline characteristics:** % Male: 45 RM + SBP and 45 SBP, Mean age: 68 RM + SBP and 70 SBP, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: not reported, FEV_1 (% mean): RM + SBP 0.91, SBP 0.66, FVC (% mean): RM + SBP 2.13, SBP 1.98, FEV_1/FVC (% mean): RM + SBP 39.9, SBP 32, Current smokers (n): SBP + RM 0/22 and SBP 6/22, GOLD stage: moderate to severe on COPD criteria, COPD exacerbations lasting 12 months: not reported, Hospitalisations in past 12 months: RM + SBP: 2 (1 to 4) and SBP: 1 (1 to 2) **Inclusion criteria:** moderate to severe COPD diagnosed by COPD criteria, at least 1 hospitalisation in previous 12 months, fluent English, able to use keyboard and mouse, willing to use computer in self-management, ambulant, living independently **Exclusion criteria:** significant comorbidities including cancer, renal failure, and cognitive impairment
Interventions	**Run-in:** initial home training was provided to all participants by a nursing informatics project manager; measurements taken at baseline, 6 months, and 12 months **Treatment arms** 1. In-home telemonitoring of daily measured physiological variables and recorded electronic diary of symptoms and medication usage via TeleMedCare System 2. Standard best practice care following guidelines in Australia and New Zealand for clinical care, access to outreach nursing, written action plan, and access to pulmonary rehabilitation
Outcomes	**Primary outcomes:** hospital admissions (COPD-related or non-COPD-related), inpatient bed-days, quality of life (SF-36 form and CRDQ form completed at 6 and 12 months) **Secondary outcomes:** 6-minute walk distance (6MWD) measured at baseline and 12 months, adherence to daily monitoring, reproducibility of physiological measurements, patient acceptance of remote monitoring
Notes	**Funding:** Department of Human Services; Victoria, Australia **Other identifier:** ACTRN12611000112965

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Reported as randomised; designations were randomly generated and sequentially numbered, but it is unclear how the sequence was generated
Allocation concealment (selection bias)	Low risk	Patients were randomly allocated to either group, using a set of sequentially numbered, opaque, sealed envelopes containing randomly generated designations
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind patients and personnel due to nature of treatment
Blinding of outcome assessment (detection bias) All outcomes	High risk	Assumed that outcome assessors were not blinded because study was open-label
Incomplete outcome data (attrition bias) All outcomes	High risk	27% vs 9% withdrawals in TM group vs standard best practice group, respectively

Antoniades 2012 *(Continued)*

Selective reporting (reporting bias)	Low risk	Outcomes reported as planned; trial registered in Australian registry website
Other bias	Low risk	None

Berkhof 2015

Study characteristics	
Methods	**Study design:** single-centre, open-label, parallel individual randomised controlled trial in the Netherlands **Duration:** 26 weeks **Setting:** Hospital Isala in Zwolle
Participants	**Population:** 101 adults recruited from 1 hospital, Isala, in Zwolle, Netherlands **Baseline characteristics:** % Male: 65 TM and 69 UC, Mean age: 68 TM in past 12 months: TM: 23 (44.2) and UC: 17 (34.7). Participants in TM group were more likely to have worse CCQ total and symptom scores, increased home oxygen and hospitalisations **Inclusion criteria:** smoking history > 10 pack-years, diagnosis of severe COPD, post-bronchodilator FEV_1 < 50%, FEV_1/FVC < 70%, written informed consent **Exclusion criteria:** history of asthma, unable to answer phone, life expectancy < 6 months
Interventions	Measurements taken at baseline and 6 months **Treatment arms** 1. Telemedicine intervention (telephone-based) plus regular outpatient visits at baseline and 6 months 2. Control (regular outpatient visit at baseline and 6 months)
Outcomes	**Primary outcomes:** COPD-specific health status using clinical COPD questionnaire **Secondary outcomes:** SGRQ and SF-36 questionnaires, resource use in primary and secondary care
Notes	**Funding:** Isala hospital **Other identifier:** none

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomization was performed with a computer minimisation programme to achieve balanced groups for gender, age (< 65 years or ≥ 65 years), predicted forced expiratory volume in 1 second (FEV_1 < 35% or ≥ 35%), body mass index (< 21 or ≥ 21 kg/m^2)
Allocation concealment (selection bias)	Unclear risk	No further information provided
Blinding of participants and personnel (performance bias)	High risk	Unable to blind patients and personnel due to nature of treatment

Berkhof 2015 *(Continued)*

All outcomes		
Blinding of outcome assessment (detection bias) All outcomes	High risk	Although no further information was provided, it was probably not possible to blind due to nature of intervention
Incomplete outcome data (attrition bias) All outcomes	Low risk	Although attrition was slightly higher in control group, it was still below 10%
Selective reporting (reporting bias)	High risk	No protocol found on registry websites, so unclear whether outcomes were reported as planned. Hospitalisation outcomes reported as median and IQR, suggesting that data are not normally distributed. Contacted study authors, no response
Other bias	Low risk	None

Bourbeau 2016

Study characteristics	
Methods	**Study design:** multi-centre, open-blinded, parallel individual randomised controlled trial in France, Germany, Italy, and Spain **Duration:** 52 weeks **Setting:** 33 investigative centres: 12 in France, 8 in Germany, 6 in Italy, 7 in Spain
Participants	**Population:** 319 adults recruited from 33 investigative centres in 4 countries (12 centres in France, 8 in Germany, 6 in Italy, 7 in Spain) **Baseline characteristics:** % Male: 69.4 TH and 69.8 UC, Mean age: 67.3 TH and 66.6 UC, % White: not reported, % African: not reported, % LTOT: 75.8 TH and 72.8 UC, % Home oxygen: not reported, % Anxiety or depression: TH: moderate to severe anxiety 22.8 and moderate to severe depression 77.8, UC: moderate to severe anxiety 30.5 and moderate to severe depression 79.3, Baseline medications: long-acting anticholinergics, long-acting beta2-agonist, long-acting inhaled corticosteroids, FEV_1 (% mean): TH 37.8 and UC 36.4, FVC (% mean): not reported, FEV_1/FVC (% mean): TH 45.7 and UC 43.7, Current smokers (n): TH 34 and UC 34, GOLD stage III/IV, COPD exacerbations last 12 months: TH: 1.3 ± 0.7 and UC: 1.3 ± 0.8, Hospitalisation in past 12 months: TH: 20 (12.7) and UC: 19 (11.7) **Inclusion criteria:** COPD patients aged ≥ 35 years with post-bronchodilator FEV_1/FVC ratio ≤ 70%; FEV_1 < 50% of predicted value; ≥ 10 pack-year smoking history; at least 1 severe exacerbation in previous year **Exclusion criteria:** not expected to survive longer than 6 months; unable to read or speak the country language or having cognitive/psychiatric disease; on continuous treatment of > 10 mg per day prednisone or equivalent for longer than 6 weeks; living in a nursing home
Interventions	**Run-in:** each patient received multi-component home-based disease management or usual management care training and education, and was assessed for respiratory and global health status during a 3- to 5-week run-in period **Treatment arms** 1. Home-based management ("Living Well with COPD" plus TM/e-health) 2. Routine COPD management

Bourbeau 2016 *(Continued)*

Outcomes	**Primary outcomes:** number of unscheduled all-cause hospitalisation days, normalised to 1 year of follow-up **Secondary outcomes:** number of COPD exacerbations (mild, moderate, or severe to require hospitalisation and/or death), 6-minute walk distance (6MWD), BODE, anxiety and depression (HADS), health status using SGRQ-C
Notes	**Funding:** Air Liquide Healthcare **Other identifier:** NCT01241526

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A pre-specified randomised list was generated prior to the study by a partial minimisation computer algorithm. Participants were randomised via a dedicated interactive voice response system
Allocation concealment (selection bias)	Unclear risk	No further information provided
Blinding of participants and personnel (performance bias) All outcomes	High risk	Open study design; neither study investigators nor patients were blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Open study design; neither study investigators nor outcome assessors were blinded
Incomplete outcome data (attrition bias) All outcomes	High risk	20/157 participants in intervention arm did not complete the study, with 34/162 participants in UC arm; 23/34 of this group resulted in deaths compared to 3/157 deaths in intervention arm. Overall attrition in total randomised group was 15%
Selective reporting (reporting bias)	Low risk	Outcomes were reported according to protocol
Other bias	Low risk	None

Calvo 2014

Study characteristics

Methods	**Study design:** multi-centre, open-label, parallel cluster-randomised controlled trial in Spain **Duration:** 30 weeks **Setting:** pneumology services and primary care centres
Participants	**Population:** 60 adults recruited from pneumology services at Hospital University La Princesa, Primary Care Centres, in its area including Goya, Montesa, Lagasca, and Castello, and other primary care centres in the district of Salamanca in Madrid but not identified **Baseline characteristics:** % Male: 75.9 TH and 73.3 UC, Mean age: 75 TH and 72.7 UC, % White: not reported, % African: not reported, % LTOT: 100 TH and 100 UC, % Home oxygen: not reported, % Anxi-

Calvo 2014 *(Continued)*

	ety or depression: TH 3.70 anxiety and 3.80 depression, UC 3.0 anxiety and 3.5 depression, Baseline medications: 83% LAMA + LABA + ICS; 13% PDE4 inhibitors; 39% mucolytics; 8% theophyllines; 8% oral steroids, FEV_1 (% mean): TH 38.3 and UC 37.1, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): none for last 6 months, GOLD stage: severe to very severe, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: TH: 1.7 ± 1.0 and UC: 1.9 ± 1.4 **Inclusion criteria:** prior COPD diagnosis according to GOLD criteria 2011, severe/very severe FEV_1/FVC < 0.70 and % FEV_1 < 50, age ≥ 50 years, long-term home oxygen therapy, not a current smoker for at least 6 months **Exclusion criteria:** did not meet at least 1 of the inclusion criteria, enrolled in palliative care programme for lung or other disease, at risk for social exclusion or institutionalised, deemed unable to understand all procedures
Interventions	**Run-in:** patients entering study had to be in stable situation and 15 days free of COPD exacerbation; initial clinic visit **Treatment arms** 1. Home telehealth monitoring 2. Usual care (continued with scheduled medical visits by pneumologist or primary care physician)
Outcomes	**Primary outcomes:** numbers of emergency room visits, hospitalisations; length of hospital stay; mortality **Secondary outcomes:** none listed
Notes	**Funding:** Linde Healthcare **Other identifier:** NCT02499068

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Patients were randomised by a 2-colour code, either individually randomised or cluster-randomised (depending on location of referral); not enough information
Allocation concealment (selection bias)	Low risk	Allocation was achieved by using coloured envelopes selected at chance
Blinding of participants and personnel (performance bias) All outcomes	High risk	Open-label study; neither study investigators nor patients were blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Open-label study; neither study investigators nor patients were blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low withdrawal rates: 2/30 patients withdrew from treatment arm, none from conventional care arm
Selective reporting (reporting bias)	Unclear risk	No further information about trial registration or whether outcomes reported were planned
Other bias	Low risk	None

Casas 2006

Study characteristics	
Methods	**Study design:** multi-centre, single-blinded, parallel individual randomised controlled trial in Spain and Belgium **Duration:** 52 weeks **Setting:** tertiary care hospitals
Participants	**Population:** 155 adults recruited from 2 tertiary hospitals, Hospital Clinic Barcelona and University Hospital Gathuisberg, UZ-Leuven **Baseline characteristics:** % Male: 77 IC and 88 UC, Mean age: 70 IC and 72 UC, % White: not reported, % African: not reported, % LTOT: 25 IC and 23 UC, % Home oxygen: not reported, % Anxiety or depression: IC 8.5 and UC 8.2, Baseline medications: influenza and pneumococcal vaccination, FEV_1 (% mean): IC 43 and UC 41, FVC (% mean): IC 64 and UC 63, FEV_1/FVC (% mean): IC 48 and UC 48, Current smokers (n): IC 21 and UC 19, GOLD stage: not reported, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: IC: 1.0 ± 1.3 and UC 0.6 ± 1.2 **Inclusion criteria:** COPD patients discharged from hospital from previous episode of exacerbation requiring hospitalisation for > 48 hours **Exclusion criteria:** not living in healthcare area, severe comorbidity (lung cancer, extremely severe neurological/cardiovascular condition), admitted to nursing home, unable to participate because not literate or no phone access at home
Interventions	**Run-in:** during hospitalisation, 2 hours before discharge, participants received a 2-hour comprehensive education on disease and disease management; at Barcelona only, participant received 1 visit 72 hours after discharge; in Leuven, general practitioners made regular planned home visits **Treatment arms** 1. Integrated care intervention (comprehensive discharge assessment, education programme on self-management, individualised action plan, ICT web-based platform for nurse to access patient or carer and HCP during follow-up) 2. Usual care (usual hospital discharge protocol)
Outcomes	**Primary outcomes:** re-hospitalisation rate during follow-up **Secondary outcomes:** not reported
Notes	**Funding:** CHRONIC project (IST-1999/12158) from European Union **Other identifier:** none

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomisation was achieved by using computer-generated random numbers
Allocation concealment (selection bias)	Low risk	Participants were blindly allocated
Blinding of participants and personnel (performance bias)	High risk	Open study design; neither study investigators nor patients were blinded

Casas 2006 *(Continued)*

All outcomes		
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	No further information provided
Incomplete outcome data (attrition bias) All outcomes	Low risk	Similar percentage of withdrawals in each group: 74% intervention and 80% usual care patients at end of follow-up; majority of dropouts due to death/palliative care
Selective reporting (reporting bias)	Unclear risk	No registry information found; unclear whether outcomes reported as planned
Other bias	Low risk	None

De San Miguel 2013

Study characteristics	
Methods	**Study design:** single-centre, single-blinded, parallel individual randomised controlled trial in Western Australia **Duration:** 26 weeks **Setting:** health and community care organisation based in Western Australia
Participants	**Population:** 80 adults recruited from Western region of Australia **Baseline characteristics:** % Male: 38.9 RM and 57 UC, Mean age: 71 RM and 74 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: oxygen, FEV_1 (% mean): not reported, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): not reported, GOLD stage: not reported, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: not reported **Inclusion criteria:** COPD diagnosis, receiving domiciliary oxygen, English speaking, living in metropolitan area **Exclusion criteria:** dementia, receiving palliative care, no telephone land line, unable to use telehealth equipment due to cognitive impairment/physical impairment
Interventions	Measurements taken at baseline, monthly, and at end of study **Treatment arms** 1. Docobo HealthHub portable equipment installed at patient's home with education booklet about COPD and TM manual 2. Control: educational booklet about COPD
Outcomes	**Primary outcomes:** health services usage, annual cost savings, quality of life, participant satisfaction **Secondary outcomes:** none
Notes	**Funding:** Australian Department of Health and Ageing **Other identifier:** none
Risk of bias	

De San Miguel 2013 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Before recruitment, random number generator in STATA version 9 was used to randomly allocate 80 study numbers to intervention or control group (40 in each)
Allocation concealment (selection bias)	Low risk	Envelopes were made up with study number written on the outside and group assignment on the inside
Blinding of participants and personnel (performance bias) All outcomes	High risk	No further information provided, but not possible to blind patients or personnel due to nature of intervention
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	No further information provided
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	9/80 patients withdrew from the study (11.25%) (7 deceased, 2 withdrawn). Of 2 participants who withdrew, 1 was unable to manage the equipment, and 1 was no longer interested in taking part. Unclear which allocations patients who withdrew came from
Selective reporting (reporting bias)	Unclear risk	No registry information found; unclear if outcomes reported as planned
Other bias	Low risk	None

Farmer 2017

Study characteristics	
Methods	**Study design:** multi-centre, open-label, parallel individual randomised trial in United Kingdom **Duration:** 52 weeks **Setting:** primary and secondary care clinics
Participants	**Population:** 166 adults recruited from primary and secondary care, respiratory hospital outpatient clinics, pulmonary rehab courses in adjacent counties of Oxfordshire and Berkshire, UK **Baseline characteristics:** % Male: 61.8 RM and 60.7 UC, Mean age: 69.8 RM and 69.8 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: RM group: median 5 COPD medications and UC group median 5 COPD medications; RM group took median 4 other medications and UC group took 5 other medications, FEV_1 (% mean): RM 47.4 and UC 50.1, FVC (% mean): RM 47.6 and UC 49.8, FEV_1/FVC (% mean): not reported, Current smokers (n): RM 23 and UC 13, GOLD stage: RM: 37.3% moderate, 62.7% severe/very severe; UC: 41.1% moderate, 58.9% were severe/very severe, COPD exacerbations in last 12 months: not reported, Hospitalisations in past 12 months: not reported **Inclusion criteria:** COPD diagnosis FEV_1, post bronchodilation < 80% and predicted FEV_1:FVC ratio < 0.70. Smoking > 10 pack-years, MRC dyspnoea ≥ 2, registered with GP and COPD exacerbation in last 12 months, or referred to PR **Exclusion criteria:** other significant lung disease, chronic heart failure, life expectancy < 3 months, cognitive impairment, no Internet-enabled mobile phone network

Farmer 2017 *(Continued)*

Interventions	**Run-in:** initial 6-week period of EDGE platform, symptom diary, and physiological measurements done daily; measurements taken at baseline and at 3, 6, and 12 months **Treatment arms** 1. EDGE platform-based exacerbation monitoring and self-management support on a tablet computer 2. Standardised usual care
Outcomes	**Primary outcomes:** quality of life scales: SGRQ-C **Secondary outcomes:** hospital admissions, length of stay, deaths, number of recorded exacerbations, antibiotic/oral steroid use, presenting at ED or admitted to hospital due to acute change in respiratory condition, time to first exacerbation, EQ-5D, Anxiety (SCL-10A), depression (SCL-20)
Notes	**Funding:** Health Innovation Challenge fund (Wellcome Trust, Dept of Health). Trial was sponsored by University of Oxford. Study authors received funding from NIHR and Biomedical Research Centre (BRC) **Other identifier:** ISRCTN 40367841

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A computer programme (Sortition V1.2) was used to randomise participants. Research nurse carried out randomisation by accessing Sortition using Web browser on a tablet computer at assessment visit only after completion of consent procedures and baseline measurements
Allocation concealment (selection bias)	Unclear risk	Allocation of participants was carried out in 2:1 ratio of intervention and usual care. However, it is unclear whether allocation was concealed. Research nurse carried out randomisation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Open-label study; neither study investigators nor patients were blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Open-label study; neither study investigators nor patients were blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Attrition was similar in each treatment group, with similar numbers, although more deaths occurred in the intervention group. 14/110 (12.7%) in intervention arm withdrew, 7/56 (12.5%) from control arm withdrew. An additional 5 allocated to intervention did not receive the intervention; this is unclear
Selective reporting (reporting bias)	Low risk	Outcomes were reported as planned; study authors provided data on request
Other bias	Low risk	None

Ho 2016

Study characteristics

Methods	**Study design:** single-centre, open-label, parallel individual randomised controlled trial in Taiwan

Ho 2016 *(Continued)*

	Duration: 26 weeks **Setting:** tertiary care
Participants	**Population:** 106 adults recruited from 1 hospital (National Taiwan University Hospital, a tertiary care referral centre) **Baseline characteristics:** % Male: 81 TM and 72 UC, Mean age: 81.4 TM and 79.0 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: SABA: TM group: 89%; UC group: 85%; LABA: TM group: 60%, UC group: 66%; anticholinergic: TM group: 68%, UC group: 64%; ICS: TM group: 62%, UC group: 70%, FEV_1 (% mean): TM 62 and UC 62, FVC (% mean): not reported, FEV_1/FVC (% mean): TM 0.53 and UC 0.55, Current smokers (n): not reported, GOLD stage: Mild/moderate: TM group: 66%; UC group: 64%. Severe/very severe: TM group:34%, UC group:36%, COPD exacerbations last 12 months: TM: 19 (36) and UC: 17 (32), Hospitalisations in past 12 months: TM: 16 (30) and UC: 19 (36) **Inclusion criteria:** COPD exacerbation as main diagnosis, current or former smoker, spirometry-confirmed airflow limitation (value of forced expiratory volume in 1 second divided by forced vital capacity < 0.71), discharge to home, accessibility to Internet and phone **Exclusion criteria:** consent not provided, unable to access study website, enrolled in other trials
Interventions	**Run-in:** prior to hospital discharge, patients were trained in use of equipment (pulse oximeter, thermometer, sphygmomanometer) and online diary by study nurse **Treatment arms** 1. Telemonitoring intervention 2. Usual care
Outcomes	**Primary outcomes:** frequency of re-admission, time to first hospital re-admission due to COPD exacerbation **Secondary outcomes:** time to first ED visit due to COPD, all-cause hospital re-admissions, number of all-cause ED visits
Notes	**Funding:** National Taiwan University **Other identifier:** NCT01724684

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Patients were randomised via a computer-generated programme
Allocation concealment (selection bias)	Unclear risk	It is unclear whether allocation concealment was achieved
Blinding of participants and personnel (performance bias) All outcomes	High risk	It was not possible to blind participants or investigators
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors were blinded to group allocation
Incomplete outcome data (attrition bias)	Low risk	All participants finished study

Ho 2016 *(Continued)*

All outcomes		
Selective reporting (reporting bias)	Low risk	Outcomes reported as planned; trial registered at clinical.trials.gov
Other bias	Low risk	None

Jakobsen 2015

Study characteristics	
Methods	**Study design:** multi-centre, open-label, parallel individual randomised controlled trial in Denmark **Duration:** 26 weeks **Setting:** university hospitals
Participants	**Population:** 57 adults recruited from 2 hospital in Copenhagen, Denmark: Frederiksberg University Hospital and Herlev University Hospital **Baseline characteristics:** % Male: 37.9 RM and 39.3 UC, Mean age: not reported, % White: not reported, % African: not reported, % LTOT: 3.4 RM and 7.1 UC, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: Corticosteroids (prednisone), antibiotics (amoxicillin, clavulanic acid, beta2-agonists and anticholinergics, fenoterol, ipratropium bromide nebuliser, 02 therapy as needed, sedative levomepromazine as needed, FEV_1 (% mean): RM 0.7 (0.4 to 2.1) and UC 0.7 (0.4 to 1.8), FVC (% mean): RM 1.5 (0.5 to 3.4) and UC 1.6 (0.7 to 3.4), FEV_1/FVC (% mean): not reported, Current smokers (n): RM 16 and UC 14, GOLD stage: III/IV, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: not reported **Inclusion criteria:** GOLD stage III or IV, able to follow instructions, admission > 2 days, ≥ 45 years of age **Exclusion criteria:** need for NIV/ventilator at time of baseline, severely overweight, serious comorbidity (cancer, unstable heart disease, diabetes, any condition that prevents participation), unable to follow instructions, temperature above 38 degrees requiring antibiotics, in another trial within 30 days of current trial, MMSE score < 24, not literate, unable to understand Danish, not able to complete follow-up, severe psychiatric disorder, neuropsychological testing in last year, severe vision or hearing disorder
Interventions	**Run-in:** within 24 hours after hospitalisation, patient was trained with telehealth equipment; re-test of equipment was done when patient got home within first 24 hours of admission; measurements taken at baseline, during intervention, and at 30, 60, 90, and 180 days after discharge **Treatment arms** 1. Remote telemonitoring using a touch screen with a web cam for videoconferencing on discharge from hospital 2. Usual care and treatment at hospital until discharge (typically between 5 and 7 days)
Outcomes	**Primary outcomes:** re-admission due to COPD **Secondary outcomes:** mortality, NIV, hospitalisation days, QOL, adverse events, patient satisfaction, healthcare costs, physiological measures
Notes	**Funding:** The Philanthropic Foundation TrygFonden, The Health Insurance Foundation, The Danish Lung Association, The Toyota Foundation, The Frederiksberg Foundation, and Lykfeldt's grant **Other identifier:** NCT01155856

Jakobsen 2015 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Patients were externally randomised 1:1 in fixed blocks of 4; the sequence was computer-generated
Allocation concealment (selection bias)	Low risk	Allocation was concealed in sequentially numbered sealed opaque envelopes delivered to hospitals in batches of 10. The envelope was opened by participant only after written consent
Blinding of participants and personnel (performance bias) All outcomes	High risk	Trial was reported as open-label at clinical trials website
Blinding of outcome assessment (detection bias) All outcomes	High risk	Trial was reported as open-label at clinical trials website
Incomplete outcome data (attrition bias) All outcomes	Low risk	Similar discontinuation numbers in each group; similar numbers of deaths in each group: IC 10/29 (24%), UC 8/28 (29%)
Selective reporting (reporting bias)	Low risk	Outcomes were reported as planned in the protocol; study was registered at trial registry
Other bias	Low risk	None

Jódar-Sanchez 2013

Study characteristics	
Methods	**Study design:** single-centre, open-label, parallel individual randomised controlled trial in Spain **Duration:** 17 weeks **Setting:** hospital care
Participants	**Population:** 45 adults recruited from hospital in Madrid, Spain **Baseline characteristics:** % Male: 95 RM and 95 UC, Mean age: 74 RM and 71 UC, % White: not reported, % African: not reported, % LTOT: 100 RM and 100 UC, % Home oxygen: not reported, % Anxiety or depression: RM 10 and UC 10, Baseline medications: not reported, FEV_1 (% mean): RM 38 and UC 37, FVC (% mean): RM 59 and UC 63, FEV_1/FVC (% mean): not reported, Current smokers (n): not reported, GOLD stage: very severe, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: not reported **Inclusion criteria:** adult diagnosis of COPD and chronic respiratory failure with LTOT indication according to GOLD, at least 1 hospitalisation in the last year, clinically stable in the last 3 months **Exclusion criteria:** not following LTOT at enrolment, no home telephone line, not given informed consent
Interventions	**Run-in:** measurements taken at baseline and at end of study **Treatment arms**

Jódar-Sanchez 2013 *(Continued)*

1. Telehealth intervention
2. Standard care

Outcomes	**Primary outcomes:** exacerbations, A&E department visits, hospital admissions **Secondary outcomes:** SGRQ, EQ-5D, patient satisfaction
Notes	**Funding:** Spanish Ministry of Science and Innovation **Other identifier:** none

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Trial was reported as randomised, but randomisation process not described
Allocation concealment (selection bias)	Unclear risk	No further information provided
Blinding of participants and personnel (performance bias) All outcomes	High risk	Open-label study; neither study investigators nor patients were blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Open-label study; no measures were reported to show that outcome assessors were blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	1 death and 1 withdrawal in each group were observed; all analysed
Selective reporting (reporting bias)	Unclear risk	Outcomes were reported as planned; however, no trial registration details were found
Other bias	Low risk	None

Koff 2009

Study characteristics

Methods	**Study design:** single-centre, open-label, parallel individual randomised controlled trial in the United States **Duration:** 13 weeks **Setting:** clinics in a university hospital
Participants	**Population:** 40 adults recruited from COPD clinic and general pulmonary clinic at University of Colorado Hospital, in Aurora, Colorado **Baseline characteristics:** % Male: 45 IC and 50 UC, Mean age: 66.6 IC and 65.0 UC, % White: 85 IC and 95 UC, % African: 10 IC and 5 UC, % LTOT: 95 IC and 95 UC, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: flu vaccine, FEV_1 (% mean): IC 33.6 and UC 31.1, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): IC 3 and UC 4, GOLD stage:

Koff 2009 *(Continued)*

	III/IV, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: IC: 0.55 ± 0.21 and UC: 0.6 ± 0.21 **Inclusion criteria:** COPD GOLD stage III/IV, phone land line **Exclusion criteria:** non-literate, active treatment for lung cancer, not able to speak English, not able to complete a 6-minute walk test
Interventions	Measurements made at baseline and 3 months **Treatment arms** 1. Proactive integrated care including remote home monitoring using Health Buddy System 2. Usual care
Outcomes	**Primary outcomes:** quality of life measured by SGRQ **Secondary outcomes:** healthcare costs, COPD exacerbations, equipment satisfaction
Notes	**Funding:** University of Colorado Hospital **Other identifier:** NCT01044927

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Trial was reported as randomised, but randomisation process was not described
Allocation concealment (selection bias)	Low risk	Participants chose a "blinded envelope that contained a group indicator"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of participants or personnel not possible due to nature of intervention
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding of outcome assessors not possible due to nature of intervention
Incomplete outcome data (attrition bias) All outcomes	Low risk	Similar attrition in each arm; 5%; those who withdrew were accounted for
Selective reporting (reporting bias)	Unclear risk	Unclear whether outcomes were reported as planned. Could not find a protocol nor registration at trial website. Number of people who had an exacerbation in the UC group was reported as unknown
Other bias	Low risk	None

Lewis 2010

Study characteristics

Methods	**Study design:** single-centre, open-label, parallel individual randomised controlled trial in the United Kingdom

Lewis 2010 *(Continued)*

	Duration: 26 weeks **Setting:** general hospital
Participants	**Population:** 40 adults recruited from a general hospital in Wales, UK **Baseline characteristics:** % Male: 50 RM and 50 UC, Mean age: 70 RM and 73 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: RM: HADSA: 5.6 ± 3.5, HADSD 6.3 ± 3.5 and UC: HADSA: 6.3 ± 3.5, HADSD 5.9 ± 2.8, Baseline medications: not reported, FEV_1 (% mean): RM 38 and UC 40, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): RM 1 and UC 1, GOLD stage: moderate/severe, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: RM: 0 (0, 1.0) and UC: 0 (0, 0.8) **Inclusion criteria:** COPD (GOLD stage moderate/severe), completed 12 to 18 sessions of PR programme, maximal respiratory medication, standard telephone line installed at home, willing to have TM equipment installed at home, willing to provide consent **Exclusion criteria:** chronic asthma and ILD, went to < 12 sessions of PR programme, not living at home
Interventions	**Run-in:** measurements were taken at baseline, 4 weeks, 25 weeks, 30 weeks, and 52 weeks **Treatment arms** 1. Telemonitoring intervention plus standard care 2. Standard care
Outcomes	**Primary outcomes:** SGRQ **Secondary outcomes:** EQ-5D, HADS, mortality, patient satisfaction
Notes	**Funding:** EU grant **Other identifier:** ISRCTN 41424840 **Other:** study was planned for 26 weeks, but usual care continued for 52 weeks

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A computer programme was used to generate random numbers into 2 groups
Allocation concealment (selection bias)	Low risk	Sealed opaque envelopes were used to conceal randomisation sequence
Blinding of participants and personnel (performance bias) All outcomes	High risk	It would not be possible to blind participants to the intervention. Clinical staff (hospital doctors and general practitioners) were not aware of telemonitoring allocation; however, it is unclear whether Chronic Disease Management Team was aware of allocation
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors were blinded to group allocation
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	3 withdrawals (including 2 deaths) occurred in the RM group (15%); unclear how many deaths/withdrawals occurred in SC group

Lewis 2010 *(Continued)*

Selective reporting (reporting bias)	High risk	Data reported as medians and IQRs; means given for hospitalisations, but no SDs. Trial was registered
Other bias	Low risk	None

McDowell 2015

Study characteristics

Methods	**Study design:** multi-centre, open-label, parallel individual randomised controlled trial in Ireland **Duration:** 26 weeks **Setting:** specialist respiratory service
Participants	**Population:** 110 adults recruited from a specialist respiratory service in Northern Ireland **Baseline characteristics:** % Male: 41.8 RM and 45.5 UC, Mean age: 69.8 RM and 70.2 UC, % White: not reported, % African: not reported, % LTOT: 27.3 RM and 25.5 UC, % Home oxygen: not reported, % Anxiety or depression: RM: HADSA: 8.3 (5.2); HADSD: 6.8 (3.8) UC: HADSA: 7.9 (4.3); HADSD: 7.9 (3.9), Baseline medications: flu vaccine, FEV_1 (% mean): RM 45.5 and UC 43.4, FVC (% mean): RM 71.7 and UC 70.4, FEV_1/FVC (% mean): not reported, Current smokers (n): RM 21 and UC 18, GOLD stage: II/III, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: RM: 0.82 (0.9) and UC: 1.05 (0.9) **Inclusion criteria:** COPD diagnosis GOLD II or III, at least 2 of ED admissions, hospital admissions, or emergency GP contacts in last year before the study **Exclusion criteria:** other respiratory disease, cognitively impaired/unable to learn about telemonitoring intervention
Interventions	**Run-in:** 5 consecutive days (mornings) of clinical and symptom observations reported by participant prior to study for trending **Treatment arms** 1. Telemonitoring intervention plus usual care 2. Usual care
Outcomes	**Primary outcomes:** health-related quality of life: SGRQ-C **Secondary outcomes:** EQ-5D, HADSA HADSD, health care utilisation, number of exacerbations, satisfaction, cost-effectiveness
Notes	**Funding:** European Centre for Connected Health **Other identifier:** none

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A computer-generated randomisation procedure was used to generate the sequence, which was prepared by a researcher who was not involved in the trial
Allocation concealment (selection bias)	Low risk	Randomisation sequence was concealed in sequentially numbered envelopes and was consecutively opened on receipt of informed consent from the patient

McDowell 2015 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel were not blinded to treatment
Blinding of outcome assessment (detection bias) All outcomes	High risk	Primary outcome assessors were not blinded to treatment allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	Similar rates of attrition in each group; however, more withdrawals from trial in the RM group than in the usual care group
Selective reporting (reporting bias)	Unclear risk	Unclear whether trial was registered; therefore, unclear if all outcomes were reported as planned
Other bias	Low risk	None

Minguez 2017

Study characteristics	
Methods	**Study design:** single-centre, open-label, parallel individual randomised controlled trial in Spain **Duration:** 26 weeks **Setting:** university hospital
Participants	**Population:** 116 adults recruited from Pneumology Department of Puerta de Hierro University Hospital, in Majadahonda, Spain **Baseline characteristics:** % Male: 76 RM and 62.5 UC, Mean age: 68 RM and 70 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: 36 RM and 32 UC, % Anxiety or depression: not reported, Baseline medications: not reported, FEV_1 (% mean): RM 50 and UC 51.5, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): RM 23 and UC 18, GOLD stage: not reported, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: not reported **Inclusion criteria:** COPD diagnosis, admission due to exacerbation, no severe coexisting condition, no fever for 48 hours, aerosol treatment at most every 6 hours, IV glucocorticoid < 40 mg twice daily, thoracic radiography without new disease, subjective improvement in patient, familiar suitable environment **Exclusion criteria:** terminal conditions including neoplasia, alcoholism, IV medication, not able to understand and take part in programme, ICU or NIV during exacerbation, institutionalised, hemodynamic instability
Interventions	**Run-in:** early assisted discharge from hospital; measurements taken at baseline, 30 days, and 6 months **Treatment arms** 1. Telemonitoring intervention 2. Control (face-to-face visits)
Outcomes	**Primary outcomes:** time to first exacerbation

Minguez 2017 *(Continued)*

	Secondary outcomes: satisfaction, anxiety, QOL, adherence to treatment, monitoring compliance, use of health resources
Notes	**Funding:** Strategic Health Action, PITES-ISA research projects **Other identifier:** NCT01951261

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Patients were randomised, but randomisation process was not described
Allocation concealment (selection bias)	Unclear risk	No further information provided
Blinding of participants and personnel (performance bias) All outcomes	High risk	Open-label; due to nature of intervention, participants or personnel could not be blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Open-label study; investigators were not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	Similar attrition in both groups: 5/56 in control group, 6/55 in TM group
Selective reporting (reporting bias)	Unclear risk	Not all information was provided in publication; continuous outcomes were reported as medians and IQRs. However, upon contact with study authors, we were able to obtain results as means and SDs. Number of participants completing protocol follow-up was different in the publication from numbers provided by study authors
Other bias	High risk	Study authors stated that due to selection process, results cannot be generalised to the whole COPD population; patients were selected due to intellect and cognitive capacity

Pedone 2013

Study characteristics

Methods	**Study design:** single-centre, open-label, parallel block and stratified randomised controlled trial in Italy **Duration:** 39 weeks **Setting:** university pulmonary medicine outpatient clinic
Participants	**Population:** 99 adults recruited from 1 university pulmonary medicine outpatient facility, in Rome, Italy **Baseline characteristics:** % Male: 72 RM and 63 UC, Mean age: 74.1 RM and 75.4 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: not reported, FEV_1 (% mean): RM 52.5 and UC 55.4, FVC

Pedone 2013 *(Continued)*

	(% mean): RM 78.8 and UC 78.5, FEV_1/FVC (% mean): not reported, Current smokers (n): not reported, GOLD stage: II/III, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: not reported **Inclusion criteria:** COPD GOLD II and III **Exclusion criteria:** cognitive impairment preventing use of experimental intervention
Interventions	Measurements were taken at baseline and daily **Treatment arms** 1. Telemonitoring via Bluetooth using Web-based 'SweetAge' monitoring system 2. Standard care
Outcomes	**Primary outcomes:** number of exacerbations, number of hospitalisations **Secondary outcomes:** not reported
Notes	**Funding:** Lazio Region through FILAS **Other identifier:** NCT01481506

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A computer-generated number list was used to randomise participants
Allocation concealment (selection bias)	Unclear risk	No further information
Blinding of participants and personnel (performance bias) All outcomes	High risk	Trial was open-label
Blinding of outcome assessment (detection bias) All outcomes	High risk	Trial was open-label
Incomplete outcome data (attrition bias) All outcomes	High risk	No participants in usual care group dropped out, whereas 11/50 in RM group did (22%)
Selective reporting (reporting bias)	Low risk	Study authors reported outcomes as planned in trials registry, but SDs for length of stay were incomplete. Contacted study authors, who provided data for SDs. Trial was registered
Other bias	Low risk	None

Pinnock 2013

Study characteristics

Methods	**Study design:** multi-centre, open-label, parallel individual randomised controlled trial in the United Kingdom

Pinnock 2013 *(Continued)*

	Duration: 52 weeks **Setting:** primary care
Participants	**Population:** 256 adults randomised from 96 primary care practices **Baseline characteristics:** % Male: 41 RM and 49 UC, Mean age: 69.4 RM and 68.4 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: HADS: RM 9.8 (5.2) and UC 9.6 (4.6), Depression: RM 8.9 (4.4) and UC 8.2 (4.1), Baseline medications: not reported, FEV_1 (% mean): RM 44 and UC 40, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): RM 37 and UC 30, GOLD stage: Mild/moderate: RM 46 and UC 42, Severe: RM 45 and UC 42, Very severe: RM 37 and UC 44, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: RM 2.3 (2.1) and UC 2.5 (2.6) **Inclusion criteria:** patient registered with GP practice in Lothian and admitted to 1 of 3 acute hospitals with a primary diagnosis of COPD exacerbation in the last 12 months **Exclusion criteria:** other significant lung disease, unable to consent, unable to use the intervention, other significant medical or social reasons at GP discretion
Interventions	Measurements taken at baseline and at 3, 6, 9, and 12 months **Treatment arms** 1. Touchscreen telemonitor used to send secure data about COPD vitals and symptoms by remote server to UK health services 2. Education on living with COPD and exacerbation management
Outcomes	**Primary outcomes:** time to first hospital admission with exacerbation of COPD **Secondary outcomes:** frequency of admissions, time to first hospitalisation due to COPD exacerbation, number of deaths, number and duration of admissions (all cause), number of exacerbations, SGRQ, HADS, self-efficacy scale SECD6, number and duration of contacts with community services, LINQ, MARS
Notes	**Funding:** Chief Scientist Office, NHS Applied Research Programme Grant **Other identifier:** ISRCTN96634935

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Participants were randomised in a stratified approach according to clinical service providing COPD care, and were centrally randomised 1:1 via randomised blocks of 2 or 4. All eligible participants will be randomised by randomised blocks of varying size, stratified by the service that will providing clinical care (i.e. Edinburgh Respiratory Physiotherapy Service, Mid-Lothian Chronic Disease Nursing Team) to control or intervention. This will be managed by the telephone randomisation service of the Edinburgh Clinical Trials Unit, which will generate the randomisation sequence
Allocation concealment (selection bias)	High risk	"It is not possible to blind clinicians or patients to allocation thus potentially introducing bias in subsequent care"
Blinding of participants and personnel (performance bias) All outcomes	High risk	"It is not possible to blind clinicians or patients to allocation thus potentially introducing bias in subsequent care"

Pinnock 2013 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	Low risk	Trial administrators entering data were blind to allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	Similar numbers of participants in each group did not complete questionnaires at endpoint: 23/128 in RM group, 28/128 in control group
Selective reporting (reporting bias)	Low risk	Study authors reported outcomes as planned; their protocol was registered at ISRCTN Registry
Other bias	Low risk	None

Ringbaek 2015

Study characteristics	
Methods	**Study design:** multi-centre, open-label, parallel block randomised controlled trial in Denmark **Duration:** 26 weeks **Setting:** respirator outpatient clinics
Participants	**Population:** 281 adults recruited from pulmonary wards at 4 hospitals: Hvidovre, Bispedjerg, Herlev, Amager Hospitals **Baseline characteristics:** % Male: 39 TM and 55 UC, Mean age: 69.8 TM and 69.4 UC, % White: not reported, % African: not reported, % LTOT: 26 TM and 27 UC, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: Oral prednisone (8.5%), Roflumilast (4.6%), ICS (91%), LAMA (89%), LABA (96%), FEV_1 (% mean): TM 34.9 and UC 33.8, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): TM 35 and UC 47, GOLD stage: severe and very severe, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: TM 0.91 (0 to 7) and UC 1.22 (0 to 23) **Inclusion criteria:** stable severe to very severe COPD as measured by GOLD, at high risk of exacerbations and hospitalisations, $FEV_1 < 0.7$, post-bronchodilator $FEV_1 < 60\%$ predicted, hospitalisation in last 3 years due to exacerbation, LTOT for at least 3 months, regular respiratory outpatient clinic visits, COPD as main cause of disability, living in 1 of 6 municipalities of Copenhagen, living within area of recruiting hospital **Exclusion criteria:** COPD exacerbation 3 weeks before trial, not giving informed consent, unable to use tablet computer, not able to participate/living outside catchment area 2 weeks or more during study period, language barrier or cognitive disorder, no telephone line
Interventions	Measurements taken at baseline and at 6-month follow-up **Treatment arms** 1. Tablet computer used to send measurements to a call centre 2. Outpatient pulmonary rehab and supported discharge to reduce pulmonary re-admissions 3. Usual care
Outcomes	**Primary outcomes:** health-related QOL by 15D questionnaire **Secondary outcomes:** CAT
Notes	**Funding:** not reported

Ringbaek 2015 *(Continued)*

Other identifier: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"1:1 allocation using randomised blocks of four (via numbered envelopes) for 6 months"
Allocation concealment (selection bias)	Low risk	"1:1 allocation using randomised blocks of four (via numbered envelopes) for 6 months"
Blinding of participants and personnel (performance bias) All outcomes	High risk	It would not be possible to blind patients in the telehealth care arm to treatment, nor people who are administering the intervention due to the nature of the intervention
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear whether outcome assessors were blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	Similar numbers of deaths were observed in both treatment arms (8 vs 9). Two people in the intervention arm withdrew for technical reasons (although the technical reasons are not explained further). Similar attrition overall in both treatment groups
Selective reporting (reporting bias)	Unclear risk	No protocol was registered; it is not clear whether outcomes were reported as planned
Other bias	Low risk	There was good compliance with the TM intervention: "100 (82.6%) patients participated in at least six consultations"

Ritchie 2016

Study characteristics

Methods	**Study design:** single-centre, single-blinded, parallel individual randomised controlled trial in the United States **Duration:** 12 weeks **Setting:** urban academic hospital
Participants	**Population:** 137 adults recruited from an urban academic hospital in Alabama that serves central and northern regions **Baseline characteristics:** % Male: 41.5 IC and 68.7 UC, Mean age: 63.8 IC and 63.4 UC, % White: 67.7 IC and 67.2 UC, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: not reported, FEV_1 (% mean): not reported, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): IC 18 and UC 21, GOLD stage: not reported, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: not reported **Inclusion criteria:** English-speaking, admitted to hospital from home, > 6 months' prognosis of COPD or CHF, access to telephone, expected to be discharged to home, impaired cognition (on validated scale) 6+ (eligible to participate, with caregiver willing to act as proxy), Medicare beneficiary

Ritchie 2016 *(Continued)*

	Exclusion criteria: prognosis < 6 months, cognitive impairment without proxy/caregiver, heart and lung transplants, dialysis, already in CF programme/receiving intensive monitored care, ventricular assist device, use of pre-planned phone service
Interventions	**Run-in:** 1 visit by care transition nurse prior to discharge; measurements at baseline and 30 days **Treatment arms** 1. E-coach interactive voice response monitoring system (post discharge from hospital) 2. Usual discharge plan
Outcomes	**Primary outcomes:** re-hospitalisation in 30 days **Secondary outcomes:** mortality, number of patient days in hospital vs at home at 30 days
Notes	**Funding:** Agency for HealthCare Research and Quality of Care of Complex Patients Grant **Other identifier:** NCT01135381 **Note:** randomisation was stratified by condition; COPD only participants were the only group studied

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation was conducted stratified according to disease group in two independent trials (permuted block design), through a computer based random number generator. "For patients randomised to the intervention, a computer-generated alert was sent to the CTNs, who then met with the patient prior to discharge"
Allocation concealment (selection bias)	Unclear risk	Research personnel recruiting participants were blinded to group assignment, but no description of how this was achieved is provided
Blinding of participants and personnel (performance bias) All outcomes	High risk	Due to the nature of the intervention, care transition nurses or participants could not be blinded to the intervention
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors were blinded to group assignment
Incomplete outcome data (attrition bias) All outcomes	Low risk	There was low % withdrawal in each group; reasons for withdrawal in COPD subgroups remain unclear
Selective reporting (reporting bias)	High risk	Outcomes were reported according to the protocol; however in the publication, study authors stated that 2 deaths occurred in the usual care group at 30 days, but this is not reported at clinicaltrials.gov and is not clearly explained in the publication
Other bias	Low risk	Although not reported in the publication, AEs and SAEs were reported at clinicaltrials.gov

Rose 2018

Study characteristics	
Methods	**Study design:** multi-centre, open-label, parallel stratified randomised controlled trial in Canada **Duration:** 52 weeks **Setting:** large community teaching hospitals
Participants	**Population:** 475 adults recruited from large community teaching hospitals in Canada **Baseline characteristics:** % Male: 50 IC and 44 UC, Mean age: 71 IC and 71 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: 33 IC and 27 UC, % Anxiety or depression: not reported, Baseline medications: inhaled bronchodilator (95%), inhaled steroid (91%), antihypertensive (65%), influenza vaccine, pneumonia vaccine, FEV_1 (% mean): IC 43 and UC 45, FVC (% mean): not reported, FEV_1/FVC (% mean): IC 50 and UC 52, Current smokers (n): IC 53 and UC 59, GOLD stage: not reported, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: IC 1.3 ± 1.3 and UC 1.4 ± 1.3 **Inclusion criteria:** COPD diagnosis, FEV_1 < 70%, 2 or more comorbidities as identified by Canadian Thoracic Society COPD Guidelines, CVD, osteopenia/osteoporosis, glaucoma/cataract, cachexia/malnutrition, peripheral muscle dysfunction, lung cancer, diabetes, chronic kidney disease/other primary admitting/presenting diagnosis + COPD as a significant morbidity + ≥ 1 other morbidity, admission to hospital or presenting at a participating ED, first referral to respiratory centre/respirology team with 1 or more ED presentations or hospital admissions in the last 12 months **Exclusion criteria:** no access to primary care physician, asthma, terminal disease with ≤ 6 months' life expectancy, dementia/no caregiver, uncontrolled psychiatric disorder, cognitive dysfunction, no phone, not able to attend follow-up visit at participating hospital
Interventions	Measurements taken at baseline and at 3, 6, and 12 months **Treatment arms** 1. Programme of integrated care (including telephone consultations), education on living with COPD and individualised care, action plan for self-management of disease in addition to usual care 2. Usual care
Outcomes	**Primary outcomes:** number of emergency department visits **Secondary outcomes:** number of hospital admissions, number of hospitalisation days, mortality, time to first emergency department presentation, change in BODE index, EQ-5D-3L, SGRQ, HADS, COPD-SES, CSQ8, Caregiver Impact Scale, adherence to chronic disease management measures, smoking cessation, vaccination status - all at 52 weeks
Notes	**Funding:** not reported **Other identifier:** NCT01648621

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation was performed 1:1 via a centralised computer-generated schedule stratified by study site
Allocation concealment (selection bias)	Unclear risk	No further information provided
Blinding of participants and personnel (performance bias)	High risk	Patients and personnel were not blinded

Rose 2018 *(Continued)*

All outcomes		
Blinding of outcome assessment (detection bias) All outcomes	High risk	Outcome assessors were not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	Premature terminations low in intervention (N = 8) and control (N = 4) groups. 3 people in control group withdrew It should be noted that study authors stated that for secondary outcomes measured at 12 months by questionnaire (e.g. SGRQ, HADS), data were missing, and results should be interpreted with caution, as this would likely have introduced bias in the results
Selective reporting (reporting bias)	High risk	HRQOL data were not reported sufficiently; requested further information."Most outcomes mentioned were reported, though we do not have sight of a published protocol". Study authors were "unable to compare the frequency of exacerbation that did not result in an emergency department visit or hospitalisation in the control arm as these participants were not contacted weekly or monthly to collect these data". On contact with study author, we were unable to obtain disaggregated data for each treatment arm, as data analysis was combined
Other bias	Low risk	None

Shany 2016

Study characteristics	
Methods	**Study design:** single-centre, open-label, parallel individual randomised controlled trial in Sydney, Australia **Duration:** 52 weeks **Setting:** hospital-based respiratory care
Participants	**Population:** 42 adults recruited from a hospital-based respiratory Ambulatory Care Service-Plus in the suburbs of Sydney **Baseline characteristics:** % Male: 48 RM and 43 UC, Mean age: 72.1 RM and 74.2 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: RM Anxiety: 7.8 ± 4.7 RM Depression 6.0 ± 3.0 and UC Anxiety: 6.2 ± 4.0 UC Depression 6.4 ± 4.5, Baseline medications: not reported, FEV_1 (% mean): RM 32.1 and UC 39.7, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): not reported, GOLD stage: severe, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: RM 3.0 ± 2.0 and UC 2.5 ± 0.9 **Inclusion criteria:** at least 1 hospital admission for COPD exacerbation in preceding year **Exclusion criteria:** not fluent in English, cognitive impairment, motor deficit, part of another trial, no land line connection at home
Interventions	Measurements taken at baseline and at end of study **Treatment arms** 1. Telehealth intervention plus usual care (RACS-Plus) 2. Control (RACS-Plus)
Outcomes	**Primary outcomes:** ED visits, hospital admissions, hospital LOS

Shany 2016 *(Continued)*

	Secondary outcomes: QOL measures, anxiety and depression, costs for hospital admissions
Notes	**Funding:** Department of State and Regional Development of NSW Government, TelemedCare, Australian Research Council, Sydney West Area Health Service, University of NSW **Other identifier:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Study authors reported in their additional document that randomisation was performed according to a computerised randomisation programme in which participants were stratified according to how long they had been on the RACS-plus programme
Allocation concealment (selection bias)	Unclear risk	Concealment of the allocation process was not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind patients or personnel because the intervention was delivered differently to each group
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	No blinding was reported in the study of outcome assessors. The only blinding that took place involved assessment of the duration of ED presentation and hospitalisation, and COPD categorisation. "The duration of ED presentation and hospital admissions as well as their categorisation as a result of COPD were blinded assessments of the Health Information Records Service in the hospital. This was compared to an independent, un-blinded search of electronic patient records and discharge diagnoses in the electronic medical record" Comment: mixed
Incomplete outcome data (attrition bias) All outcomes	High risk	The percentage of attrition was higher in the intervention group (47%) than in the control group (14%) due to premature termination of the intervention. This occurred because participants were unwell, refused to consent to the intervention, or were in a nursing home
Selective reporting (reporting bias)	High risk	Registration of the trial was not found. Study authors reported to measure SGRQ and HADS, but results reported only at baseline, not at end of treatment
Other bias	Low risk	None

Sink 2020

Study characteristics

Methods	**Study design:** multi-centre, open-label, parallel individual randomised controlled trial in the United States **Duration:** 34 weeks **Setting:** primary care clinic
Participants	**Population:** 168 adults recruited from 2 hospitals in Missouri

Sink 2020 *(Continued)*

	Baseline characteristics: % Male: 35 RM and 38 UC, Mean age: 59.8 RM and 61.9 UC, % White: 29 RM and 28 UC, % African: 66 RM and 65 UC, % LTOT: % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: not reported, FEV_1 (% mean): RM 0.65 and UC 0.63, FVC (% mean): not reported, FEV_1/FVC (% mean): RM 0.64 and UC 0.61, Current smokers (n): RM 41 and UC 32, GOLD stage: mild (22%), moderate (54%), severe (17%) very severe (7%), COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: not reported **Inclusion criteria:** COPD diagnosis, > 18 years of age, consent to provide telephone number to receive text or voice messages, able to complete enrolment process, able to understand voice calls in English **Exclusion criteria:** intending to move away from clinic during the study period
Interventions	Measurements taken at baseline, daily or twice a week, and at end of study **Treatment arms** 1. EpxCOPD system via automated telephone call or text 2. Usual care
Outcomes	**Primary outcomes:** time to hospitalisation **Secondary outcomes:** engagement with Epharmix Telemed System
Notes	**Funding:** none **Other identifier:** NCT03002311

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomisation was performed using the Excel random number generator function in a 1:1 ratio. Randomisation was carried out by independent researchers. 17 participants in the control group were included without randomisation
Allocation concealment (selection bias)	Unclear risk	No further information provided
Blinding of participants and personnel (performance bias) All outcomes	High risk	Open-label study
Blinding of outcome assessment (detection bias) All outcomes	High risk	Open-label study
Incomplete outcome data (attrition bias) All outcomes	High risk	Although similar withdrawals, percentage of withdrawals was > 20% in each arm
Selective reporting (reporting bias)	Low risk	Trial was registered at the trials registry, but this publication seems to be just about COPD subgroups, so not all outcomes have been reported in the publication
Other bias	High risk	17 people were included in the trial, even though they were not assigned to 1 of the residents at the time of enrolment because these patients had been seen in previous years by resident physicians who had graduated at the time of the study. They were included in the control group without randomisation,

Sink 2020 *(Continued)*

	so 68/85 were randomised in the control group. FEV_1/FVC was different between randomised and non-randomised participants in the control group

Soriano 2018

Study characteristics	
Methods	**Study design:** multi-centre, open-label, parallel block randomised controlled trial in Spain **Duration:** 52 weeks **Setting:** hospitals and primary care centres
Participants	**Population:** 229 adults recruited from 5 Madrid hospitals **Baseline characteristics:** % Male: 78.3 RM and 82.5 UC, Mean age: 71.5 RM and 71.3 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: 100 RM and 100 UC, % Anxiety or depression: RM Goldberg anxiety 1.5 ± 2.3 and Goldberg depression 2.5 ± 2.4 and UC Goldberg anxiety 1.8 ± 2.5 and Goldberg depression 2.9 ± 2.5, Baseline medication: LABA (98%), LAMA (98%), ICS (94%), SAA (57%), PDE4 inhibitor (16%), theophylline (14%), oral steroid (4%), b2-adrenergic receptor agonists (5%), FEV_1 (% mean): RM 34.2 and UC 32.2, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): not reported, GOLD stage: stable and severe, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: RM 2.0 ± 1.3 and UC 2.0 ± 1.2 **Inclusion criteria:** 50 to 90 years of age, COPD diagnosis (GesEPOC criteria), FEV_1 < 50%, 2+ moderate/severe exacerbations per year, clinically stable, home O_2 therapy, signed informed consent **Exclusion criteria:** unable to understand TM programme, < 12 months' life expectancy, terminal heart failure, advanced renal insufficiency/dialysis, residential hospice or institutionalised, MM test score < 24 (dementia), recommended as not complying with treatment/monitoring required by lung disease, failure to complete inclusion criteria
Interventions	**Run-in:** initial home visit to install equipment and train patient or caregiver and 4 days of physiological measurements **Treatment arms** 1. Telemonitoring intervention 2. Routine clinical practice
Outcomes	**Primary outcomes:** severe exacerbations resulting in emergency department visit or hospitalisation **Secondary outcomes:** quality of life, costs, patient/clinician satisfaction
Notes	**Funding:** Fundación Teófilo Hernando, Universidad Autónoma de Madrid, with support of Linde Healthcare **Other identifier:** NCT02499068

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Reported as randomised (block randomisation), no further information, contacted study author
Allocation concealment (selection bias)	High risk	Open-label study

Soriano 2018 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Open-label study
Blinding of outcome assessment (detection bias) All outcomes	High risk	Open-label study
Incomplete outcome data (attrition bias) All outcomes	Low risk	Similar attrition in both groups, with 28/115 in TM group and 32/114 in RCP group
Selective reporting (reporting bias)	Low risk	Outcomes were reported as planned; trial was registered at clinicaltrials.gov
Other bias	Low risk	None

Sorknaes 2013

Study characteristics	
Methods	**Study design:** multi-centre, single-blinded, parallel individual randomised controlled trial in Denmark **Duration:** 26 weeks **Setting:** hospital (2 hospital sites)
Participants	**Population:** 266 adults recruited from acute medicine unit and respiratory medicine unit at 2 hospital sites in Funen, Denmark **Baseline characteristics:** % Male: 40 RM and 38 UC, Mean age: 71 RM and 72 UC, % White: not reported, % African: not reported, % LTOT: 9 RM and 12 UC, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: not reported, FEV_1 (% mean): RM 33 and UC 37, FVC (% mean): not reported, FEV_1/FVC (% mean): RM 48 and UC 47, Current smokers (n): RM 48 and UC 46, GOLD stage: severe, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: RM 2.75 (2.32) and UC 2.64 (2.5) **Inclusion criteria:** 40+ years, COPD diagnosis by spirometry, COPD exacerbations (defined as increased need for medication, increased dyspnoea, increased expectorate, increased coughing), resident in Funen and islands, written consent **Exclusion criteria:** unable to communicate via phone and/or computer screen, previous participant in protocol or received COPD suitcase, systolic BP < 100 mmHg, saturation < 90, malignancy or lobar pneumonia, cancer/recurrence of cancer in last 5 years, septic shock, AMI/renal disease/or other serious disease, diagnosed HF (EF < 30%), refused to participate
Interventions	Measurements taken at baseline and at 4, 8, 12, and 26 weeks **Treatment arms** 1. Telemonitoring and teleconsultations (started immediately after discharge from hospital due to AE-COPD) 2. Conventional treatment
Outcomes	**Primary outcomes:** hospital admission **Secondary outcomes:** mortality, time before first re-admission, hospital admissions, hospital days

Sorknaes 2013 *(Continued)*

Notes	**Funding:** partial funding from European Commission, Danish Health Foundation, Danish Nurses' Organisation, University of Southern Denmark, OUH-Odense University Hospital, Svenborg Hospital **Other identifier:** NCT01178879

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A central telephone voice response service from a computer-generated system was used for block randomisation of 10 and 14. 1:1 allocation was done, and randomisation was stratified by smoking status and trial site
Allocation concealment (selection bias)	Unclear risk	Reported allocation in 1:1 ratio; allocation concealment of outcome assessors not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Trial was single-blind; assumed patients and personnel were not blinded to treatment allocation, although not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors were blinded to treatment allocation as reported on the NCT website
Incomplete outcome data (attrition bias) All outcomes	Low risk	Number of patient deaths was similar in each group at 26 weeks; overall attrition in each group < 10%
Selective reporting (reporting bias)	Unclear risk	All outcomes were reported as planned; trial was registered at clinicaltrials.gov. Study authors mentioned time-to-event data as survival analyses, but there was no access to the data. Study authors reported as days without standard deviations
Other bias	Low risk	None

Stamenova 2020

Study characteristics

Methods	**Study design:** single-centre, open-label, parallel individual randomised controlled trial in Ontario, Canada **Duration:** 26 weeks **Setting:** community-based hospital outpatient clinic
Participants	**Population:** 122 adults recruited from an outpatient COPD clinic (and from respirologist practices) who worked at the clinic and from an outpatient COPD rehab programme affiliated with the community-based hospital **Baseline characteristics:** % Male: 56 RM and 52 SC, Mean age: 71.98 RM and 72.78 SC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: not reported, FEV_1 (% mean): RM 0.50 and SC 0.45, FVC (% mean): not reported, FEV_1/FVC (% mean): RM 0.54 and SC 0.56, Current smokers (n): RM 10 and SC 9,

Stamenova 2020 *(Continued)*

	GOLD stage: not reported, COPD exacerbations last 12 months: RM 2 and SC 1, Hospitalisations in past 12 months: RM 0 and SC 0 **Inclusion criteria:** diagnosis of COPD defined by respirologist as per clinical guidelines, > 18 years old **Exclusion criteria:** diagnosis of ILL, patients without Wi-Fi access at home, non-English-speaking, taking part in other RM programmes, not able to use technology due to physical/cognitive impairment
Interventions	Measurements taken at baseline (in person) and at 3 months and 6 months (in person or remotely) **Treatment arms** 1. Remote monitoring (Cloud DX system) 2. Self-monitoring (Cloud DX system) (treatment arm not included in this review) 3. Standard care
Outcomes	**Primary outcomes:** Partners in Health Scale (knowledge and skills to monitor disease) **Secondary outcomes:** SGRQ, Bristol COPD Knowledge Questionnaire, patient self-report (COPD ED visits, hospital admissions, length of hospital stay, number of exacerbations, COPD-related visits to GP, COPD-related RN contacts, use of medication, smoking cessation)
Notes	**Funding:** Ontario Centres of Excellence Health Technologies Fund, grant 27009 **Other identifier:** NCT03741855 **Other:** 3-arm study; each arm was separate; self-monitoring (41), remote monitoring (41), standard care (40)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	People were randomised 1:1:1 using a web-based random number generator
Allocation concealment (selection bias)	High risk	Participants were allocated using sealed envelopes to conceal allocation from the clinical study specialist; however, the specialist opened the envelopes so participants and specialist were aware of the assignment
Blinding of participants and personnel (performance bias) All outcomes	High risk	Open-label study
Blinding of outcome assessment (detection bias) All outcomes	High risk	Open-label study
Incomplete outcome data (attrition bias) All outcomes	Low risk	Attrition was similar in each group at 3 and 6 months
Selective reporting (reporting bias)	Low risk	Outcomes were reported as planned, a protocol was published, and the trial was registered. SGRQ was reported in graph format; study authors were contacted for response
Other bias	Low risk	None

Tabak 2014

Study characteristics	
Methods	**Study design:** single-centre, single-blind, parallel individual randomised controlled trial in the Netherlands **Duration:** 39 weeks **Setting:** hospital and primary care physiotherapy practice
Participants	**Population:** 29 adults recruited from a hospital and from primary care physiotherapy practices in Enschede, Netherlands **Baseline characteristics:** % Male: 50 IC and 50 UC, Mean age: 64.1 IC and 62.8 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: not reported, FEV_1 (% mean): IC 50.0 and UC 36.0, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): IC 4 and UC 4, GOLD stage: not reported, COPD exacerbations last 12 months: not reported, Hospitalisations in last 12 months: not reported **Inclusion criteria:** clinical diagnosis of COPD according to GOLD guidelines, not exacerbation-free in the month prior to enrolment, ≥ 3 exacerbations or hospitalisations (respiratory related) in the previous 2 years, ex/current smoker, 40+ years, FEV_1 25% to 80% predicted, Dutch-speaking and understanding Dutch, Internet at home **Exclusion criteria:** other serious illness, short life expectancy, other condition affecting bronchial symptoms/lung function, severe mental illness, uncontrolled diabetes during COPD exacerbation in past, hospitalisation due to diabetes in previous 2 years, regular oxygen therapy, maintenance antibiotic therapy, alpha-1-antitrypsin deficiency, disorder/condition seriously affecting daily activities, hand impairment/unable to use app
Interventions	**Run-in:** two 90-minute sessions with the nurse practitioner for disease self-management; measurements taken at baseline and at 1, 3, 6, and 9 months **Treatment arms** 1. Web-based telehealth programme (teleconsultations - general or exercise-related, self-management, web-based exercise, activity coach) 2. Usual care
Outcomes	**Primary outcomes:** number of hospitalisations, length of stay, number of emergency department visits **Secondary outcomes:** 6MWT, EuroQoL-5D, Multidimensional Fatigue Inventory 20, Clinical COPD Questionnaire, dyspnoea
Notes	**Funding:** NL Agency, a division of the Dutch Ministry of Economic Affairs **Other identifier:** Netherlands Trial register (NTR3072)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Participants were randomised using a computer-generated randomisation list (Blocked Stratified Randomisation version 5; Steven Piantadosi)
Allocation concealment (selection bias)	Low risk	Participants were allocated by a data manager in order of inclusion following the randomisations list, which was placed in a sealed envelope

Tabak 2014 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Trial was open-label
Blinding of outcome assessment (detection bias) All outcomes	High risk	Trial was open-label
Incomplete outcome data (attrition bias) All outcomes	High risk	85% in the usual care group withdrew, and 33% in the telehealth group "The study showed a high attrition rate. The strict criteria in relation to exacerbations/hospitalisations meant that the participants in general had a poor and unstable health status, especially in the control group, who had significantly worse dyspnoea levels"
Selective reporting (reporting bias)	Low risk	Contacted study authors regarding a few of the outcomes, as they were not reported in a format that could be used. The trial was registered, and all outcomes were reported as planned
Other bias	Low risk	None

Udsen 2017

Study characteristics	
Methods	**Study design:** multi-centre, open-label, parallel cluster randomised controlled trial in Denmark **Duration:** 52 weeks **Setting:** primary care
Participants	**Population:** 1225 adults recruited from 26 municipal districts in the North Denmark region **Baseline characteristics:** % Male: 48.3 RM and 43.7 UC, Mean age: 69.6 RM and 70.3 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline medications: not reported, FEV_1 (% mean): RM 47.7 and UC 48.4, FVC (% mean): RM 70.4 and UC 73.3, FEV_1/FVC (% mean): not reported, Current smokers (n): RM 196 and UC 189, GOLD stage: I, II, III, IV COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: not reported **Inclusion criteria:** COPD diagnosis by spirometry, treated according to GOLD guidelines, wanting to get COPD treatment, COPD the primary condition, residing permanently in the North Denmark region, MRC modified ≥ 2 or MRC ≥ 3 or CAT ≥ 10, at least 2 exacerbations in the last year **Exclusion criteria:** no phone line or GSM coverage, unable to speak or understand Danish to complete questionnaires, cognitive impairment
Interventions	Measurements taken at baseline and at 12 months **Treatment arms** 1. Tablet computer used to collect disease-specific data (measured vital signs and COPD symptoms) 2. Usual care practice
Outcomes	**Primary outcomes:** quality of life (SF-36 physical and mental composite subscale scores) **Secondary outcomes:** incremental cost-effectiveness ratio

Udsen 2017 *(Continued)*

Notes	**Funding:** North Denmark Region, 11 municipalities in the North Denmark Region; Obel Family Foundation; Danish Agency for Digitalization Policy Strategy; European Social Fund **Other identifier:** NCT01984840

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Districts were distributed randomly by a blinded volunteer with no relation to the trial, who performed randomisation by throwing a dice
Allocation concealment (selection bias)	Low risk	Randomisation of clusters was done by sealed envelopes overseen by a person not affiliated with the trial
Blinding of participants and personnel (performance bias) All outcomes	High risk	Trial was open-label
Blinding of outcome assessment (detection bias) All outcomes	High risk	Trial was open-label
Incomplete outcome data (attrition bias) All outcomes	High risk	Attrition was similar in both groups; however, more people in the THC group withdrew consent to the intervention compared to the UC group. Overall, attrition was high, with 50% of participants dropping out of the study. 61% of participants at all cost categories and EQ-5D summary scores had completed registration
Selective reporting (reporting bias)	Low risk	All outcomes were reported as planned; trial was registered at clinicaltrials.gov
Other bias	Low risk	None

Vianello 2016

Study characteristics

Methods	**Study design:** multi-centre, open-label, parallel individual randomised control trial in Italy **Duration:** 52 weeks **Setting:** primary and secondary clinics
Participants	**Population:** 334 adults recruited from a hospital or from outpatient pulmonary clinics in Padova, Treviso, Venice, and Verona, Italy **Baseline characteristics:** % Male: 71 RM and 73 UC, Mean age: 75.96 RM and 76.48 UC, % White: not reported, % African: not reported, % LTOT: 41.30 RM and 39.42 UC, % Home oxygen: not reported, % Anxiety or depression: HADSA: RM 4.68 (3.45) and UC 5.4 (3.35), HADSD: RM 5.1 (4.42) and UC 5.48 (4.49), Baseline medications: LABA: RM 97% and UC 94%, LAMA: RM 87.17% and UC 86.27%, Inhaled ICS: RM 83.48% and UC 76.92%, Systemic steroid: RM 6.52% and UC 4.81%, FEV_1 (% mean): RM 41.90 and UC 41.87, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): RM 10 and UC 3, GOLD stage: III/IV, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: not reported

Vianello 2016 *(Continued)*

	Inclusion criteria: 18+ years, COPD GOLD class III and IV, life expectancy > 12 months, able to use telemonitoring equipment (assisted or alone) **Exclusion criteria:** unwilling to use telemonitoring equipment, significant lung disease, not willing to provide consent, serious social problems, negative feedback from GP
Interventions	Measurements at baseline and at 12 months **Treatment arms** 1. Telemonitoring system to send physiological and symptom data to web-based platform 2. Self-management educational materials
Outcomes	**Primary outcomes:** HRQL, SF-36v2 (Italian version) **Secondary outcomes:** HADS, number and duration of hospitalisations, AECOPD, number and duration of any cause hospitalisations, number of re-admissions due to exacerbations, number of any cause re-admissions, number of appointments with pulmonary specialist, number of ED visits, number of deaths
Notes	**Funding:** part of the Renewing Health Project founded by the European Commission **Other identifier:** NCT01513980

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A computer programme was used for randomisation of participants and allowed check of any inequality of characteristics by age and gender. Patients were randomised in a 2:1 allocation
Allocation concealment (selection bias)	High risk	Allocation was not concealed, but participants were allocated in a 2:1 ratio for TM and control groups, respectively
Blinding of participants and personnel (performance bias) All outcomes	High risk	Trial was open-label
Blinding of outcome assessment (detection bias) All outcomes	High risk	Trial was open-label
Incomplete outcome data (attrition bias) All outcomes	Low risk	Attrition was similar in each treatment group, although it was > 20% in each group and overall
Selective reporting (reporting bias)	Low risk	Outcomes were reported as planned; study was registered at clinicaltrials.gov
Other bias	Low risk	None

Walker 2018

Study characteristics

Walker 2018 *(Continued)*

Methods	**Study design:** multi-centre, open-label, parallel individual randomised controlled trial in Spain, United Kingdom, Slovenia, Estonia, and Sweden **Duration:** 39 weeks **Setting:** clinics, hospitals, and community health services
Participants	**Population:** 312 adults recruited from 6 sites in 5 countries (United Kingdom 75, Sweden 63, Estonia 80, Spain 61, Slovenia 33) **Baseline characteristics:** % Male: 66 RM and 65 UC, Mean age: 71 RM and 71 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: Mean depression PHQ-9 score RM 6.27 (5.69) and UC 5.97 (5.79), Baseline medications: not reported, FEV_1 (% mean): RM 49.4 and UC 50.4, FVC (% mean): RM 73.8 and UC 75.8, FEV_1/FVC (% mean): RM 0.53 and UC 0.53, Current smokers (n): not reported, GOLD stage: RM: I (3%), II (47%), III (36%), IV (15%) and UC: I (2%), II (48%), III (39%), IV (11%), COPD exacerbations last 12 months: 1 exacerbation: RM 63 (41%) and UC 59 (37%); More than 1 exacerbation: RM 91 (59%) and UC 99 (63%), Hospitalisations in past 12 months: RM 64 (42%) and UC 65 (41%) **Inclusion criteria:** GOLD grade II or higher, exacerbations or hospitalisation or both in the last year, co-morbidities such as CHF, SDB, smoking pack-years > 10 years, able to provide written consent, able to use TM equipment at home, reliable mobile phone coverage at home, > 60 years **Exclusion criteria:** any condition likely to put patient at risk, significant visual or mental condition, planned long-time absence from home
Interventions	Measurements taken at baseline, every 2 months (CAT, PHQ-9, MLHFQ), every 3 months (EQ-5D, exacerbations, medication use, use of GP), and at end of study **Treatment arms** 1. CHROMED remote monitoring platform 2. Control group
Outcomes	**Primary outcomes:** time to first hospitalisation, quality of life (change in EQ-5D utility index score) **Secondary outcomes:** moderate exacerbation rate, hospitalisation, CAT, PHQ-9, MLHFQ questionnaires, cost utility analysis
Notes	**Funding:** European commission grant **Other identifier:** NCT01960907

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Concealed computer-generated randomisation with 4-element block design stratified by centre was used
Allocation concealment (selection bias)	Unclear risk	Randomisation sequence was concealed, but it is unclear how allocation was concealed
Blinding of participants and personnel (performance bias) All outcomes	High risk	Trial was open-label
Blinding of outcome assessment (detection bias)	High risk	Trial was open-label

Walker 2018 *(Continued)*

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	Low risk	Attrition was similar in TM (29%) and control groups (22%)
Selective reporting (reporting bias)	Low risk	Outcomes were reported as planned. Study authors were contacted about time to first hospitalisation to see if they could provide HR and 95% CI, which they provided on request. Trial was registered at clnicaltrials.gov
Other bias	Low risk	None

Yan 2018

Study characteristics

Methods	**Study design:** single-centre, open-label, parallel individual randomised controlled trial in China **Duration:** 52 weeks **Setting:** respiratory and nosocomial infection departments at a hospital
Participants	**Population:** 240 adults recruited from the Respiratory and Nosocomial Infection Departments at a hospital in Wuhan, China **Baseline characteristics:** % Male: 60 RM and 66 UC, Mean age: 65.4 RM and 64.6 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: not reported, baseline medications: not reported, FEV_1 (% mean): RM 40.98 and UC 41.08, FVC (% mean): not reported, FEV_1/FVC (% mean): RM 54.08 and UC 53.47, Current smokers (n): RM 108 and UC 104, GOLD stage: RM: I (12), II (27), III (67), IV (14) and UC: I (10), II (25), III (70), IV (15), COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: not reported **Inclusion criteria:** not reported **Exclusion criteria:** not reported
Interventions	Measurements at baseline and at 1 year **Treatment arms** 1. Mobile platform doctor network consulting through video, voice, picture, and text 2. Education information sent electronically
Outcomes	**Primary outcomes:** pulmonary function tests, quality of life (CAT) assessments, hospitalisations **Secondary outcomes:** not reported
Notes	**Funding:** China Medical Board **Other identifier:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Study authors reported that participants were randomly assigned but provided no further information

Yan 2018 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	No further information provided
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind participants and personnel due to nature of the intervention
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	No further information provided
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	All participants were included, but it is unclear whether any withdrew
Selective reporting (reporting bias)	High risk	No Prisma diagram provided, data in Tables 3 and 4 (continuous data) not clear. Unclear whether SDs or SEs were reported. Trial not registered at trials website; unable to contact study author as email provided was incorrect. Contacted one of the other study authors; awaiting response
Other bias	Low risk	None

6MWD: 6-minute walking distance; **6MWT:** 6-minute walk test; **A&E:** accident and emergency visits; **AECOPD:** acute exacerbations of chronic obstructive pulmonary disease; **AEs:** adverse events; **AMI:** acute myocardial infarction; **β_2-agonist:** beta2-agonist; **BODE:** body mass index, airflow obstruction, dyspnoea, and exercise capacity index; **BP:** blood pressure; **BRC:** Biomedical Research Centre; **CAT:** Chronic Obstructive Pulmonary Disease Assessment Test; **CCQ:** Clinical Chronic Obstructive Pulmonary Disease Questionnaire; **CF:** cystic fibrosis; **CHF:** congestive heart failure; **CHROMED:** Telemonitoring in Chronic Obstructive Pulmonary Disease in five countries; **CHRONIC:** an information Capture and Processing Environment for Chronic Patients in the Information Society project; **CI:** confidence interval; **COPD:** chronic obstructive pulmonary disease; **COPD-SES:** Chronic Obstructive Pulmonary Disease Self-Efficacy Scale; **CRDQ:** Chronic Respiratory Disease Questionnaire; **CSQ-8:** Client Satisfaction Questionnaire-8; **CTN:** care transition nurse; **CVD:** cardiovascular disease; **ED:** emergency department; **EDGE:** sElf-management anD support proGrammE; **EF:** ejection fraction; **EpxCOPD:** Epharmix chronic obstructive pulmonary disease system; **EQ-5D:** EuroQoL 5 Dimensions Questionnaire; **EQ-5D-3L:** EuroQoL 5 Dimensions 3-Level Version Questionnaire; **EU:** European Union; **EuroQoL-5D:** European Quality of Life 5 Dimension Questionnaire; **FEV_1:** forced expiratory volume in one second; **FEV_1/FVC:** forced expiratory volume in one second/forced vital capacity ratio; **FILAS:** locations and financial instruments for producers in Rome and Lazio; **FVC:** forced vital capacity; **GesEPOC:** Spanish National Guidelines for Chronic Obstructive Disease Care; **GOLD:** Global Initiative for Obstructive Lung Disease; **GOLD I:** Global Initiative for Obstructive Lung Disease stage 1; **GOLD II:** Global Initiative for Obstructive Lung Disease stage 2; **GOLD III:** Global Initiative for Obstructive Lung Disease stage 3; **GOLD IV:** Global Initiative for Obstructive Lung Disease stage 4; **GP:** general practitioner; **GSM:** Group Special Mobile; **HADS:** Hospital Anxiety and Depression Scale; **HADS-A**: Hospital Anxiety and Depression Scale - Anxiety; **HADS-D:** Hospital Anxiety and Depression Scale - Depression; **HCP:** healthcare provider; **HF:** heart failure; **HR:** hazard ratio; **HRQOL:** health-related quality of life; **IC:** integrated care; **ICS:** inhaled corticosteroid; **ICT:** information and communication technologies; **ICU:** intensive care unit; **ILD:** interstitial lung disease; **ILL:** interstitial lung disease; **IQR:** interquartile range; **ISRCTN:** primary clinical trial registry recognised by World Health Organization and International Committee of Medical Journal Editors; **IST:** Information Sciences and Technology; **IV:** intravenous; **LABA:** long-acting beta-adrenergic agonist; **LAMA:** long-acting muscarinic antagonist; **LINQ:** Lung Information Needs Questionnaire; **LOS:** length of stay; **LTOT:** long-term oxygen therapy; **MARS:** Medication Adherence Report Scale; **MLHFQ:** Minnesota Living With Heart Failure Questionnaire; **MM:** Mini Mental Test; **MMSE:** Mini Mental State Examination; **MRC:** Medical Research Council; **(n):** number; **NCT:** ClinicalTrials.gov identifier; **NHS:** National Health Service; **NIHR:** National Institute for Health Research; **NIV:** non-invasive ventilation; **NL Agency:** division of the Dutch Ministry of Economic Affairs; **NSW:** New South Wales; **O_2:** oxygen; **PDE4:** phosphodiesterase 4 inhibitors; **PHQ-9:** Patient Health Questionnaire-9; **PITES-ISA:** Strategic Health Action research projects; **PR:** pulmonary rehabilitation; **QOL:** quality of life; **RACS-Plus:** Respiratory Ambulatory Care Service-Plus; **RCP:** routine clinical practice; **RM:** remote in-home telemonitoring; **RN:** registered nurse; **SAA:** short-acting adrenergic; **SABA:** short-acting beta2-agonist; **SAE:** serious adverse event; **SBP:** standard best practice care; **SC:** standard care; **SCL-10A:** Standard Checklist 10-Item Anxiety Measure; **SCL-20:** Standard Checklist 20-Item Questionnaire; **SD:** standard deviation; **SDB:** sleep-disordered breathing; **SECD6:** Self-Efficacy for Managing Chronic Disease 6-Item Scale; **SE:** standard error; **SF-36:** Short Form 36 questionnaire; **SF36v2:** Short Form 36 questionnaire Italian version; **SGRQ:** St George's Respiratory Questionnaire; **SGRQ-C:** chronic obstructive pulmonary disease-specific version of St George's Respiratory Questionnaire; **STATA:** Software for Statistics and Data Science; **TH:** telehealth; **THC:** telehealthcare; **TM:** telemonitoring; **UC:** usual care; **UK:** United Kingdom.

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
ACTRN12614000296639	Wrong intervention
Alonso 2004	Wrong study design
Bentley 2014	Intervention duration < 3 months
Bernocchi 2016	Wrong intervention
Bischoff 2012	Wrong intervention
Chau 2012	Intervention duration < 3 months
Cooper 2019	Wrong study design
Cordova 2007	Wrong population
Dinesen 2012	Wrong intervention/comparator: telerehabilitation intervention compared to exercise
Emme 2014	Wrong population
Finkelstein 2004	COPD population < 50%
Fors 2018	Wrong intervention
Gaeckle 2016	Wrong study design
Gellis 2014	COPD population < 50%
Grabenhorst 2013	Wrong intervention
Henderson 2013	COPD population < 50%
ISRCTN13081008	Wrong study design
ISRCTN34235668	Wrong study design
ISRCTN34252610	Wrong study design
ISRCTN41238563	COPD population < 50%
Jehn 2013	Wrong intervention
Johnston 2000	COPD population < 50%
Juan 2011	Wrong study design
Kamei 2011	Wrong study design
Kamei 2018	Wrong study design
Kenealy 2015	COPD population < 50%

Study	Reason for exclusion
Ko 2015	Wrong intervention
Lavensen 2012_2016	Intervention duration < 3 months
Levine 2018	COPD population < 50%
Mair 2002	Wrong population
Mudiyanselage 2018	COPD population < 50%
NCT00916799	Wrong study design
NCT01044927	Wrong study design
NCT01495780	Wrong study design
NCT01644045	Wrong study design
NCT01892566	Wrong population
NCT02085187	Wrong intervention
NCT02269618	Mixed population
NCT02528370	Wrong study design
NCT02706600	Wrong intervention
NCT02791451	Wrong study design
NCT02803489	Wrong study design
NCT03127852	Wrong population
NCT03129477	Wrong study design
NCT03131622	Wrong intervention
NCT03353064	Wrong population
NCT03640260	Wrong intervention
NCT03739957	Wrong study design
NCT03837847	Wrong intervention
NCT04108143	Wrong study design
Nohra 2020	Wrong study design
Norgaard 2014	Wrong population
Paquin 2014	Unclear population
Pare 2006	Wrong study design

Study	Reason for exclusion
Pinnock 2012	Wrong study design
Reinius 2013	COPD population < 50%
Shah 2017	Wrong study design
Sirichana 2013	Wrong study design
Sorknaes 2011	Intervention duration < 3 months
Sridhar 2008	Wrong intervention
Tong 2012	Wrong study design
Troosters 2003	Wrong intervention
Vega 2008	Wrong study design
Vitacca 2008	COPD population < 50%
Walters 2013	Wrong intervention
Whitten 2007	COPD population < 50%
Wolpin 2011	Wrong intervention
Wong 2005	Wrong intervention

Characteristics of studies awaiting classification *[ordered by study ID]*

Cartwright 2013

Methods	**Study design:** multi-centre, unknown blinding, parallel, cluster-randomised controlled trial in United Kingdom **Duration:** 52 weeks **Setting:** GP practices
Participants	**Population:** 3230 adults recruited from 238 practices in Cornwall, Kent, and Newham, United Kingdom **Baseline characteristics:** unknown **Inclusion criteria:** ≥ 18 years, diagnosis of primary or secondary care of COPD, diabetes or HF (no formal clinical assessment of severity of disease but inclusion based on relevant Quality Outcomes Framework register in primary care, confirmed medical diagnosis in primary or secondary care medical records: general practice read codes or ICD-10 classification, or confirmed by local clinician or patient's hospital consultant, patients were not excluded on basis of physical comorbidities) **Exclusion criteria:** does not understand English, not able to complete questionnaires, does not have appropriate power supply or telephone line, previous telehealth study with telehealth equipment
Interventions	Measurements at baseline and at 3 and 6 months

Cartwright 2013 *(Continued)*

	Treatment arms 1. Telecare monitors/devices that send alerts when required and telehealth intervention
Outcomes	**Primary outcomes:** quality of life (SF-12, EQ-5D, generic COPD QOL questionnaire, depression (CES-D), anxiety (STAI-6) **Secondary outcomes:** none listed
Notes	**Funding:** Department of Health, England **Other identifier:** ISRCTN43002091

Chatwin 2016

Methods	**Study design:** multi-centre, single-blinded, stratified randomised controlled trial in United Kingdom **Duration:** 52 weeks **Setting:** primary and secondary clinics
Participants	**Population:** 68 adults recruited from outpatient and inpatient clinics at Royal Brompton & Harefield NHS Foundation Trust, West Middlesex University Hospital, and St George's University Hospital **Baseline characteristics:** % Male: 63 all, Mean age: 65.3 all, % White: not reported, % African: not reported, % LTOT: 59 all, % Home oxygen: not reported, % Anxiety and depression 8 (4) all and 7 (4) all, Baseline medications: not reported, FEV_1: all 0.9 (0.5), FVC: all 2.1 (0.9), FEV_1/FVC: not reported, Current smokers (n): not reported, GOLD stage: all 3 (1), COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: not reported **Inclusion criteria:** ≥ 18 years old, COPD or chronic respiratory failure due to another chronic respiratory disease, admitted exacerbation in previous 6 months, met criteria for LTOT or had oxygen saturation level ≤ 90% on air for past admission **Exclusion criteria:** cognitive impairment that impairs understanding of the trial or use of telemonitoring, age < 18 years
Interventions	Measurements taken at baseline and at 3, 6, and 12 months **Treatment arms** 1. Telemonitoring monitor by broadband link to care team 2. Daily measurements and data sent Monday through Friday 3. Personalised care plan
Outcomes	**Primary outcomes:** time to first hospital admission for exacerbation **Secondary outcomes:** hospital admissions, general practitioner (GP) consultations and home visits by nurses, quality of life measured by EuroQoL-5D and hospital anxiety and depression (HAD) scale, self-efficacy score
Notes	**Funding:** National Institute for Health Research (NIHR) under the Collaborations for Leadership in Applied Health Research and Care (CLAHRC) programme for North West London **Other identifier:** NCT02180919

Martin-Lesende 2013

Methods	**Study design:** multi-centre, open-label, parallel individual randomised controlled trial **Duration:** 52 weeks **Setting:** primary care health centres in Spain
Participants	**Population:** 58 adults recruited from 20 health centres in Bilbao, Spain **Baseline characteristics:** % Male: 50 RM and 66.7 UC, 57.1 RM and 46.7 UC, % Anxiety and depression: not reported, Baseline meds: not reported, FEV_1: not reported, FVC: not reported, FEV_1/FVC: not reported, Current smokers (n): not reported, GOLD stage: moderate (17.4%), severe (21.7%), and very severe (60.9%), COPD exacerbations last 12 months: not reported, Hospitalisation in past 12 months: not reported **Inclusion criteria:** home care adult patients, diagnosis of heart failure and/or chronic lung disease 14+ years, history of 2+ hospital admissions in last year with at least 1 admission associated with at least 1 of said conditions for study **Exclusion criteria:** in residential care, receiving regular monitoring or treatment by specialist or hospitalist services, life expectancy < 6 months due to other illness, known cognitive impairment, not willing to participate
Interventions	Measurements at baseline and at 3, 6, and 12 months **Treatment arms** 1. PDA device to transmit self-measured data via Bluetooth wireless to web-based platform daily 2. Data assessed Monday through Friday during business hours
Outcomes	**Primary outcomes:** number of hospital admissions **Secondary outcomes:** length of hospital stay, mortality, use of other healthcare resources (ED visits, home visits, health centres, specialists, telephone calls), number of alerts by telemonitoring system in 5 days leading up to admission
Notes	**Funding:** Spanish Ministry of Health **Other identifier:** ISRCTN89041993

NCT00752531

Methods	**Study design:** single-blinded, parallel individual randomised controlled trial **Duration:** 78 weeks **Setting:** unknown
Participants	**Population:** 280 adult participants to be recruited in the United States **Baseline characteristics:** unknown **Inclusion criteria:** ≥ 21 years, understands English, has working telephone/cable, with diagnosed COPD, stage II/III COPD **Exclusion criteria:** moving from study area before study complete, health condition causing participant to not carry out study expectations, not able to use telephone and without assistance to do so
Interventions	Measurements at baseline and at 3, 6, 9, 12, 15, and 18 months

NCT00752531 *(Continued)*

	Treatment arms 1. Computer device for data telecommunication sessions 2. Personalised self-care plan and education 3. Patients assessed 7 times - 4 at research site and 3 at home every 3 months
Outcomes	**Primary outcomes:** lung function, respiratory symptoms **Secondary outcomes:** quality of life, use of health care, activities of daily living, self-efficacy, exercise tolerance
Notes	**Funding:** John Hopkins University **Other identifier:** NCT00752531

NCT00893685

Methods	**Study design:** multi-centre, open-label, parallel individual randomised controlled trial **Duration:** 130 weeks **Setting:** healthcare systems
Participants	**Population:** 300 adults recruited from Denmark, Estonia, Germany, Italy, Spain, Sweden **Baseline characteristics:** unknown **Inclusion criteria:** < 65 years; diagnosis of CHF, DM, or COPD **Exclusion criteria:** unable to use study equipment, dependent on others for daily living, diagnosis of dementia, impaired language, no signed informed consent, no access to ISDN or DSL service
Interventions	Measurements taken at baseline and at 15 and 30 months **Treatment arms** 1. Home television-based teleconferencing system 2. Daily monitoring sent to central monitoring unit
Outcomes	**Primary outcomes:** SF-36 questionnaire **Secondary outcomes:** hospital length of stay, transfer to elderly home, number of hospitalisations, HADS, death, injury, ambulance transport, emergency department visits, home visits by nurses, consults with GP or specialists
Notes	**Funding:** Health Information Management, Belgium **Other identifier:** NCT00893685

NCT01342263

Methods	**Study design:** mult- centre, single-blinded, parallel individual randomised controlled trial in Canada **Duration:** 104 weeks **Setting:** primary and secondary clinics

NCT01342263 *(Continued)*

Participants	**Population:** 234 adults recruited from Northern Health, Fraser Health, Interior Health, Vancouver Island Health, and Vancouver Coastal Health, Canada **Baseline characteristics:** unknown **Inclusion criteria:** ≥ 19 years of age; ≥ 2 of the following chronic diseases: CHF, DM, COPD, kidney disease, heart disease; Internet access; able to read, write, understand English **Exclusion criteria:** scheduled surgical procedures, not able to give informed consent, comorbidities interfering with management
Interventions	Measurements taken at baseline and at 24 months **Treatment arms** 1. Interactive website for disease management and daily monitoring 2. Access to dietician and exercise specialists for disease management
Outcomes	**Primary outcomes:** hospital admissions, emergency room visits, hospital length of stay, physician visits, procedures (diagnostic and lab) **Secondary outcomes:** SF-36, heiQ, satisfaction (participants and providers), social support, EQ-5D-5L, adhering to intervention
Notes	**Funding:** Simon Fraser University **Other identifier:** NCT01342263

NCT01489241

Methods	**Study design:** unknown centres, single-blinded, parallel individual randomised controlled trial in Greece **Duration:** 12 weeks **Setting:** hospitals
Participants	**Population:** 155 adults recruited from Central Greece **Baseline characteristics:** unknown **Inclusion criteria:** ≥ 40 years, able to use devices for study, willing to participate, COPD per GOLD guidelines **Exclusion criteria:** involved in previous COPD monitoring study
Interventions	Measurements taken at baseline and at 3 months **Treatment arms** 1. Phone-based telemonitoring platform 2. Data sent to telehealth centre
Outcomes	**Primary outcomes:** hospital readmissions **Secondary outcomes:** QOL SF-36, HADS, SGRQ, FEV_1, mortality, patient satisfaction survey
Notes	**Funding:** Regional Health Authority of Sterea & Thessaly

NCT01489241 *(Continued)*

	Other identifier: NCT01489241

NCT01512992

Methods	**Study design:** unknown centres, single-blinded, parallel individual randomised controlled trial in Spain **Duration:** 12 weeks **Setting:** clinic, hospital
Participants	**Population:** 380 adults recruited from clinics/hospitals in Spain **Baseline characteristics:** unknown **Inclusion criteria:** ≥ 40 years of age, COPD exacerbation, willing to participate in study, able to use devices for study **Exclusion criteria:** participated in previous COPD home telehealth study
Interventions	Measurements taken at baseline and at 3 months **Treatment arms** 1. Remote monitoring for low-complexity patients and videoconferencing remote monitoring for high-complexity patients 2. Personalised care plan 3. Self-management education for disease
Outcomes	**Primary outcomes:** hospital re-admissions **Secondary outcomes:** HQOL by SF-36, FEV_1, CAT, HADS, mortality, time to first re-admission, emergency department visits, length of stay for re-admission, patient satisfaction
Notes	**Funding:** Catalan Agency for Health Information, Assessment, and Quality **Other identifier:** NCT01512992

NCT01560741

Methods	**Study design:** unknown centres; double-blinded, parallel individual randomised controlled trial in Portugal **Duration:** 36 weeks **Setting:** hospital
Participants	**Population:** 128 adults recruited from Portugal **Baseline characteristics:** unknown **Inclusion criteria:** < 80 years of age, $PaCO_2$ > 45 mmHg, IMC > 40 kg/m^2, LTOT for at least 3 months, 1 exacerbation in last year, FEV_1 < 50%predicted, FEV_1/FVC < 60%, TLC > 90% predicted, GOLD guidelines therapy, pH > 7.35, free of exacerbations 4 weeks before recruitment

NCT01560741 *(Continued)*

	Exclusion criteria: OHS: COPD, NMD; COPD: 15% increase in FEV_1 after inhaled salbutamol (200 µg), actively smoking, history of OSA; NMD and CWD: COPD; OHS; PCF < 270; MIC/VC = 1, severe bulbar weakness
Interventions	Measurements taken at baseline, at 12 weeks, and at end of study **Treatment arms** 1. Remote monitoring while patient sleeps utilising non-invasive equipment 2. UC to receive equipment after study period
Outcomes	**Primary outcomes:** difference of 1 hour in the mean of nightly hours of use **Secondary outcomes:** QOL, health economics, arterial blood gases
Notes	**Funding:** Hospital Sao Joao **Other identifier:** NCT01560741; TeleMotiNIV2012

NCT01580072

Methods	**Study design:** unknown centres; open-label, parallel individual randomised controlled trial in Austria **Duration:** 52 weeks **Setting:** unknown
Participants	**Population:** 65 adults recruited from Carinthia, Austria **Baseline characteristics:** unknown **Inclusion criteria:** III/IV GOLD COPD, life expectancy > 12 months, able to use system **Exclusion criteria:** unknown
Interventions	Measurements taken at baseline and at 12 months **Treatment arms** 1. Mobile phone device use for telemonitoring data to a Web Portal or automatic call centre for self-monitoring and nurse monitoring
Outcomes	**Primary outcomes:** QOL SF-36, inpatient stays **Secondary outcomes:** number of bed days for hospitalised patients, number of PC visits, number of specialist visits, number of emergency department visits, mortality, CAT, SGRQ
Notes	**Funding:** Ladeskrankenanstalten-Betriebsgesellschaft **Other identifier:** NCT01580072; C250487

NCT01744028

Methods	**Study design:** unknown centres; open-label, parallel individual randomised controlled trial in Spain and Sweden **Duration:** 52 weeks

NCT01744028 *(Continued)*

	Setting: centres
Participants	**Population:** 200 adults recruited from centres in Spain and Sweden **Baseline characteristics:** unknown **Inclusion criteria:** diagnosis of COPD GOLD II or higher, current or ex-smoker with 10 pack-years nt, post-bronchodilator FEV_1 < 80% of predicted within 12 months prior, post-bronchodilator FEV_1/FVC < 70% within 12 months prior to/at screening, documented COPD exacerbations ≥ 2 in previous 12 months **Exclusion criteria:** use of investigative drugs at time of enrolment/within 30 days of 5 half-lives of enrolment, history of asthma prior to age 40 years, COPD exacerbation not resolved within 30 days prior to screening
Interventions	Measurements taken at baseline and at 12 months **Treatment arms** 1. EXACT tool used to alert clinical staff of over-set threshold from daily data 2. 4 planned study visits
Outcomes	**Primary outcomes:** number of hospitalisations for COPD, number of emergency department visits for COPD **Secondary Outcomes:** length of hospitalisation, time to first hospitalisation, used of healthcare resources (hospital, office, telephone), number of medical visits all
Notes	**Funding:** Novartis Pharmaceuticals **Other identifier:** NCT01744028; CIDD001D2401

NCT01951261

Methods	**Study design:** unknown centres; open-label, parallel individual randomised controlled trial in Spain **Duration:** 24 weeks **Setting:** hospital
Participants	**Population:** 116 adults recruited from Spain **Baseline characteristics:** unknown **Inclusion criteria:** admitted to hospital with COPD exacerbation, w/o fever 48 hours, aerosol treatment every 6 hours, no other serious unstable disease, chest X-ray without new disease, suitable environment for treatment with glucocorticoid intravenous < 40 mg twice daily **Exclusion criteria:** alcoholism, institutionalisation, not stable haemodynamics, ICU or on invasive mechanical ventilation during exacerbation, intravenous medicine, neoplasia or other chronic disease in terminal situation, inability to understand or participate in study
Interventions	Measurements taken at baseline and at 1, 4, and 24 weeks **Treatment arms** 1. Telemonitoring of patient early discharge from hospital via phone and 3 nurse visits

NCT01951261 *(Continued)*

	2. Usual care with early discharge from hospital and daily visits by hospital respiratory nurses and pulmonologists
Outcomes	**Primary outcomes:** time until first exacerbation **Secondary outcomes:** STAI, SATISFAD 10, medication adherence, telemonitoring compliance, number of home visits, CAT
Notes	**Funding:** unknown **Other identifier:** NCT01951261; TELEMEDCOPD

NCT02180919

Methods	**Study design:** unknown centres; open-label, cross-over randomised controlled trial **Duration:** 52 weeks **Setting:** unknown
Participants	**Population:** 85 adults recruited from United Kingdom **Baseline characteristics:** unknown **Inclusion criteria:** heart failure patients: ≥ 18 years of age in New York Heart Association Class II to IV at time of discharge; respiratory patients: > 18 years with diagnosis of COPD or respiratory insufficiency due to chronic respiratory disease diagnosed by a respiratory physician; arterial oxygen saturation ≤ 90%, LTOT **Exclusion criteria:** < 18 years of age, cognitive impairment to interfere with study
Interventions	Measurements taken at baseline and at 3, 6, 9, and 12 months **Treatment arms** 1. CE marked Philips Motiva system linked to patients, TV then transmitting data to a secure server daily
Outcomes	**Primary outcomes:** time to first exacerbation **Secondary outcomes:** compliance with telemonitoring, self-efficacy, contact with GP, emergency department visits, HADS, Minnesota Living With Heart Failure Questionnaire, EQ-5D, CRQ
Notes	**Funding:** Royal Brompton & Harefield NHS Foundation Trust **Other identifier:** NCT02180919; 10/H0704/19

NCT02615795

Methods	**Study design:** unknown centres; open-label, parallel individual randomised controlled trial in Denmark **Duration:** 26 weeks **Setting:** hospital
Participants	**Population:** 160 adults recruited from Denmark

NCT02615795 *(Continued)*

	Baseline characteristics: unknown **Inclusion criteria:** COPD with FEV_1/FVC < 70% at all times during study, FEV_1 < 51% during inclusion and during further study, included into study during hospitalisation with exacerbation in pulmonary symptoms **Exclusion criteria:** alcohol or drug abuse, not able to use equipment or with language barrier, asthma, psychiatric issues causing disability, unstable heart disease, terminal disease, not able to given written or verbal consent
Interventions	Measurements taken at baseline and at 12 months **Treatment arms** 1. Telemonitoring using the Tunstall monitor device to send data to medical staff for review the same day
Outcomes	**Primary outcomes:** hospitalisation days **Secondary outcomes:** mortality, contact with GP, QOL: SGRQ, HADS, SF-36, physiological measurements detecting COPD exacerbation, number of self-addressed COPD exacerbations, emergency room visits COPD-related, number of hospitalisations for COPD exacerbations, length of hospital days for COPD exacerbations
Notes	**Funding:** University of Aarhus **Other identifier:** NCT02615795; UAarhusFA

NCT02901535

Methods	**Study design:** unknown centres; single-blinded, parallel individual randomised controlled trial in Brazil **Duration:** 20 weeks **Setting:** primary care
Participants	**Population:** 240 adults recruited from Brazil **Baseline characteristics:** unknown **Inclusion criteria:** Modified Medical Research Council dyspnoea > 0, spirometry from Telessaude RS-Universidad Federal do Rio Grande do Sul **Exclusion criteria:** normal spirometry, inadequate spirometry
Interventions	Measurements taken at baseline and at 20 weeks **Treatment arms** 1. Phone call nurse 45 and 90 days 2. Teleconsultation respiratory care
Outcomes	**Primary outcomes:** mMRC **Secondary outcomes:** FEV_1, FVC
Notes	**Funding:** unknown **Other identifier:** NCT02901535

NCT03183817

Methods	**Study design:** unknown centres; open-label, parallel individual randomised controlled trial in Sweden **Duration:** 104 weeks **Setting:** hospital
Participants	**Population:** 224 adults recruited from hospital in Sweden **Baseline characteristics:** unknown **Inclusion criteria:** diagnosis COPD and/or CHF, listed at a primary care centre in Narhalsan, understands written and spoken Swedish **Exclusion criteria:** no registered address, impairment preventing use of eHealth support, SPMSQ score > 6, expected survival < 12 months from disease, alcohol or drug abuse, other disease interfering with follow-up, participating in a conflicting randomised study
Interventions	Measurements taken at baseline and at 3, 6, 12, and 24 months **Treatment arms** 1. Use of computer/phone/tablet to access the eHealth platform to document health status
Outcomes	**Primary outcomes:** change in self-efficacy **Secondary outcomes:** number of admissions, health care use, self-efficacy scale, incremental cost-utility ratio, EQ-5D, HADS, shortness of breath in heart failure questionnaire, CAT, MRC
Notes	**Funding:** Goteborg University **Other identifier:** NCT03183817; PROTECT

NCT03505138

Methods	**Study design:** unknown centres; open-label, parallel individual randomised controlled trial **Duration:** 52 weeks **Setting:** unknown
Participants	**Population:** 120 adults recruited from Spain; baseline characteristics: unknown **Inclusion criteria:** diagnosis of COPD, re-admission (2+) in last year, stable 6 weeks before study, ≥ 18 years of age, able to use a tablet to track and monitor for the study **Exclusion criteria:** does not give consent, inadequate social/family support, phone coverage issues, severe comorbidities
Interventions	Measurements taken at baseline and at 12 months **Treatment arms** 1. Tablet connected to Internet to send data to pneumologist if alerts an exacerbation
Outcomes	**Primary outcomes:** re-admission in patients with COPD

NCT03505138 *(Continued)*

	Secondary outcomes: ICER, CAT, lung function (FEV_1, FVC, FEV_1/FVC), mortality, biomarker predictor of exacerbation severity, medication compliance, patient and caregiver satisfaction, EQ-5D
Notes	**Funding:** Sociedad Espanola de Neumologia y Circugia Toracica **Other identifier:** NCT03505138; CRONEX3.0

Ramos 2018

Methods	**Study design:** multi-centre, unknown blinding, parallel individual randomised controlled trial in unknown country **Duration:** 12 weeks **Setting:** not reported
Participants	**Population:** 20 adults recruited **Baseline characteristics:** % Male: 100 RM and 100 UC, Mean age: 77.0 RM and 76.63 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or depression: not reported, Baseline meds: not reported, FEV_1 (% mean): RM 48.75 and UC 42.81, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): not reported, GOLD stage: not reported, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: not reported **Inclusion criteria:** not reported **Exclusion criteria:** not reported
Interventions	Measurements taken at baseline and at end of study **Treatment arms** 1. Telephone assistance for COPD
Outcomes	**Primary outcomes:** exacerbation rate, hospital admission, mortality **Secondary outcomes:** not reported
Notes	**Funding:** not reported **Other identifier:** not reported **Other:** only conference abstract available; pilot project

Tivota 2015

Methods	**Study design:** single-centre, open-label, parallel individual randomised controlled trial in Norway **Duration:** 104 weeks **Setting:** hospital - Trondheim University Hospital
Participants	**Population:** 172 adults recruited from Department of Thoracic Medicine or Observation Unit at Trondheim University Hospital in Norway **Baseline characteristics:** % Male: 43 IC and 45 UC, Mean age: 72.5 IC and 73.1 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety or

Tivota 2015 *(Continued)*

	depression: not reported, Baseline medication: Inhaled LAMA: IC group: 39%; UC group 51%. LABA + ICS: IC group: 70%; UC group: 71%, FEV_1 (% mean): IC 34.9 and UC 33.4, FVC (% mean): not reported, FEV_1/FVC (% mean): not reported, Current smokers (n): IC 18 and UC 15, GOLD stage: III/IV, COPD exacerbations last 12 months: not reported, Hospitalisations in past 12 months: IC: 1.0 (1,1) and UC: 1.0 (1,2) **Inclusion criteria:** admission due to AECOPD, GOLD III/IV diagnosis, residing in Trondheim area, Norwegian-speaking, able to sign consent form **Exclusion criteria:** short life span due to serious disease (< 6 months' survival)
Interventions	Routine calls per month; home visits at days 3 and 14, then at 6, 12, 24 months post discharge **Treatment arms** 1. Home integrated disease management administered by specialist nurse including call centre for support, interactive e-learning, and individualised plan for self-management of disease
Outcomes	**Primary outcomes:** number of hospital admissions (AECOPD), number of in-hospital days (AECOPD), QOL (SGRQ), HADS **Secondary outcomes:** mortality, Charlson Co-morbidity Index
Notes	**Funding:** Central Norway Regional Health Authority and The Research Council of Norway **Other identifier:** NCT00702078

Venter 2012

Methods	**Study design:** multi-centre, unknown blinding, parallel individual randomised controlled trial in New Zealand **Duration:** 52 weeks **Setting:** hospital
Participants	**Population:** 20 patients recruited from Turangi or Taupo area in New Zealand **Baseline characteristics:** unknown **Inclusion criteria:** not reported **Exclusion criteria:** not reported
Interventions	Measurements taken at baseline and at 6 and 12 months **Treatment arms** 1. Touch screen computer linked to a web portal to send measurement data to local nurses 2. Enrolled in the Healthright nurse-led disease management programme (included home visits and individual care planning)
Outcomes	**Primary outcomes:** usefulness of telehealth technology, effects of health outcomes, effects of telehealth monitoring and early intervention **Secondary outcomes:** unknown
Notes	**Funding:** Lakes District Health Board, Lake Taupo Primary Health Organisation, Healthcare of New Zealand

Venter 2012 *(Continued)*

	Other identifier: unknown

Walker 2017

Methods	**Study design:** multi-centre, open-label, parallel individual randomised controlled trial in Estonia, Slovenia, Spain, Sweden, United Kingdom **Duration:** 39 weeks **Setting:** hospital, clinic, community health service
Participants	**Population:** 312 adults recruited from 6 sites (hospital, clinic, community health service) in 5 countries (Estonia, Slovenia, Spain, Sweden, UK) **Baseline characteristics:** % Male: 66 IC and 65 UC, Mean age: 71 IC and 71 UC, % White: not reported, % African: not reported, % LTOT: not reported, % Home oxygen: not reported, % Anxiety and depression: Mean depression PHQ9 score was 6.27 (IC) and Mean depression PHQ9 score was 5.97 (UC), Baseline meds: not reported, FEV_1: IC 49.4 and UC 50.4, FVC: IC 73.8 and UC 75.8, FEV_1/FVC: IC: 0.53 and UC: 0.53, Current smokers (n): not reported, GOLD stage: IC: I (3%), II (47%), III (36%), IV (15%) and UC: I (2%), II (48%), III (39%), IV (11%), COPD exacerbations last 12 months: 1 exacerbation: IC 63 (41%) and UC 59 (37%); more than 1 exacerbation: IC 91 (59%) and UC 99 (63%), Hospitalisation in past 12 months: IC 64 (42%) and UC 65 (41%) **Inclusion criteria:** GOLD grade II or higher, exacerbations or hospitalisation or both in the last year, comorbidities such as CHF, SDB, smoking pack-years > 10 years, able to provide written consent, able to use TM equipment at home, reliable mobile phone coverage at home, > 60 years of age **Exclusion criteria:** any condition likely to put patient at risk, significant visual or mental condition, planned long-time absence from home
Interventions	Measurements taken at baseline and at end of study **Treatment arms** 1. Touch screen PC to enter data and diary information daily 2. Monthly telephone interviews
Outcomes	**Primary outcomes:** time to first hospitalisation, quality of life (change in EQ-5D utility index score) **Secondary outcomes:** moderate exacerbation rate, hospitalisation, CAT, PHQ-9, MLHFQ questionnaires, cost-utility analysis
Notes	**Funding:** European Commission grant **Other identifier:** NCT01960907

AECOPD: acute exacerbations of chronic obstructive pulmonary disease; **CAT:** Chronic Obstructive Pulmonary Disease Assessment Test; **CE:** Conformity European (marked Philips Motiva System); **CES-D:** Centre for Epidemiologic Studies Depression Scale; **CHF:** congestive heart failure; **CLAHRC:** Collaborations for Leadership in Applied Health Research and Care; **COPD:** chronic obstructive pulmonary disease; **CRQ:** Chronic Respiratory Disease Questionnaire; **CWD:** chest wall disease; **DM:** diabetes mellitus; **DSL:** digital subscriber line; **ED:** emergency department; **EQ-5D:** EuroQoL 5 Dimensions Questionnaire; **EQ-5D-5L:** EuroQoL 5 Dimensions 5-Level Version Questionnaire; **EuroQoL-5D:** European Quality of Life 5 Dimension Questionnaire; **EXACT:** Exacerbations of Chronic Pulmonary Disease Tool; **FEV_1:** forced expiratory volume in one second; **FEV_1/FVC:** forced expiratory volume in one second/forced vital capacity ratio; **FVC:** forced vital capacity; **GOLD:** Global Initiative for Obstructive Lung Disease; **GOLD I:** Global Initiative for Obstructive Lung Disease stage 1; **GOLD II:** Global Initiative for Obstructive Lung Disease stage 2; **GOLD III:** Global Initiative for Obstructive Lung Disease stage 3; **GOLD IV:** Global Initiative for Obstructive Lung Disease stage 4; **GP:** general practitioner; **HADS:** Hospital Anxiety and Depression Scale; **heiQ:** Health Education Impact Questionnaire; **HF:** heart failure; **HRQOL:** health-related quality of life; **IC:** integrated care; **ICD10:** International Statistical Classification of Diseases and Related Health Problems, Tenth Edition; **ICER:** incremental cost-effectiveness ratio; **ICU:** intensive care unit; **IMC:** equivalent

to body mass index; **ISDN:** Integrated Services Digital Network; **LABA + ICS:** long-acting beta-adrenergic agonist + inhaled corticosteroid; **LAMA:** long-acting muscarinic antagonist; **LTOT:** long-term oxygen therapy; **MIC/VC:** maximal insufflation capacity/vital capacity ratio; **MLHFQ:** Minnesota Living With Heart Failure Questionnaire; **mMRC:** Modified Medical Research Council; **MRC:** Medical Research Council; **(n):** number; **NIHR:** National Institute for Health Research; **NMD:** neuromuscular disease; **nt:** number of packages of cigarettes smoked daily, number of years of smoking; **OHS:** obesity hypoventilation syndrome; **OSA:** obstructive sleep apnoea; **$PaCO_2$:** partial pressure of carbon dioxide; **PC:** primary care; **PCF:** peak cough flow; **PDA:** personal digital assistant; **pH:** power of hydrogen (acidity or basicity of aqueous solution); **PHQ-9:** Patient Health Questionnaire-9; **QOL:** quality of life; **QOL SF-36:** Health-Related Quality of Life as Measured by Short Form 36 Version 2 Questionnaire; **RM:** remote in-home telemonitoring; **SATISFAD 10:** instrument that evaluates satisfaction with home care services, self-administered; **SDB:** sleep-disordered breathing; **SF-12:** Short Form 12 Questionnaire; **SF-36:** Short Form 36 Questionnaire; **SGRQ:** St George's Respiratory Questionnaire; **SPMSQ:** Short Portable Mental Status Questionnaire; **STAI:** State-Trait Anxiety Inventory; **STAI-6:** State Trait Anxiety Inventory - 6 anxiety scores; **TLC:** total lung capacity; **TM:** telemonitoring; **TV:** television; **UC:** usual care; **UK:** United Kingdom; **w/o:** without.

Characteristics of ongoing studies *[ordered by study ID]*

NCT02756533

Study name	Impact of a telemonitoring program on the rate of hospitalizations for worsening of cardio-respiratory symptoms in COPD patients treated at home by long-term non-invasive ventilation (NIV)
Methods	**Study design:** multi-centre, double-blinding, parallel individual randomised controlled trial in France **Duration:** 52 weeks **Setting:** clinic or hospital
Participants	**Population:** 140 patients recruited from hospitals and clinics in France **Baseline characteristics:** unknown **Inclusion criteria:** ≥ 18 years of age, COPD diagnosis, Social Security coverage, hospitalised ≥ 1 time in last year for exacerbation, treated by long-term NIV **Exclusion criteria:** major protected by law, pregnant, deprived of liberty, GP or pulmonologist of patient not willing to participate, disease causing a threat to life excluding COPD
Interventions	Measurements taken unknown **Treatment arms:** • Daily telemonitoring recorded by NIV • Contacted via telephone
Outcomes	**Primary outcomes:** number of hospitalisations for cardio-respiratory symptoms **Secondary outcomes:** number of hospitalisations, mortality, detection of COPD exacerbation, length of hospitalisation, medical cost, QOL by SRI
Starting date	08.01.2016
Contact information	Jean-Christian Borel, PhD, +33762707821, j.borel@agiradom.com; Renaud Tamisier, Pr MD PhD, +33476768732, rtamisier@chu-grenoble.fr
Notes	**Funding:** University Hospital, Grenoble **Other identifier:** NCT02756533; 38RC15.179

NCT03396172

Study name	FreeDom: innovative strategy for the management of COPD exacerbations combining early hospitalisation discharge, automated oxygen weaning at home, telemedicine, and telerehabilitation
Methods	**Study design:** unknown centres, open-blinding, parallel individual randomised controlled trial in Canada **Duration:** 12 weeks **Setting:** hospital
Participants	**Population:** 100 patients recruited from hospitals in Canada **Baseline characteristics:** unknown **Inclusion criteria:** diagnosis of COPD, ex-smoker (10 pack-year history), acute exacerbation (< 15 days), oxygen therapy need (rate < 6 L/min for SpO_2 > 90%), ≥ 40 years of age **Exclusion criteria:** no consent, imminent intubation per pulmonologists, sleep apnoea, NIV used at home, non-autonomous and alone at home, lives > 50 km from hospital, already in the study within 3 months, lack of free O_2 system at time of study
Interventions	**Run-in:** at hospital before discharge. Measurements taken at baseline and at 1 and 3 months **Treatment arms** • FreeDom used for early discharge home for telemedicine and telerehab (home hospitalisation)
Outcomes	**Primary outcomes:** number of hospital days during COPD exacerbation **Secondary outcomes:** emergency department visits, hospital re-admissions, HRQL, costs of care, oxygenation, number of consultations (phone, video, rehab, home)
Starting date	05.24.2018
Contact information	Francois Lellouche, 418-656-8711 ext 3572, francois.lellouche@criucpq.ulaval.ca; Pierre-alexandre Bouchard, 418-656-8711 ext 2712, pierre-alexandre.bouchard@criucpq.ulaval.ca
Notes	**Funding:** Laval University **Other identifier:** NCT03396172; 21419

NCT03558763

Study name	Remote monitoring of patients with chronic obstructive pulmonary disease using a tablet system. A randomised cross-over pilot study of feasibility evaluation and quality of life measurements
Methods	**Study design:** unknown centres; open-label blinding, cross-over individual randomised controlled trial in Sweden **Duration:** 56 weeks **Setting:** unknown
Participants	**Population:** 70 patients recruited from Sweden **Baseline characteristics:** unknown

NCT03558763 *(Continued)*

	Inclusion criteria: diagnosis of COPD, GOLD grade D, FEV < 80% predicted, cognitive ability for study judged by investigator, living at home and able to manage daily living activities, gives informed consent and willing to participate, FEV_1/FVC (post bronchodilator) < 0.7 **Exclusion criteria:** COPD exacerbation during 1 month before study, severe disease other than COPD affecting HRQL as judged by investigator, long-term stay away from home (> 2 weeks) w/o Internet connectivity
Interventions	Measurements taken at baseline and at 26 weeks, 30 weeks, and 56 weeks **Treatment arms** • Table system telemonitoring device with weekly video calls (first 4 weeks, then monthly thereafter) • Data obtained and uploaded twice weekly
Outcomes	**Primary outcomes:** SF-12 **Secondary outcomes:** cost-utility evaluation
Starting date	06.07.2018
Contact information	None listed
Notes	**Funding:** Vastra Gotaland Region **Other identifier:** NCT03558763

NCT04080570

Study name	Remote physician care for home hospital patients
Methods	**Study design:** multi-centre, open-label, parallel individual randomised controlled trial in the United States **Duration:** 4 weeks **Setting:** 2 hospitals
Participants	**Population:** estimated 260 adults to be recruited from 2 hospitals in Massachusetts **Baseline characteristics:** unknown which characteristics **Inclusion criteria:** within 5 miles of ED, able to consent, has caregiver who can stay with the participant for the first 24 hours, primary diagnosis of COPD **Exclusion criteria:** undomiciled, on methadone, police custody, in nursing facility, domestic violence, acute delirium, end-stage kidney disease, AMI, acute cerebral vascular accident, acute haemorrhage, primary diagnosis requiring multiple/routine administration of IV narcotics for pain control, unable to walk to bedside toilet unless help at home, CT, MRI, endoscopic procedure, blood transfusion, cardiac stress test, surgery, high risk of clinical decline
Interventions	**Run in:** initial in-home visit by a physician **Treatment arms** • Telemonitoring via video by a physician
Outcomes	**Primary outcomes:** adverse events

NCT04080570 *(Continued)*

	Secondary outcomes: unplanned re-admissions after first admission, Picker Experience Questionnaire score, global experience score
Starting date	
Contact information	
Notes	**Funding:** Brigham and Women's Hospital **Other identifier:** NCT04080570

Rassouli 2018

Study name	Telehealth vs standard care COPD - an international randomised controlled trial
Methods	**Study design:** multi-centre, unknown blinding, cross-over randomised controlled trial in Switzerland **Duration:** 52 weeks **Setting:** 6 centres in Switzerland
Participants	**Population:** projected number of participants 175 from 6 centres (Cantonal Hospital St Gallen, University Hospital Basel, Fachkliniken Wangen, University Hospital Zurich, Cantonal Hospital Glarus, Cantonal Hospital Munsterlingen) **Baseline characteristics:** unknown which characteristics **Inclusion criteria:** COPD GOLD diagnosis B-D, ≥ 40 years old **Exclusion criteria:** unable to consent, unable to follow trial procedures
Interventions	Measurements taken at baseline and at 6 months (at cross-over) and 12 months; CAT scores done weekly **Treatment arms** • Integrated Telehealth web-based treatment network • Usual care; will received standard best practice
Outcomes	**Primary outcomes:** change in CAT at 6 months **Secondary outcomes:** change in SF-36, change in SGRQ, patient satisfaction
Starting date	01.05.2016
Contact information	Prof Dr Martin Brutsche, Klinik fur Pneumologie and Schlafmedizin, Kantonsspital St. Gallen, Rorschacher Strasse 95, 9007 St. Gallen, Phone: +41 71 494 11 11, Fax: +41 71 494 61 18, E-mail: martin.brutsche@kssg.ch
Notes	**Funding:** provided in future protocol **Other identifier:** EKSG-Nr: 15/184

AMI: acute myocardial infarction; **CAT:** Chronic Obstructive Pulmonary Disease Assessment Test; **COPD:** chronic obstructive pulmonary disease; **CT:** computed tomography; **ED:** emergency department; **FEV_1:** forced expiratory volume in one second; **FEV_1/FVC:** forced expiratory volume in one second/forced vital capacity ratio; **GOLD:** Global Initiative for Obstructive Lung Disease; **GOLD B:** Global Initiative for Obstructive Lung Disease - moderate; **GOLD C:** Global Initiative for Obstructive Lung Disease - severe; **GOLD D:** Global Initiative for

Obstructive Lung Disease - very severe; **GP:** general practitioner; **HRQOL:** health-related quality of life; **IV:** intravenous; **NIV:** non-invasive ventilation; **pk/yr:** pack per year; **QOL:** quality of life; **SF-12:** Short Form 12-Item Questionnaire; **SF-36:** Short Form 36-Item Questionnaire; **SGRQ:** St George's Respiratory Questionnaire; **SpO_2:** oxygen saturation; **SRI:** severe respiratory insufficiency score; **w/o:** without.

DATA AND ANALYSES

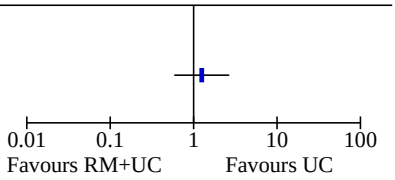
Comparison 1. Remote monitoring plus usual care vs usual care alone

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 RM + UC: exacerbations: number of people experiencing 1 or more exacerbations	1		Odds Ratio (M-H, Random, 95% CI)	Totals not selected
1.1.1 6 to < 12 months	1		Odds Ratio (M-H, Random, 95% CI)	Totals not selected
1.2 RM + UC: exacerbations: mean number of exacerbations (subgroup duration)	2		Mean Difference (IV, Random, 95% CI)	Totals not selected
1.2.1 6 to < 12 months	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
1.2.2 ≥ 12 months	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
1.3 RM + UC: quality of life: SGRQ total (subgroup duration)	3		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.3.1 6 to < 12 months	2	204	Mean Difference (IV, Random, 95% CI)	-1.49 [-9.43, 6.44]
1.3.2 ≥ 12 months	1	205	Mean Difference (IV, Random, 95% CI)	0.90 [-3.71, 5.51]
1.4 RM + UC: hospital service utilisation: mean hospital admissions (all-cause) (single)	3	342	Mean Difference (IV, Random, 95% CI)	0.09 [-0.43, 0.60]
1.5 RM + UC: hospital service utilisation: hospital admissions (COPD-related)	3	400	Std. Mean Difference (IV, Random, 95% CI)	-0.01 [-0.21, 0.18]
1.6 RM + UC: hospital service utilisation: hospital admission rate ratio (GIV)	1		Rate Ratio (IV, Random, 95% CI)	Totals not selected
1.7 RM + UC: hospital service utilisation: HR: time to first hospitalisation after start of intervention	1		Hazard Ratio (IV, Random, 95% CI)	Totals not selected
1.8 RM + UC: hospital service utilisation: hospital admissions (COPD-related) (hazard ratio)	1		Hazard Ratio (IV, Random, 95% CI)	Totals not selected
1.9 RM + UC vs UC: hospital use: time to first COPD-related re-admission	1		Hazard Ratio (IV, Random, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.10 RM + UC: hospital use: time to first COPD-related ED visit	1		Hazard Ratio (IV, Random, 95% CI)	Totals not selected
1.11 RM + UC: hospital service utilisation: length of stay (all-cause)	4	604	Mean Difference (IV, Random, 95% CI)	-0.81 [-4.83, 3.22]
1.12 RM + UC: hospital service utilisation: length of stay (all-cause) (hazard ratio)	1		Hazard Ratio (IV, Random, 95% CI)	Totals not selected
1.13 RM + UC: hospital service utilisation: length of stay (COPD-related)	3	618	Std. Mean Difference (IV, Random, 95% CI)	-0.11 [-0.30, 0.09]
1.14 RM + UC: hospital service utilisation: length of stay (COPD-related) (hazard ratio)	1		Hazard Ratio (IV, Random, 95% CI)	Totals not selected
1.15 RM + UC: mortality (all-cause)	7	927	Odds Ratio (M-H, Random, 95% CI)	0.99 [0.62, 1.58]
1.16 RM + UC: A/D: HADS anxiety (change from baseline, mean difference between groups)	4		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.16.1 26 weeks	2		Mean Difference (IV, Random, 95% CI)	1.86 [0.68, 3.04]
1.16.2 52 weeks	2		Mean Difference (IV, Random, 95% CI)	0.32 [-0.47, 1.10]
1.17 RM + UC: A/D: HADS depression (change from baseline, mean difference between groups) (single)	3	577	Mean Difference (IV, Random, 95% CI)	-0.00 [-0.76, 0.76]
1.17.1 26 weeks	1	110	Mean Difference (IV, Random, 95% CI)	-0.63 [-2.05, 0.79]
1.17.2 52 weeks	2	467	Mean Difference (IV, Random, 95% CI)	0.23 [-0.68, 1.13]
1.18 RM + UC: self-efficacy: self-efficacy for managing chronic disease (6-item scale)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
1.19 RM + UC: hospital service utilisation: length of stay (COPD-related) (subgroup duration)	3	618	Std. Mean Difference (IV, Random, 95% CI)	-0.11 [-0.30, 0.09]

Analysis 1.1. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 1: RM + UC: exacerbations: number of people experiencing 1 or more exacerbations

Study or Subgroup	RM+UC Events	RM+UC Total	UC Events	UC Total	Odds Ratio M-H, Random, 95% CI
1.1.1 6 to < 12 months					
Berkhof 2015 (1)	31	59	23	49	1.25 [0.59 , 2.67]

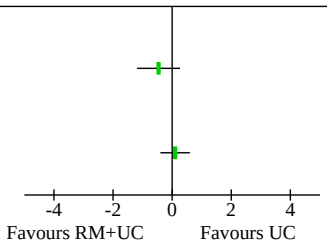


Footnotes

(1) Asynchronous: Wireless RM system + HCP monitoring, processing + feedback; 26 weeks follow up

Analysis 1.2. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 2: RM + UC: exacerbations: mean number of exacerbations (subgroup duration)

Study or Subgroup	RM+UC Mean	RM+UC SD	RM+UC Total	UC Mean	UC SD	UC Total	Mean Difference IV, Random, 95% CI
1.2.1 6 to < 12 months							
McDowell 2015 (1)	2.35	1.8	48	2.81	1.9	52	-0.46 [-1.19 , 0.27]
1.2.2 ≥ 12 months							
Pinnock 2013 (2)	1.2	1.9	97	1.1	1.6	92	0.10 [-0.40 , 0.60]



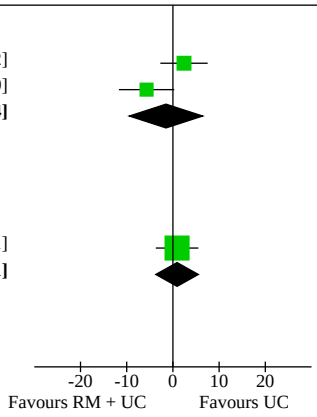
Footnotes

(1) Asynchronous: remote monitoring + usual care; 26 weeks follow up

(2) Asynchronous: remote monitoring + usual care; 52 weeks follow up

Analysis 1.3. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 3: RM + UC: quality of life: SGRQ total (subgroup duration)

Study or Subgroup	RM + UC vs UC Mean	RM + UC vs UC SD	RM + UC vs UC Total	UC Mean	UC SD	UC Total	Weight	Mean Difference IV, Random, 95% CI
1.3.1 6 to < 12 months								
Berkhof 2015 (1)	6.7	12.7	50	4.3	12.6	44	51.9%	2.40 [-2.72 , 7.52]
McDowell 2015 (2)	61.1	17	55	66.8	15	55	48.1%	-5.70 [-11.69 , 0.29]
Subtotal (95% CI)			**105**			**99**	**100.0%**	**-1.49 [-9.43 , 6.44]**
Heterogeneity: Tau² = 24.72; Chi² = 4.06, df = 1 (P = 0.04); I² = 75%								
Test for overall effect: Z = 0.37 (P = 0.71)								
1.3.2 ≥ 12 months								
Pinnock 2013 (3)	68.2	16.3	105	67.3	17.3	100	100.0%	0.90 [-3.71 , 5.51]
Subtotal (95% CI)			**105**			**100**	**100.0%**	**0.90 [-3.71 , 5.51]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.38 (P = 0.70)								



Footnotes

(1) Synchronous: in-home remote monitoring (telephone-based) + usual care; 26 weeks follow up

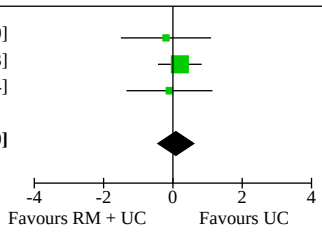
(2) Asynchronous: remote monitoring + usual care; 26 weeks follow up

(3) Asynchronous: remote monitoring + usual care; 52 weeks follow up

Analysis 1.4. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 4: RM + UC: hospital service utilisation: mean hospital admissions (all-cause) (single)

Study or Subgroup	RM + UC Mean	RM + UC SD	RM + UC Total	UC Mean	UC SD	UC Total	Weight	Mean Difference IV, Random, 95% CI
Antoniades 2012 (1)	2	2.3	22	2.2	2.1	22	15.7%	-0.20 [-1.50 , 1.10]
Pinnock 2013 (2)	2.2	2.9	128	2	2.2	128	67.0%	0.20 [-0.43 , 0.83]
Shany 2016 (2)	2.4	2	21	2.5	2.1	21	17.3%	-0.10 [-1.34 , 1.14]
Total (95% CI)			**171**			**171**	**100.0%**	**0.09 [-0.43 , 0.60]**

Heterogeneity: Tau² = 0.00; Chi² = 0.40, df = 2 (P = 0.82); I² = 0%
Test for overall effect: Z = 0.32 (P = 0.75)
Test for subgroup differences: Not applicable



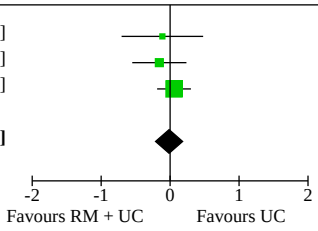
Footnotes

(1) Asynchronous: remote monitoring (in-home TeleMedCare system) + standard best practice; 52 weeks follow up
(2) Asynchronous: remote monitoring + usual care; 52 weeks follow up

Analysis 1.5. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 5: RM + UC: hospital service utilisation: hospital admissions (COPD-related)

Study or Subgroup	RM + UC Mean	RM + UC SD	RM + UC Total	UC Mean	UC SD	UC Total	Weight	Std. Mean Difference IV, Random, 95% CI
Antoniades 2012 (1)	1.3	1.7	22	1.5	1.8	22	11.0%	-0.11 [-0.70 , 0.48]
McDowell 2015 (2)	0.5	0.9	48	0.65	1	52	24.9%	-0.16 [-0.55 , 0.24]
Pinnock 2013 (3)	1.2	1.9	128	1.1	1.6	128	64.1%	0.06 [-0.19 , 0.30]
Total (95% CI)			**198**			**202**	**100.0%**	**-0.01 [-0.21 , 0.18]**

Heterogeneity: Tau² = 0.00; Chi² = 0.93, df = 2 (P = 0.63); I² = 0%
Test for overall effect: Z = 0.15 (P = 0.88)
Test for subgroup differences: Not applicable

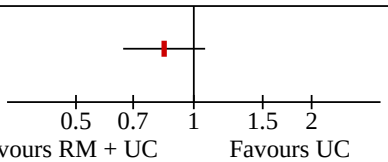


Footnotes

(1) Asynchronous: remote monitoring + standard best practice; 52 weeks follow up
(2) Asynchronous: remote monitoring + usual care; 26 weeks follow up
(3) Asynchronous: remote monitoring + usual care; 52 weeks follow up

Analysis 1.6. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 6: RM + UC: hospital service utilisation: hospital admission rate ratio (GIV)

Study or Subgroup	log[Rate Ratio]	SE	Rate Ratio IV, Random, 95% CI
Vianello 2016 (1)	-0.1744	0.123	0.84 [0.66 , 1.07]

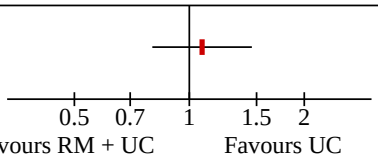


Footnotes

(1) Asynchronous: remote monitoring + usual care; 52 weeks

Analysis 1.7. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 7: RM + UC: hospital service utilisation: HR: time to first hospitalisation after start of intervention

Study or Subgroup	log[Hazard Ratio]	SE	Hazard Ratio IV, Random, 95% CI	Hazard Ratio IV, Random, 95% CI
Pinnock 2013 (1)	0.077	0.1531	1.08 [0.80 , 1.46]	

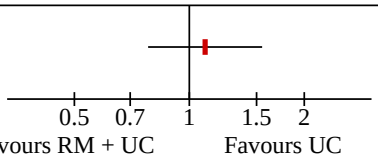


Footnotes

(1) Asynchronous: remote monitoring + usual care; 52 weeks follow up

Analysis 1.8. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 8: RM + UC: hospital service utilisation: hospital admissions (COPD-related) (hazard ratio)

Study or Subgroup	log[Hazard Ratio]	SE	Hazard Ratio IV, Random, 95% CI	Hazard Ratio IV, Random, 95% CI
Pinnock 2013 (1)	0.0953	0.1754	1.10 [0.78 , 1.55]	

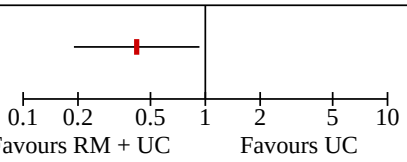


Footnotes

(1) Asynchronous: remote monitoring + usual care; 52 weeks

Analysis 1.9. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 9: RM + UC vs UC: hospital use: time to first COPD-related re-admission

Study or Subgroup	log[Hazard Ratio]	SE	Hazard Ratio IV, Random, 95% CI	Hazard Ratio IV, Random, 95% CI
Ho 2016 (1)	-0.8675	0.4047	0.42 [0.19 , 0.93]	

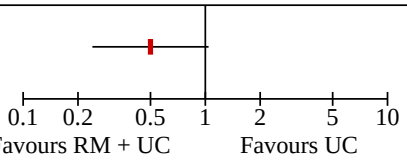


Footnotes

(1) Asynchronous: remote monitoring + usual care; 26 weeks

Analysis 1.10. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 10: RM + UC: hospital use: time to first COPD-related ED visit

Study or Subgroup	log[Hazard Ratio]	SE	Hazard Ratio IV, Random, 95% CI	Hazard Ratio IV, Random, 95% CI
Ho 2016 (1)	-0.6931	0.3745	0.50 [0.24 , 1.04]	



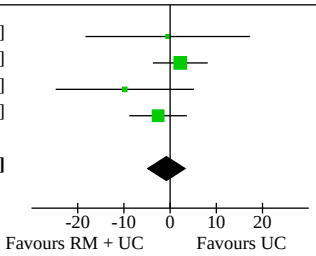
Footnotes

(1) Asynchronous: remote monitoring + usual care; 26 weeks

Analysis 1.11. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 11: RM + UC: hospital service utilisation: length of stay (all-cause)

Study or Subgroup	RM + UC Mean	RM + UC SD	RM + UC Total	UC Mean	UC SD	UC Total	Weight	Mean Difference IV, Random, 95% CI
Antoniades 2012 (1)	21.6	30.4	22	22.1	29.9	22	5.1%	-0.50 [-18.32 , 17.32]
Pinnock 2013 (2)	16.2	27.2	128	14	20.8	128	46.0%	2.20 [-3.73 , 8.13]
Shany 2016 (3)	20.6	18.5	21	30.4	29.7	21	7.2%	-9.80 [-24.77 , 5.17]
Vianello 2016 (3)	22.9	25	181	25.5	23.2	81	41.7%	-2.60 [-8.83 , 3.63]
Total (95% CI)			**352**			**252**	**100.0%**	**-0.81 [-4.83 , 3.22]**

Heterogeneity: Tau² = 0.00; Chi² = 2.69, df = 3 (P = 0.44); I² = 0%
Test for overall effect: Z = 0.39 (P = 0.69)
Test for subgroup differences: Not applicable

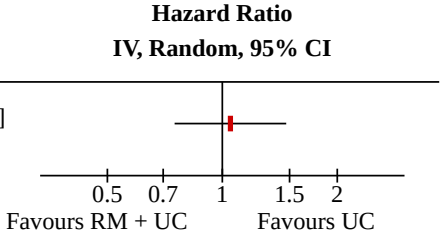


Footnotes

(1) Asynchronous: remote in-home telemonitoring (TeleMedCare system) + standard best practice; 52 weeks
(2) Asynchrnous: remote monitoring + usual care; 52 weeks
(3) Asynchronous: remote monitoring + usual care; 52 weeks

Analysis 1.12. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 12: RM + UC: hospital service utilisation: length of stay (all-cause) (hazard ratio)

Study or Subgroup	log[Hazard Ratio]	SE	Hazard Ratio IV, Random, 95% CI
Pinnock 2013 (1)	0.0488	0.1717	1.05 [0.75 , 1.47]



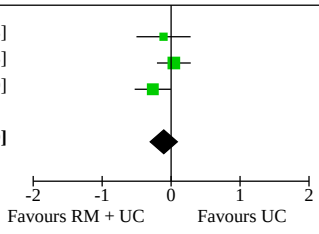
Footnotes

(1) Asynchronous: remote monitoring + usual care; 52 weeks

Analysis 1.13. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 13: RM + UC: hospital service utilisation: length of stay (COPD-related)

Study or Subgroup	RM + UC Mean	RM + UC SD	RM + UC Total	UC Mean	UC SD	UC Total	Weight	Std. Mean Difference IV, Random, 95% CI
McDowell 2015 (1)	3.4	7.7	48	4.3	8.5	52	20.6%	-0.11 [-0.50 , 0.28]
Pinnock 2013 (2)	9.5	19.1	128	8.8	15.9	128	41.6%	0.04 [-0.21 , 0.28]
Vianello 2016 (2)	18.9	15.3	181	23.3	19	81	37.8%	-0.27 [-0.53 , -0.00]
Total (95% CI)			**357**			**261**	**100.0%**	**-0.11 [-0.30 , 0.09]**

Heterogeneity: Tau² = 0.01; Chi² = 2.77, df = 2 (P = 0.25); I² = 28%
Test for overall effect: Z = 1.06 (P = 0.29)
Test for subgroup differences: Not applicable

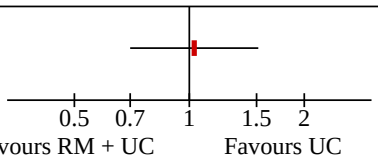


Footnotes

(1) Asynchronous: remote monitoring + usual care; 26 weeks
(2) Asynchronous: remote monitoring + usual care; 52 weeks

Analysis 1.14. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 14: RM + UC: hospital service utilisation: length of stay (COPD-related) (hazard ratio)

Study or Subgroup	log[Hazard Ratio]	SE	Hazard Ratio IV, Random, 95% CI
Pinnock 2013 (1)	0.0296	0.1971	1.03 [0.70 , 1.52]



Footnotes

(1) Asynchronous: remote monitoring + usual care; 52 weeks

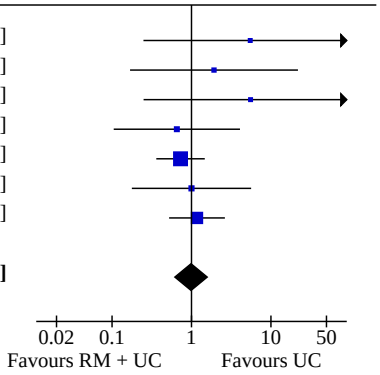
Analysis 1.15. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 15: RM + UC: mortality (all-cause)

Study or Subgroup	RM + UC Events	RM + UC Total	UC Events	UC Total	Weight	Odds Ratio M-H, Random, 95% CI
Antoniades 2012 (1)	2	22	0	22	2.3%	5.49 [0.25 , 121.18]
Berkhof 2015 (2)	2	52	1	49	3.7%	1.92 [0.17 , 21.87]
Lewis 2010 (3)	2	20	0	20	2.3%	5.54 [0.25 , 123.08]
McDowell 2015 (4)	2	55	3	55	6.5%	0.65 [0.10 , 4.08]
Pinnock 2013 (5)	16	128	21	128	44.4%	0.73 [0.36 , 1.47]
Shany 2016 (5)	3	21	3	21	7.3%	1.00 [0.18 , 5.63]
Vianello 2016 (5)	23	230	9	104	33.5%	1.17 [0.52 , 2.63]
Total (95% CI)		**528**		**399**	**100.0%**	**0.99 [0.62 , 1.58]**
Total events:	50		37			

Heterogeneity: Tau² = 0.00; Chi² = 3.77, df = 6 (P = 0.71); I² = 0%

Test for overall effect: Z = 0.06 (P = 0.96)

Test for subgroup differences: Not applicable



Footnotes

(1) Asynchronous:Remote in-home telemonitoring (TeleMedCare system) + standard best practice; 52 weeks

(2) Synchronous: Remote monitoring (telephone-based) + usual care ; 26 weeks

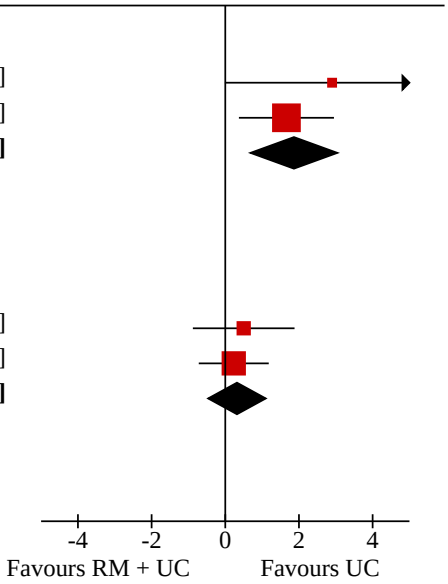
(3) Asynchronous: remote monitoring + standard care; 26 weeks

(4) Asynchronous: remote monitoring + usual care; 26 weeks

(5) Asynchronous: remote monitoring + usual care; 52 weeks

Analysis 1.16. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 16: RM + UC: A/D: HADS anxiety (change from baseline, mean difference between groups)

Study or Subgroup	MD	SE	Weight	Mean Difference IV, Random, 95% CI
1.16.1 26 weeks				
Lewis 2010 (1)	2.9	1.4847	16.4%	2.90 [-0.01 , 5.81]
McDowell 2015 (2)	1.66	0.6582	83.6%	1.66 [0.37 , 2.95]
Subtotal (95% CI)			**100.0%**	**1.86 [0.68 , 3.04]**
Heterogeneity: Tau² = 0.00; Chi² = 0.58, df = 1 (P = 0.45); I² = 0%				
Test for overall effect: Z = 3.10 (P = 0.002)				
1.16.2 52 weeks				
Pinnock 2013 (3)	0.5	0.7041	32.2%	0.50 [-0.88 , 1.88]
Vianello 2016 (3)	0.23	0.4847	67.8%	0.23 [-0.72 , 1.18]
Subtotal (95% CI)			**100.0%**	**0.32 [-0.47 , 1.10]**
Heterogeneity: Tau² = 0.00; Chi² = 0.10, df = 1 (P = 0.75); I² = 0%				
Test for overall effect: Z = 0.79 (P = 0.43)				
Test for subgroup differences: Chi² = 4.59, df = 1 (P = 0.03), I² = 78.2%				

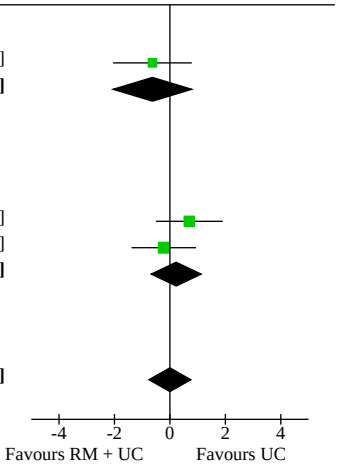


Footnotes

(1) Asynchronous: remote monitoring + standard care; 26 weeks
(2) Asynchronous: remote monitoring + usual care; 26 weeks
(3) Asynchronous: remote monitoring + usual care; 52 weeks

Analysis 1.17. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 17: RM + UC: A/D: HADS depression (change from baseline, mean difference between groups) (single)

Study or Subgroup	RM + UC Mean	RM + UC SD	RM + UC Total	UC Mean	UC SD	UC Total	Weight	Mean Difference IV, Random, 95% CI
1.17.1 26 weeks								
McDowell 2015 (1)	6.87	3.67	55	7.5	3.92	55	26.4%	-0.63 [-2.05 , 0.79]
Subtotal (95% CI)			**55**			**55**	**26.4%**	**-0.63 [-2.05 , 0.79]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.87 (P = 0.38)								
1.17.2 52 weeks								
Pinnock 2013 (2)	9.1	4.6	105	8.4	4.2	100	35.6%	0.70 [-0.50 , 1.90]
Vianello 2016 (2)	0.5	4.3	181	0.72	4.5	81	38.0%	-0.22 [-1.38 , 0.94]
Subtotal (95% CI)			**286**			**181**	**73.6%**	**0.23 [-0.68 , 1.13]**
Heterogeneity: Tau² = 0.06; Chi² = 1.16, df = 1 (P = 0.28); I² = 14%								
Test for overall effect: Z = 0.49 (P = 0.62)								
Total (95% CI)			**341**			**236**	**100.0%**	**-0.00 [-0.76 , 0.76]**
Heterogeneity: Tau² = 0.04; Chi² = 2.19, df = 2 (P = 0.33); I² = 9%								
Test for overall effect: Z = 0.00 (P = 1.00)								
Test for subgroup differences: Chi² = 1.00, df = 1 (P = 0.32), I² = 0%								

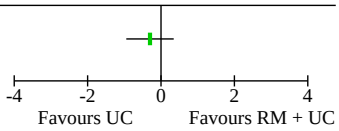


Footnotes

(1) Asynchronous: remote monitoring + usual care; 26 weeks
(2) Asynchronous: remote monitoring + usual care; 52 weeks

Analysis 1.18. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 18: RM + UC: self-efficacy: self-efficacy for managing chronic disease (6-item scale)

Study or Subgroup	RM + UC Mean	RM + UC SD	RM + UC Total	UC Mean	UC SD	UC Total	Mean Difference IV, Random, 95% CI
Pinnock 2013 (1)	5	2.2	105	5.3	2.5	100	-0.30 [-0.95 , 0.35]



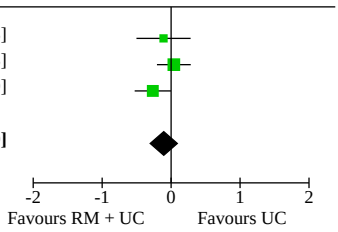
Footnotes

(1) Asynchronous: remote monitoring + usual care; 52 weeks

Analysis 1.19. Comparison 1: Remote monitoring plus usual care vs usual care alone, Outcome 19: RM + UC: hospital service utilisation: length of stay (COPD-related) (subgroup duration)

Study or Subgroup	RM + UC Mean	RM + UC SD	RM + UC Total	UC Mean	UC SD	UC Total	Weight	Std. Mean Difference IV, Random, 95% CI
McDowell 2015 (1)	3.4	7.7	48	4.3	8.5	52	20.6%	-0.11 [-0.50 , 0.28]
Pinnock 2013 (2)	9.5	19.1	128	8.8	15.9	128	41.6%	0.04 [-0.21 , 0.28]
Vianello 2016 (2)	18.9	15.3	181	23.3	19	81	37.8%	-0.27 [-0.53 , -0.00]
Total (95% CI)			**357**			**261**	**100.0%**	**-0.11 [-0.30 , 0.09]**

Heterogeneity: Tau² = 0.01; Chi² = 2.77, df = 2 (P = 0.25); I² = 28%
Test for overall effect: Z = 1.06 (P = 0.29)
Test for subgroup differences: Not applicable



Footnotes

(1) Asynchronous: remote monitoring + usual care; 26 weeks
(2) Asynchronous: remote monitoring + usual care; 52 weeks

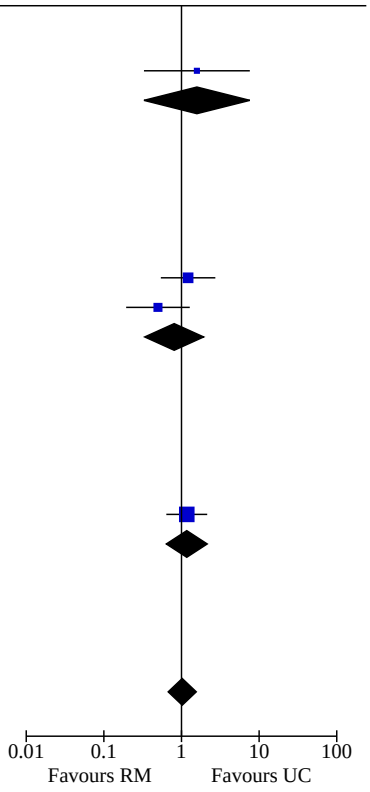
Comparison 2. Remote monitoring vs usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.1 RM vs UC: exacerbations: number of people experiencing 1 or more exacerbations	4	424	Odds Ratio (M-H, Random, 95% CI)	1.02 [0.67, 1.55]
2.1.1 3 to < 6 months	1	45	Odds Ratio (M-H, Random, 95% CI)	1.58 [0.33, 7.59]
2.1.2 6 to < 12 months	2	210	Odds Ratio (M-H, Random, 95% CI)	0.81 [0.34, 1.93]
2.1.3 ≥ 12 months	1	169	Odds Ratio (M-H, Random, 95% CI)	1.17 [0.64, 2.14]
2.2 RM vs UC: exacerbations: mean number of exacerbations (subgroup duration)	2	297	Std. Mean Difference (IV, Random, 95% CI)	0.22 [-0.01, 0.44]
2.2.1 6 to < 12 months	1	68	Std. Mean Difference (IV, Random, 95% CI)	0.33 [-0.15, 0.81]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.2.2 ≥ 12 months	1	229	Std. Mean Difference (IV, Random, 95% CI)	0.18 [-0.08, 0.44]
2.3 RM vs UC: time to first exacerbation	1		Hazard Ratio (IV, Random, 95% CI)	Totals not selected
2.4 RM vs UC: quality of life: SGRQ total (duration of treatment)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
2.4.1 3 to < 6 months	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
2.5 RM vs UC: quality of life: CAT total score	3		Mean Difference (IV, Random, 95% CI)	Subtotals only
2.5.1 6 to < 12 months	2	405	Mean Difference (IV, Random, 95% CI)	0.06 [-1.34, 1.45]
2.5.2 ≥ 12 months	1	229	Mean Difference (IV, Random, 95% CI)	0.10 [-1.42, 1.62]
2.6 RM vs UC: dyspnoea symptoms: CRQ-SAS	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
2.7 RM vs UC: hospital service utilisation: number of people admitted to hospital	2	357	Odds Ratio (M-H, Random, 95% CI)	1.21 [0.75, 1.94]
2.7.1 3 to < 6 months	1	45	Odds Ratio (M-H, Random, 95% CI)	1.58 [0.33, 7.59]
2.7.2 6 to < 12 months	1	312	Odds Ratio (M-H, Random, 95% CI)	1.18 [0.72, 1.94]
2.8 RM vs UC: hospital service utilisation: mean hospital admissions (all-cause) (single)	4	1409	Std. Mean Difference (IV, Random, 95% CI)	-0.02 [-0.22, 0.19]
2.9 RM vs UC: hospital service utilisation: hospital admissions (COPD-related)	2	129	Mean Difference (IV, Random, 95% CI)	-0.19 [-0.41, 0.02]
2.10 RM + fb vs RM: hospital service utilisation: HR: time to first hospitalisation after start of intervention	1		Hazard Ratio (IV, Random, 95% CI)	Totals not selected
2.11 RM vs UC: hospital service utilisation: length of stay (all-cause)	5	1638	Std. Mean Difference (IV, Random, 95% CI)	-0.05 [-0.19, 0.08]
2.12 RM vs UC: hospital service utilisation: length of stay (COPD-related)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
2.13 RM vs UC: mortality (all-cause)	6	798	Odds Ratio (M-H, Random, 95% CI)	0.68 [0.37, 1.25]

Analysis 2.1. Comparison 2: Remote monitoring vs usual care, Outcome 1: RM vs UC: exacerbations: number of people experiencing 1 or more exacerbations

Study or Subgroup	RM Events	RM Total	UC Events	UC Total	Weight	Odds Ratio M-H, Random, 95% CI
2.1.1 3 to < 6 months						
Jódar-Sanchez 2013 (1)	5	24	3	21	7.0%	1.58 [0.33 , 7.59]
Subtotal (95% CI)		**24**		**21**	**7.0%**	**1.58 [0.33 , 7.59]**
Total events:	5		3			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.57 (P = 0.57)						
2.1.2 6 to < 12 months						
Minguez 2017 (2)	18	55	16	56	26.5%	1.22 [0.54 , 2.73]
Pedone 2013 (3)	9	50	15	49	19.4%	0.50 [0.19 , 1.28]
Subtotal (95% CI)		**105**		**105**	**45.9%**	**0.81 [0.34 , 1.93]**
Total events:	27		31			
Heterogeneity: Tau² = 0.20; Chi² = 1.99, df = 1 (P = 0.16); I² = 50%						
Test for overall effect: Z = 0.49 (P = 0.63)						
2.1.3 ≥ 12 months						
Soriano 2018 (4)	49	87	43	82	47.1%	1.17 [0.64 , 2.14]
Subtotal (95% CI)		**87**		**82**	**47.1%**	**1.17 [0.64 , 2.14]**
Total events:	49		43			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.51 (P = 0.61)						
Total (95% CI)		**216**		**208**	**100.0%**	**1.02 [0.67 , 1.55]**
Total events:	81		77			
Heterogeneity: Tau² = 0.00; Chi² = 2.90, df = 3 (P = 0.41); I² = 0%						
Test for overall effect: Z = 0.10 (P = 0.92)						
Test for subgroup differences: Chi² = 0.73, df = 2 (P = 0.70), I² = 0%						

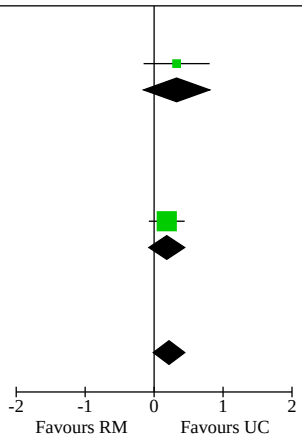


Footnotes

(1) Asynchronous: remote monitoring; 17 weeks
(2) Asynchronous: remote monitoring; 26 weeks
(3) Synchronous: remote monitoring via Bluetooth; 39 weeks
(4) Asynchronous: remote monitoring via hub Internet connection; 52 weeks

Analysis 2.2. Comparison 2: Remote monitoring vs usual care, Outcome 2: RM vs UC: exacerbations: mean number of exacerbations (subgroup duration)

Study or Subgroup	RM Mean	RM SD	RM Total	UC Mean	UC SD	UC Total	Weight	Std. Mean Difference IV, Random, 95% CI
2.2.1 6 to < 12 months								
Stamenova 2020 (1)	0.8	1.13	35	0.48	0.76	33	22.7%	0.33 [-0.15 , 0.81]
Subtotal (95% CI)			**35**			**33**	**22.7%**	**0.33 [-0.15 , 0.81]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 1.34 (P = 0.18)								
2.2.2 ≥ 12 months								
Soriano 2018 (2)	1.1	1.13	115	0.9	1.04	114	77.3%	0.18 [-0.08 , 0.44]
Subtotal (95% CI)			**115**			**114**	**77.3%**	**0.18 [-0.08 , 0.44]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 1.39 (P = 0.17)								
Total (95% CI)			**150**			**147**	**100.0%**	**0.22 [-0.01 , 0.44]**
Heterogeneity: Tau² = 0.00; Chi² = 0.27, df = 1 (P = 0.61); I² = 0%								
Test for overall effect: Z = 1.86 (P = 0.06)								
Test for subgroup differences: Chi² = 0.27, df = 1 (P = 0.61), I² = 0%								



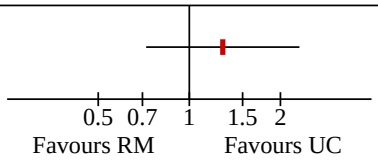
Footnotes

(1) Asynchronous: remote monitoring with Cloud DX; 26 weeks

(2) Asynchronous: remote monitoring via hub Internet connection; 52 weeks

Analysis 2.3. Comparison 2: Remote monitoring vs usual care, Outcome 3: RM vs UC: time to first exacerbation

Study or Subgroup	log[Hazard Ratio]	SE	Hazard Ratio IV, Random, 95% CI
Minguez 2017 (1)	0.2546	0.2975	1.29 [0.72 , 2.31]

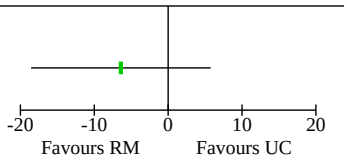


Footnotes

(1) Asynchronous: remote monitoring daily; 26 weeks

Analysis 2.4. Comparison 2: Remote monitoring vs usual care, Outcome 4: RM vs UC: quality of life: SGRQ total (duration of treatment)

Study or Subgroup	RM Mean	RM SD	RM Total	UC Mean	UC SD	UC Total	Mean Difference IV, Random, 95% CI
2.4.1 3 to < 6 months							
Jódar-Sanchez 2013 (1)	-10.9	21.9	24	-4.5	19.7	21	-6.40 [-18.56 , 5.76]

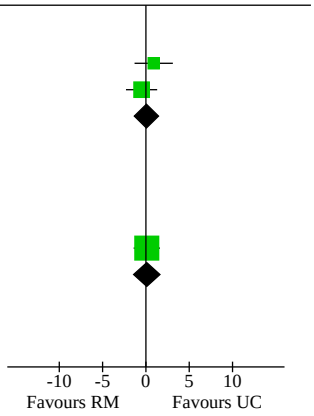


Footnotes

(1) Asynchronous: remote monitoring via hub; 17 weeks

Analysis 2.5. Comparison 2: Remote monitoring vs usual care, Outcome 5: RM vs UC: quality of life: CAT total score

Study or Subgroup	RM Mean	RM SD	RM Total	UC Mean	UC SD	UC Total	Weight	Mean Difference IV, Random, 95% CI
2.5.1 6 to < 12 months								
Minguez 2017 (1)	9.6	6.3	49	8.7	4.9	52	39.9%	0.90 [-1.31 , 3.11]
Walker 2018 (2)	16.7	7.71	150	17.2	8.3	154	60.1%	-0.50 [-2.30 , 1.30]
Subtotal (95% CI)			**199**			**206**	**100.0%**	**0.06 [-1.34 , 1.45]**
Heterogeneity: Tau² = 0.00; Chi² = 0.93, df = 1 (P = 0.34); I² = 0%								
Test for overall effect: Z = 0.08 (P = 0.93)								
2.5.2 ≥ 12 months								
Soriano 2018 (3)	21.5	5.6	115	21.4	6.1	114	100.0%	0.10 [-1.42 , 1.62]
Subtotal (95% CI)			**115**			**114**	**100.0%**	**0.10 [-1.42 , 1.62]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.13 (P = 0.90)								
Test for subgroup differences: Chi² = 0.00, df = 1 (P = 0.97), I² = 0%								

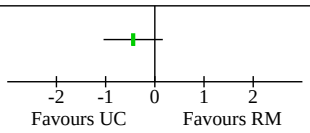


Footnotes

(1) Asynchronous: remote monitoring; 26 weeks
(2) Asynchronous: remote monitoring + set phone calls; 39 weeks
(3) Asynchronous: remote monitoring via hub Internet connection; 52 weeks

Analysis 2.6. Comparison 2: Remote monitoring vs usual care, Outcome 6: RM vs UC: dyspnoea symptoms: CRQ-SAS

Study or Subgroup	RM Mean	RM SD	RM Total	UC Mean	UC SD	UC Total	Mean Difference IV, Random, 95% CI
De San Miguel 2013 (1)	3.72	1.31	35	4.16	1.26	35	-0.44 [-1.04 , 0.16]

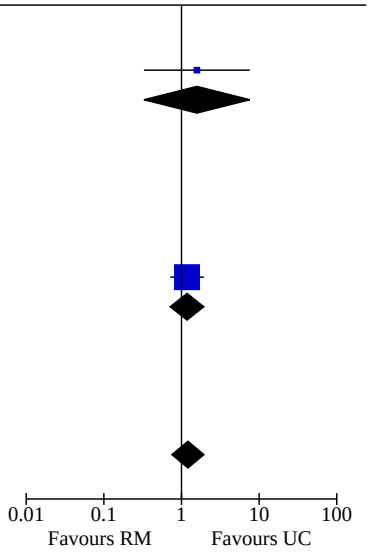


Footnotes

(1) Asynchronous: remote monitoring via HealthHub; 26 weeks

Analysis 2.7. Comparison 2: Remote monitoring vs usual care, Outcome 7: RM vs UC: hospital service utilisation: number of people admitted to hospital

Study or Subgroup	RM Events	RM Total	UC Events	UC Total	Weight	Odds Ratio M-H, Random, 95% CI
2.7.1 3 to < 6 months						
Jódar-Sanchez 2013 (1)	5	24	3	21	9.1%	1.58 [0.33 , 7.59]
Subtotal (95% CI)		**24**		**21**	**9.1%**	**1.58 [0.33 , 7.59]**
Total events:	5		3			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.57 (P = 0.57)						
2.7.2 6 to < 12 months						
Walker 2018 (2)	45	154	41	158	90.9%	1.18 [0.72 , 1.94]
Subtotal (95% CI)		**154**		**158**	**90.9%**	**1.18 [0.72 , 1.94]**
Total events:	45		41			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.65 (P = 0.52)						
Total (95% CI)		**178**		**179**	**100.0%**	**1.21 [0.75 , 1.94]**
Total events:	50		44			
Heterogeneity: Tau² = 0.00; Chi² = 0.12, df = 1 (P = 0.73); I² = 0%						
Test for overall effect: Z = 0.79 (P = 0.43)						
Test for subgroup differences: Chi² = 0.12, df = 1 (P = 0.73), I² = 0%						



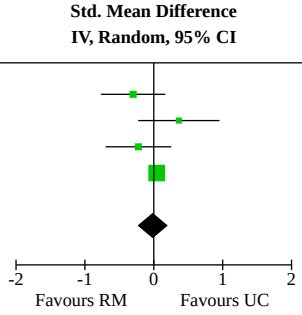
Footnotes

(1) Asynchronous: remote monitoring via hub; 17 weeks

(2) Asynchronous: remote monitoring + set phone calls; 39 weeks

Analysis 2.8. Comparison 2: Remote monitoring vs usual care, Outcome 8: RM vs UC: hospital service utilisation: mean hospital admissions (all-cause) (single)

Study or Subgroup	RM Mean	RM SD	RM Total	UC Mean	UC SD	UC Total	Weight	Std. Mean Difference IV, Random, 95% CI
De San Miguel 2013 (1)	0.44	0.73	36	0.74	1.2	35	15.1%	-0.30 [-0.77 , 0.17]
Jódar-Sanchez 2013 (2)	0.38	0.82	24	0.14	0.36	21	10.2%	0.36 [-0.23 , 0.95]
Stamenova 2020 (3)	0.15	0.42	35	0.3	0.85	33	14.6%	-0.22 [-0.70 , 0.25]
Udsen 2017 (4)	0.5	1.2	578	0.45	1.2464	647	60.0%	0.04 [-0.07 , 0.15]
Total (95% CI)			**673**			**736**	**100.0%**	**-0.02 [-0.22 , 0.19]**
Heterogeneity: Tau² = 0.01; Chi² = 4.22, df = 3 (P = 0.24); I² = 29%								
Test for overall effect: Z = 0.15 (P = 0.88)								
Test for subgroup differences: Not applicable								



Footnotes

(1) Asynchronous: remote monitoring via HealthHub; 26 weeks

(2) Asynchronous: remote monitoring via hub; 17 weeks

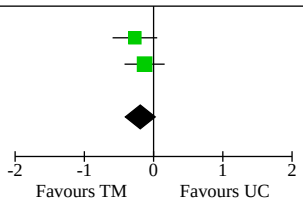
(3) Asynchronous: remote monitoring with Cloud DX; 26 weeks

(4) Asynchronous: remote monitoring via wireless transmission; 52 weeks

Analysis 2.9. Comparison 2: Remote monitoring vs usual care, Outcome 9: RM vs UC: hospital service utilisation: hospital admissions (COPD-related)

Study or Subgroup	TM Mean	TM SD	TM Total	UC Mean	UC SD	UC Total	Weight	Mean Difference IV, Random, 95% CI
De San Miguel 2013 (1)	0.22	0.48	36	0.49	0.85	35	44.7%	-0.27 [-0.59 , 0.05]
Stamenova 2020 (2)	0.05	0.22	25	0.18	0.81	33	55.3%	-0.13 [-0.42 , 0.16]
Total (95% CI)			**61**			**68**	**100.0%**	**-0.19 [-0.41 , 0.02]**

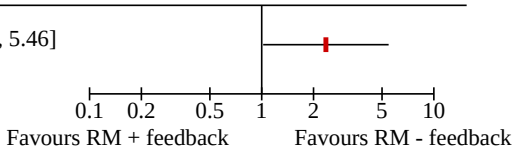
Heterogeneity: Tau² = 0.00; Chi² = 0.40, df = 1 (P = 0.53); I² = 0%
Test for overall effect: Z = 1.75 (P = 0.08)
Test for subgroup differences: Not applicable



Footnotes
(1) Asynchronous: remote monitoring via HealthHub; 26 weeks
(2) Asynchronous: remote monitoring with Cloud DX; 26 weeks

Analysis 2.10. Comparison 2: Remote monitoring vs usual care, Outcome 10: RM + fb vs RM: hospital service utilisation: HR: time to first hospitalisation after start of intervention

Study or Subgroup	log[Hazard Ratio]	SE	Hazard Ratio IV, Random, 95% CI
Sink 2020 (1)	0.8587	0.428	2.36 [1.02 , 5.46]

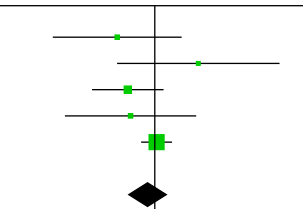


Footnotes
(1) Asynchronous: remote monitoring; 34 weeks

Analysis 2.11. Comparison 2: Remote monitoring vs usual care, Outcome 11: RM vs UC: hospital service utilisation: length of stay (all-cause)

Study or Subgroup	TM Mean	TM SD	TM Total	UC Mean	UC SD	UC Total	Weight	Std. Mean Difference IV, Random, 95% CI
De San Miguel 2013 (1)	2.9	7.3	36	5.2	9.3	35	7.8%	-0.27 [-0.74 , 0.19]
Jódar-Sanchez 2013 (2)	4.4	12.2	24	1.4	4	21	5.0%	0.32 [-0.27 , 0.91]
Soriano 2018 (3)	18.9	16	115	22.4	19.5	114	21.4%	-0.20 [-0.46 , 0.06]
Stamenova 2020 (4)	0.29	1.18	35	0.64	2.55	33	7.5%	-0.18 [-0.65 , 0.30]
Udsen 2017 (5)	2.7	7.4	578	2.6	7.9	647	58.3%	0.01 [-0.10 , 0.13]
Total (95% CI)			**788**			**850**	**100.0%**	**-0.05 [-0.19 , 0.08]**

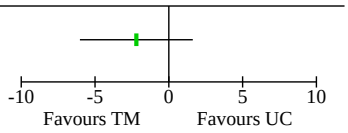
Heterogeneity: Tau² = 0.00; Chi² = 4.84, df = 4 (P = 0.30); I² = 17%
Test for overall effect: Z = 0.76 (P = 0.45)
Test for subgroup differences: Not applicable



Footnotes
(1) Asynchronous: remote monitoring via HealthHub; 26 weeks
(2) Asynchronous: remote monitoring via hub; 17 weeks
(3) Asynchronous: remote monitoring via hub Internet connection; 52 weeks
(4) Asynchronous: remote monitoring with Cloud DX; 26 weeks
(5) Asynchronous: remote monitoring via wireless transmission; 52 weeks

Analysis 2.12. Comparison 2: Remote monitoring vs usual care, Outcome 12: RM vs UC: hospital service utilisation: length of stay (COPD-related)

Study or Subgroup	TM Mean	TM SD	TM Total	UC Mean	UC SD	UC Total	Mean Difference IV, Random, 95% CI
De San Miguel 2013 (1)	2.4	7.2	36	4.6	9.1	35	-2.20 [-6.02 , 1.62]



Footnotes

(1) Asynchronous: remote monitoring via HealthHub; 26 weeks

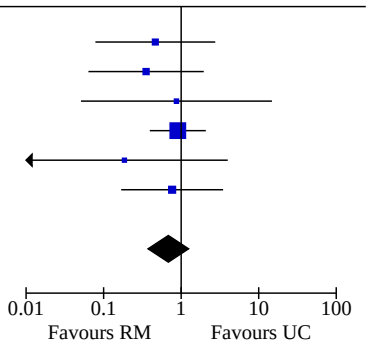
Analysis 2.13. Comparison 2: Remote monitoring vs usual care, Outcome 13: RM vs UC: mortality (all-cause)

Study or Subgroup	RM Events	RM Total	UC Events	UC Total	Weight	Odds Ratio M-H, Random, 95% CI
Calvo 2014 (1)	2	30	4	30	11.4%	0.46 [0.08 , 2.75]
De San Miguel 2013 (2)	2	36	5	35	12.3%	0.35 [0.06 , 1.95]
Jódar-Sanchez 2013 (3)	1	24	1	21	4.5%	0.87 [0.05 , 14.82]
Soriano 2018 (4)	12	115	13	114	52.2%	0.91 [0.39 , 2.08]
Stamenova 2020 (5)	0	41	2	40	3.8%	0.19 [0.01 , 3.99]
Walker 2018 (6)	3	154	4	158	15.7%	0.76 [0.17 , 3.48]
Total (95% CI)		**400**		**398**	**100.0%**	**0.68 [0.37 , 1.25]**
Total events:	20		29			

Heterogeneity: Tau² = 0.00; Chi² = 1.94, df = 5 (P = 0.86); I² = 0%

Test for overall effect: Z = 1.24 (P = 0.21)

Test for subgroup differences: Not applicable



Footnotes

(1) Aysnchronous: remote monitoring (telephone + modem); 30 weeks
(2) Asynchronous: remote monitoring via HealthHub; 26 weeks
(3) Asynchronous: remote monitoring COPD via hub; 17 weeks
(4) Asynchronous: remote monitoring via hub Internet connection; 52 weeks
(5) Asynchronous: remote monitoring with Cloud DX ; 26 weeks
(6) Asynchronous: remote monitoring + set phone calls; 39 weeks

Comparison 3. Multi-component vs usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.1 Multi: exacerbations: number of people experiencing at least 1 exacerbation/moderate to severe exacerbation (52 weeks)	3	955	Odds Ratio (M-H, Random, 95% CI)	0.98 [0.74, 1.28]
3.2 Multi: exacerbations: time to first exacerbation (hazard ratio)	1		Hazard Ratio (IV, Random, 95% CI)	Totals not selected
3.3 Multi: quality of life: SGRQ total	4		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.3.1 3 to < 6 months	1	38	Mean Difference (IV, Random, 95% CI)	-9.70 [-18.32, -1.08]

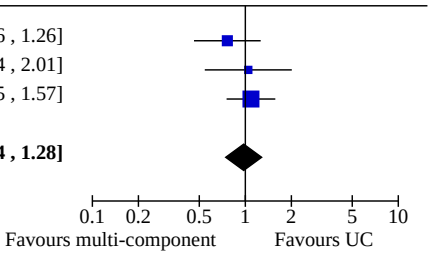
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.3.2 6 to < 12 months	1	40	Mean Difference (IV, Random, 95% CI)	7.00 [-4.79, 18.79]
3.3.3 ≥ 12 months	2	203	Mean Difference (IV, Random, 95% CI)	-1.09 [-6.24, 4.05]
3.4 Multi: quality of life: SGRQ total (GIV)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.4.1 ≥ 12 months	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.5 Multi: quality of life: CAT	2	521	Mean Difference (IV, Random, 95% CI)	-3.93 [-7.75, -0.12]
3.6 Multi: hospital use: number of people who had at least 1 hospital admission (26 or 52 weeks)	2	447	Odds Ratio (M-H, Random, 95% CI)	0.81 [0.55, 1.18]
3.7 Multi: hospital use: length of stay (mean days)	2	523	Mean Difference (IV, Random, 95% CI)	-0.66 [-2.40, 1.08]
3.7.1 6 to < 12 months	2	523	Mean Difference (IV, Random, 95% CI)	-0.66 [-2.40, 1.08]
3.8 Multi: hospital use: COPD-related length of stay (days) (26 weeks)	2	523	Mean Difference (IV, Random, 95% CI)	-0.47 [-1.49, 0.55]
3.9 Multi: hospital use: number of people re-admitted (all-cause)	3	344	Odds Ratio (M-H, Random, 95% CI)	0.50 [0.31, 0.81]
3.9.1 3 to < 6 months	1	132	Odds Ratio (M-H, Random, 95% CI)	0.53 [0.21, 1.37]
3.9.2 6 to < 12 months	1	57	Odds Ratio (M-H, Random, 95% CI)	0.81 [0.29, 2.30]
3.9.3 ≥ 12 months	1	155	Odds Ratio (M-H, Random, 95% CI)	0.40 [0.21, 0.78]
3.10 Multi: hospital use: hospital re-admission (hazard ratio)	3		Hazard Ratio (IV, Random, 95% CI)	0.77 [0.38, 1.57]
3.10.1 3 to < 6 months	1		Hazard Ratio (IV, Random, 95% CI)	0.56 [0.23, 1.36]
3.10.2 6 to < 12 months	1		Hazard Ratio (IV, Random, 95% CI)	2.01 [0.71, 5.69]
3.10.3 ≥ 12 months	1		Hazard Ratio (IV, Random, 95% CI)	0.55 [0.35, 0.86]
3.11 Multi: mortality (all-cause)	9	1886	Odds Ratio (M-H, Random, 95% CI)	0.62 [0.39, 1.01]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.11.1 3 to < 6 months	2	172	Odds Ratio (M-H, Random, 95% CI)	0.20 [0.01, 4.25]
3.11.2 6 to < 12 months	3	604	Odds Ratio (M-H, Random, 95% CI)	0.83 [0.46, 1.51]
3.11.3 ≥ 12 months	4	1110	Odds Ratio (M-H, Random, 95% CI)	0.52 [0.22, 1.22]
3.12 Multi: AE: number of people who had an adverse event (52 weeks) (add to SOF table)	2	485	Odds Ratio (M-H, Random, 95% CI)	0.91 [0.62, 1.33]
3.13 Multi: A/D: HADS total	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.14 HADS-A and HADS-D	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.14.1 HADS-A	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.14.2 HADS-D	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.15 Multi: satisfaction: client satisfaction questionnaire	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

Analysis 3.1. Comparison 3: Multi-component vs usual care, Outcome 1: Multi: exacerbations: number of people experiencing at least 1 exacerbation/moderate to severe exacerbation (52 weeks)

Study or Subgroup	Multi-component Events	Total	UC Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Bourbeau 2016 (1)	112	157	124	162	28.9%	0.76 [0.46 , 1.26]
Farmer 2017 (2)	66	110	33	56	17.0%	1.05 [0.54 , 2.01]
Rose 2018 (3)	140	236	134	234	54.1%	1.09 [0.75 , 1.57]
Total (95% CI)		**503**		**452**	**100.0%**	**0.98 [0.74 , 1.28]**
Total events:	318		291			

Heterogeneity: Tau² = 0.00; Chi² = 1.31, df = 2 (P = 0.52); I² = 0%
Test for overall effect: Z = 0.18 (P = 0.86)
Test for subgroup differences: Not applicable

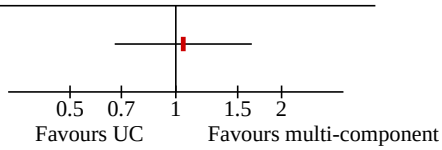


Footnotes

(1) Asynchronous: Remote monitoring (telephone/web) + self-management education; 52 weeks
(2) Asynchronous: remote monitoring + self-management support; 52 weeks
(3) Synchronous: remote consultations (telephone)+education+individualised plan for self-management; 52 weeks

Analysis 3.2. Comparison 3: Multi-component vs usual care, Outcome 2: Multi: exacerbations: time to first exacerbation (hazard ratio)

Study or Subgroup	log[Hazard Ratio]	SE	Hazard Ratio IV, Random, 95% CI
Farmer 2017 (1)	0.0488	0.2292	1.05 [0.67 , 1.65]

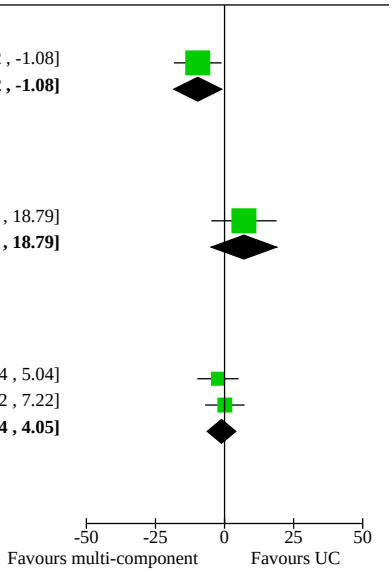


Footnotes

(1) Asynchronous: remote monitoring + self-management support; 52 weeks

Analysis 3.3. Comparison 3: Multi-component vs usual care, Outcome 3: Multi: quality of life: SGRQ total

Study or Subgroup	Multi-component Mean	SD	Total	UC Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.3.1 3 to < 6 months								
Koff 2009 (1)	-10.3	14.8	19	-0.6	12.2	19	100.0%	-9.70 [-18.32 , -1.08]
Subtotal (95% CI)			**19**			**19**	**100.0%**	**-9.70 [-18.32 , -1.08]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 2.20 (P = 0.03)								
3.3.2 6 to < 12 months								
Jakobsen 2015 (2)	55	19	21	48	19	19	100.0%	7.00 [-4.79 , 18.79]
Subtotal (95% CI)			**21**			**19**	**100.0%**	**7.00 [-4.79 , 18.79]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 1.16 (P = 0.24)								
3.3.3 ≥ 12 months								
Casas 2006 (3)	-13.4	13.4	21	-11	15.5	41	47.8%	-2.40 [-9.84 , 5.04]
Farmer 2017 (4)	56.9	19.5	93	56.8	20.9	48	52.2%	0.10 [-7.02 , 7.22]
Subtotal (95% CI)			**114**			**89**	**100.0%**	**-1.09 [-6.24 , 4.05]**
Heterogeneity: Tau² = 0.00; Chi² = 0.23, df = 1 (P = 0.63); I² = 0%								
Test for overall effect: Z = 0.42 (P = 0.68)								
Test for subgroup differences: Chi² = 5.42, df = 2 (P = 0.07), I² = 63.1%								

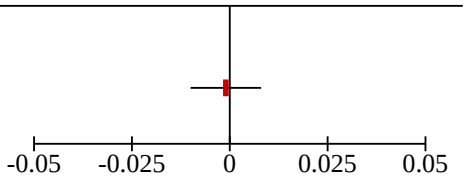


Footnotes

(1) Asynchronous: integrated care: education+teaching+remote monitoring; 39 weeks
(2) Asynchronous/synchronous: remote monitoring + video conferencing (on discharge); 26 weeks
(3) Asynchronous: integrated care intervention; 52 weeks
(4) Asynchronous: remote monitoring + self-management support; 52 weeks

Analysis 3.4. Comparison 3: Multi-component vs usual care, Outcome 4: Multi: quality of life: SGRQ total (GIV)

Study or Subgroup	MD	SE	Mean Difference IV, Random, 95% CI
3.4.1 ≥ 12 months			
Rose 2018 (1)	-0.001	0.0046	-0.00 [-0.01 , 0.01]



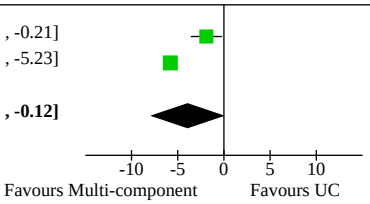
Footnotes

(1) Synchronous: remote consultations (telephone)+education+individualised plan for self-management; 52 weeks

Analysis 3.5. Comparison 3: Multi-component vs usual care, Outcome 5: Multi: quality of life: CAT

Study or Subgroup	Multi-component Mean	SD	Total	UC Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Ringbaek 2015 (1)	25.6	6.9	141	27.5	7.5	140	47.8%	-1.90 [-3.59 , -0.21]
Yan 2018 (2)	12.8	1.7	120	18.6	2.7	120	52.2%	-5.80 [-6.37 , -5.23]
Total (95% CI)			**261**			**260**	**100.0%**	**-3.93 [-7.75 , -0.12]**

Heterogeneity: Tau² = 7.19; Chi² = 18.45, df = 1 (P < 0.0001); I² = 95%
Test for overall effect: Z = 2.02 (P = 0.04)
Test for subgroup differences: Not applicable

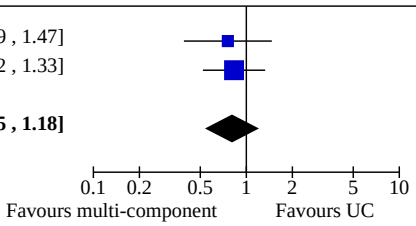


Footnotes
(1) Asynchronous: remote monitoring + video consultation + standard care; 26 weeks
(2) Synchronous: remote monitoring + remote consultation; 52 weeks

Analysis 3.6. Comparison 3: Multi-component vs usual care, Outcome 6: Multi: hospital use: number of people who had at least 1 hospital admission (26 or 52 weeks)

Study or Subgroup	Multi-component Events	Total	UC Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Farmer 2017 (1)	38	110	23	56	33.4%	0.76 [0.39 , 1.47]
Ringbaek 2015 (2)	66	141	72	140	66.6%	0.83 [0.52 , 1.33]
Total (95% CI)		**251**		**196**	**100.0%**	**0.81 [0.55 , 1.18]**
Total events:	104		95			

Heterogeneity: Tau² = 0.00; Chi² = 0.05, df = 1 (P = 0.82); I² = 0%
Test for overall effect: Z = 1.11 (P = 0.27)
Test for subgroup differences: Not applicable



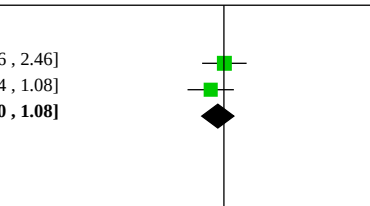
Footnotes
(1) Asynchronous: remote monitoring + self-management support; 52 weeks
(2) Asynchronous: remote monitoring + video consultation + standard care; 26 weeks

Analysis 3.7. Comparison 3: Multi-component vs usual care, Outcome 7: Multi: hospital use: length of stay (mean days)

Study or Subgroup	Multi-component Mean	SD	Total	UC Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.7.1 6 to < 12 months								
Ringbaek 2015 (1)	5.35	11.2	141	5.3	9.3	140	52.0%	0.05 [-2.36 , 2.46]
Sorknaes 2013 (2)	4.94	8.24	121	6.37	11.4	121	48.0%	-1.43 [-3.94 , 1.08]
Subtotal (95% CI)			**262**			**261**	**100.0%**	**-0.66 [-2.40 , 1.08]**
Total (95% CI)			**262**			**261**	**100.0%**	**-0.66 [-2.40 , 1.08]**

Heterogeneity: Tau² = 0.00; Chi² = 0.70, df = 1 (P = 0.40); I² = 0%
Test for overall effect: Z = 0.75 (P = 0.46)

Heterogeneity: Tau² = 0.00; Chi² = 0.70, df = 1 (P = 0.40); I² = 0%
Test for overall effect: Z = 0.75 (P = 0.46)
Test for subgroup differences: Not applicable

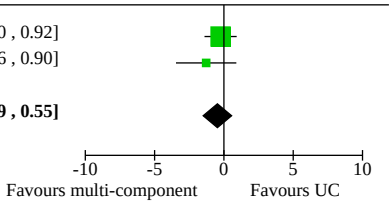


Footnotes
(1) Asynchronous: remote monitoring + video consultation + standard care; 26 weeks
(2) Asynchronous: remote monitoring + remote consultation (telephone); 26 weeks

Analysis 3.8. Comparison 3: Multi-component vs usual care, Outcome 8: Multi: hospital use: COPD-related length of stay (days) (26 weeks)

Study or Subgroup	Multi-component Mean	SD	Total	UC Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Ringbaek 2015 (1)	1.76	5.3	141	2	4.6	140	77.9%	-0.24 [-1.40 , 0.92]
Sorknaes 2013 (2)	3.88	7.39	121	5.16	9.73	121	22.1%	-1.28 [-3.46 , 0.90]
Total (95% CI)			**262**			**261**	**100.0%**	**-0.47 [-1.49 , 0.55]**

Heterogeneity: Tau² = 0.00; Chi² = 0.68, df = 1 (P = 0.41); I² = 0%
Test for overall effect: Z = 0.90 (P = 0.37)
Test for subgroup differences: Not applicable

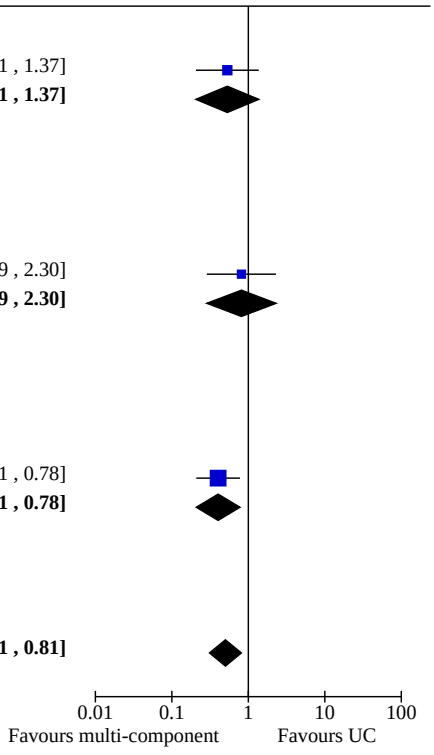


Footnotes
(1) Asynchronous: remote monitoring + video consultation + standard care; 26 weeks
(2) Synchronous: remote monitoring + video consultation+ education+usual care; 26 weeks

Analysis 3.9. Comparison 3: Multi-component vs usual care, Outcome 9: Multi: hospital use: number of people re-admitted (all-cause)

Study or Subgroup	Multi-component Events	Total	UC Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
3.9.1 3 to < 6 months						
Ritchie 2016 (1)	8	65	14	67	25.6%	0.53 [0.21 , 1.37]
Subtotal (95% CI)		**65**		**67**	**25.6%**	**0.53 [0.21 , 1.37]**
Total events:	8		14			
Heterogeneity: Not applicable						
Test for overall effect: Z = 1.31 (P = 0.19)						
3.9.2 6 to < 12 months						
Jakobsen 2015 (2)	13	29	14	28	21.2%	0.81 [0.29 , 2.30]
Subtotal (95% CI)		**29**		**28**	**21.2%**	**0.81 [0.29 , 2.30]**
Total events:	13		14			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.39 (P = 0.70)						
3.9.3 ≥ 12 months						
Casas 2006 (3)	29	65	60	90	53.2%	0.40 [0.21 , 0.78]
Subtotal (95% CI)		**65**		**90**	**53.2%**	**0.40 [0.21 , 0.78]**
Total events:	29		60			
Heterogeneity: Not applicable						
Test for overall effect: Z = 2.71 (P = 0.007)						
Total (95% CI)		**159**		**185**	**100.0%**	**0.50 [0.31 , 0.81]**
Total events:	50		88			

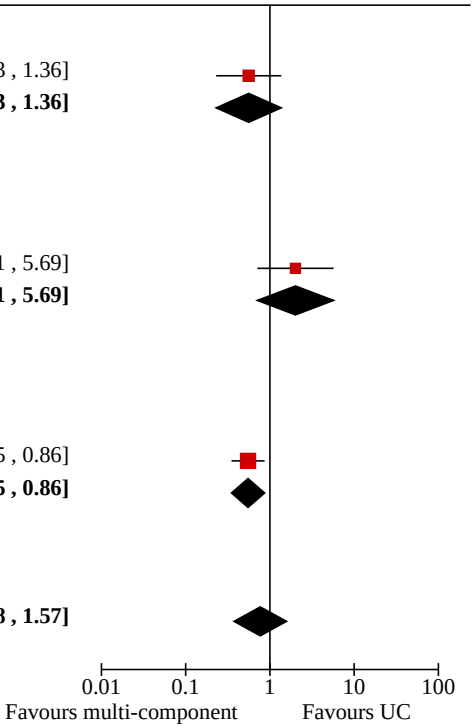
Heterogeneity: Tau² = 0.00; Chi² = 1.27, df = 2 (P = 0.53); I² = 0%
Test for overall effect: Z = 2.82 (P = 0.005)
Test for subgroup differences: Chi² = 1.27, df = 2 (P = 0.53), I² = 0%



Footnotes
(1) Asynchronous: E-coach platform + remote monitoring + self management + education; 12 weeks
(2) Asynchronous and synchronous: remote monitoring + video conferencing; 26 weeks
(3) Asynchronous: Integrated care + individual plan + telephone calls; 52 weeks

Analysis 3.10. Comparison 3: Multi-component vs usual care, Outcome 10: Multi: hospital use: hospital re-admission (hazard ratio)

Study or Subgroup	log[Hazard Ratio]	SE	Weight	Hazard Ratio IV, Random, 95% CI
3.10.1 3 to < 6 months				
Ritchie 2016 (1)	-0.5798	0.454	29.7%	0.56 [0.23 , 1.36]
Subtotal (95% CI)			**29.7%**	**0.56 [0.23 , 1.36]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 1.28 (P = 0.20)				
3.10.2 6 to < 12 months				
Jakobsen 2015 (2)	0.6981	0.5309	25.4%	2.01 [0.71 , 5.69]
Subtotal (95% CI)			**25.4%**	**2.01 [0.71 , 5.69]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 1.31 (P = 0.19)				
3.10.3 ≥ 12 months				
Casas 2006 (3)	-0.5978	0.2306	44.9%	0.55 [0.35 , 0.86]
Subtotal (95% CI)			**44.9%**	**0.55 [0.35 , 0.86]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 2.59 (P = 0.010)				
Total (95% CI)			**100.0%**	**0.77 [0.38 , 1.57]**
Heterogeneity: Tau² = 0.24; Chi² = 5.15, df = 2 (P = 0.08); I² = 61%				
Test for overall effect: Z = 0.72 (P = 0.47)				
Test for subgroup differences: Chi² = 5.15, df = 2 (P = 0.08), I² = 61.2%				



Footnotes

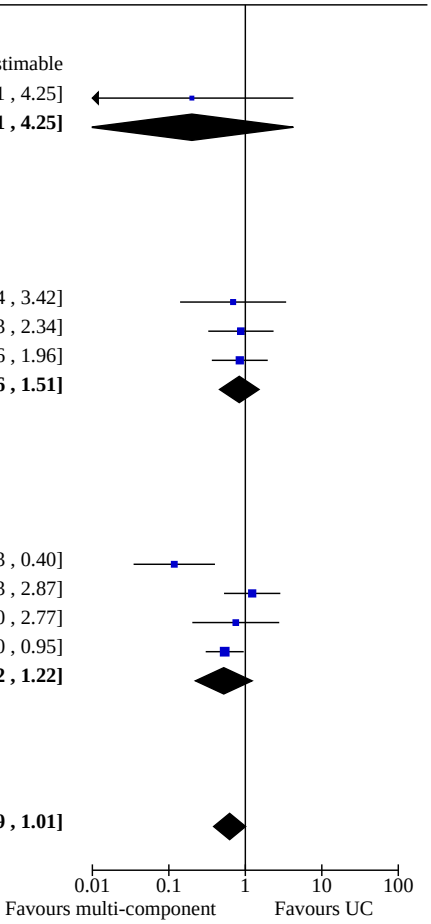
(1) Asynchronous: E-coach intervention + remote monitoring + self-management + education; 12 weeks

(2) Asynchronous: remote monitoring + video conferencing; 26 weeks

(3) Asynchronous: integrated care + individual plan + telephone calls ; 52 weeks

Analysis 3.11. Comparison 3: Multi-component vs usual care, Outcome 11: Multi: mortality (all-cause)

Study or Subgroup	Multi-component Events	Total	UC Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
3.11.1 3 to < 6 months						
Koff 2009 (1)	0	20	0	20		Not estimable
Ritchie 2016 (2)	0	65	2	67	2.3%	0.20 [0.01 , 4.25]
Subtotal (95% CI)		**85**		**87**	**2.3%**	**0.20 [0.01 , 4.25]**
Total events:	0		2			
Heterogeneity: Not applicable						
Test for overall effect: Z = 1.03 (P = 0.30)						
3.11.2 6 to < 12 months						
Jakobsen 2015 (3)	3	29	4	28	7.2%	0.69 [0.14 , 3.42]
Ringbaek 2015 (4)	8	141	9	140	14.1%	0.88 [0.33 , 2.34]
Sorknaes 2013 (5)	11	132	13	134	16.7%	0.85 [0.36 , 1.96]
Subtotal (95% CI)		**302**		**302**	**37.9%**	**0.83 [0.46 , 1.51]**
Total events:	22		26			
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.06$, df = 2 (P = 0.97); $I^2 = 0\%$						
Test for overall effect: Z = 0.60 (P = 0.55)						
3.11.3 ≥ 12 months						
Bourbeau 2016 (6)	3	157	23	162	10.6%	0.12 [0.03 , 0.40]
Casas 2006 (7)	12	65	14	90	16.6%	1.23 [0.53 , 2.87]
Farmer 2017 (8)	6	110	4	56	9.7%	0.75 [0.20 , 2.77]
Rose 2018 (9)	21	236	36	234	23.0%	0.54 [0.30 , 0.95]
Subtotal (95% CI)		**568**		**542**	**59.8%**	**0.52 [0.22 , 1.22]**
Total events:	42		77			
Heterogeneity: $Tau^2 = 0.51$; $Chi^2 = 9.98$, df = 3 (P = 0.02); $I^2 = 70\%$						
Test for overall effect: Z = 1.49 (P = 0.14)						
Total (95% CI)		**955**		**931**	**100.0%**	**0.62 [0.39 , 1.01]**
Total events:	64		105			
Heterogeneity: $Tau^2 = 0.18$; $Chi^2 = 11.65$, df = 7 (P = 0.11); $I^2 = 40\%$						
Test for overall effect: Z = 1.93 (P = 0.05)						
Test for subgroup differences: $Chi^2 = 1.43$, df = 2 (P = 0.49), $I^2 = 0\%$						



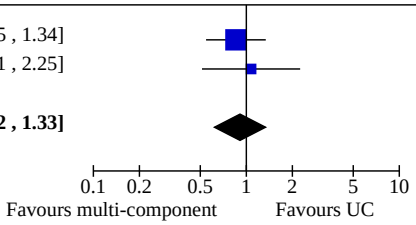
Footnotes

(1) Asynchronous: integrated care: education + teaching + remote monitoring; 39 weeks
(2) Asynchronous: E-coach platform + remote monitoring + self-management + education; 12 weeks
(3) Asynchronous and synchronous: remote monitoring + video conferencing (on discharge); 26 weeks
(4) Asynchronous: remote monitoring + video consultation + standard care; 26 weeks
(5) Asynchronous: remote monitoring + remote consultation (telephone); 26 weeks
(6) Asynchronous: remote monitoring (telephone/web) + self-management education; 52 weeks
(7) Asynchronous: integrated care + individual plan + telephone calls ; 52 weeks
(8) Asynchronous: remote monitoring + self-management support; 52 weeks
(9) Synchronous: remote consultations (telephone)+education+individualised plan for self-management; 52 weeks

Analysis 3.12. Comparison 3: Multi-component vs usual care, Outcome 12: Multi: AE: number of people who had an adverse event (52 weeks) (add to SOF table)

Study or Subgroup	Multi-component Events	Total	UC Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Bourbeau 2016 (1)	92	157	101	162	73.0%	0.85 [0.55 , 1.34]
Farmer 2017 (2)	29	110	14	56	27.0%	1.07 [0.51 , 2.25]
Total (95% CI)		**267**		**218**	**100.0%**	**0.91 [0.62 , 1.33]**
Total events:	121		115			

Heterogeneity: Tau² = 0.00; Chi² = 0.27, df = 1 (P = 0.60); I² = 0%
Test for overall effect: Z = 0.49 (P = 0.63)
Test for subgroup differences: Not applicable

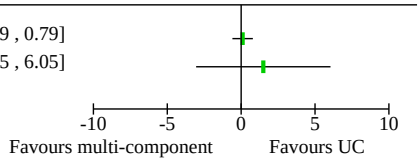


Footnotes
(1) Asynchronous: remote monitoring (telephone/web) + self-management education; 52 weeks
(2) Asynchronous: remote monitoring + self-management support; 52 weeks

Analysis 3.13. Comparison 3: Multi-component vs usual care, Outcome 13: Multi: A/D: HADS total

Study or Subgroup	Multi-component Mean	SD	Total	UC Mean	SD	Total	Mean Difference IV, Random, 95% CI
Bourbeau 2016 (1)	20.9	3.2	157	20.8	3.1	162	0.10 [-0.59 , 0.79]
Jakobsen 2015 (2)	10.8	7.5	20	9.3	6.8	18	1.50 [-3.05 , 6.05]

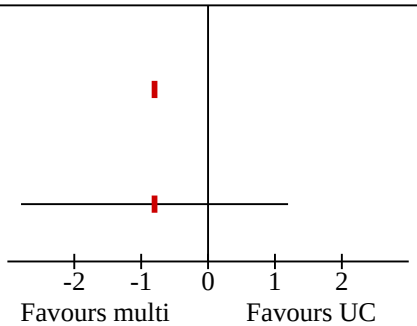
Test for subgroup differences: Not applicable



Footnotes
(1) Asynchronous: remote monitoring (telephone/web) + self-management education; 52 weeks
(2) Asynchronous and synchronous: remote monitoring + video conferencing (on discharge); 26 weeks

Analysis 3.14. Comparison 3: Multi-component vs usual care, Outcome 14: HADS-A and HADS-D

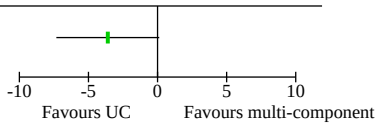
Study or Subgroup	MD	SE	Mean Difference IV, Random, 95% CI
3.14.1 HADS-A			
Rose 2018 (1)	-0.8	0.001	-0.80 [-0.80 , -0.80]
3.14.2 HADS-D			
Rose 2018 (1)	-0.8	1.0184	-0.80 [-2.80 , 1.20]



Footnotes
(1) Synchronous: remote consultations (telephone)+education+individualised plan for self-management; 52 weeks

Analysis 3.15. Comparison 3: Multi-component vs usual care, Outcome 15: Multi: satisfaction: client satisfaction questionnaire

Study or Subgroup	Multi-component Mean	SD	Total	UC Mean	SD	Total	Mean Difference IV, Random, 95% CI
Tabak 2014 (1)	26.3	4.5	12	29.9	4.8	12	-3.60 [-7.32 , 0.12]



Footnotes

(1) Asynchronous: mobile telephone/web portal + remote consultation (telephone); 39 weeks

ADDITIONAL TABLES

Table 1. Study classifications according to intervention type

Interventions	Remote monitoring (linked to healthcare professional) plus usual care vs usual care alone	Remote consultation (with health professional) plus usual care vs usual care alone (face-to-face)	Remote monitoring versus usual care (where telehealth replaces an element of usual care)	Remote consultation vs usual care (where telehealth replaces an element of usual care)	Integrated intervention vs usual care or interventions that include both monitoring and video consultations
Wired telehealth system to monitor physiological parameters processed or authorised by HCP with feedback to patient via telephone or video	Antoniades 2012 Lewis 2010 McDowell 2015 Pinnock 2013	No studies	Calvo 2014 De San Miguel 2013 Jódar-Sanchez 2013 Minguez 2017 Soriano 2018	No studies	Koff 2009
Wireless telehealth system to monitor physiological parameters that are processed or authorised by HCP with feedback to patient via telephone or video	Berkhof 2015 Ho 2016 Shany 2016 Vianello 2016	No studies	Pedone 2013 Sink 2020 Walker 2018 Stamenova 2020 Udsen 2017	No studies	Bourbeau 2016 Farmer 2017 Ringbaek 2015 Jakobsen 2015 Yan 2018 Sorknaes 2013
Store and forward telehealth system to transfer data regarding condition of patient to HCP for assessment offline	No studies	No studies	No studies	No studies	No studies
Internet-based telecommunication such as video or telephone links with HCP (Skype, text, email)	No studies	No studies	No studies	No studies	Casas 2006 Ritchie 2016 Rose 2018 Tabak 2014

HCP: healthcare professional.

Table 2. Baseline characteristics of study participants

Study ID	Concomitant treatments	COPD severity	Comorbidities, percentage, mean (SD), or median (IQR)	Mean age, years	Male or female	Exacerbations in the last 12 months, mean	Hospital admissions in the last 12 months, mean (SD) or median (IQR)
Remote monitoring plus usual care							
Antoniades 2012	NR	Moderate /severe	NR	RM + UC = 68 UC = 70	males: 20/44 (45%); females: 24/44 (54%)	NR	RM + UC = median 2 (1 to 4); UC = median 1 (1 to 2)
Berkhof 2015	Home oxygen	Severe	NR	68	males: 68/91 (75%); females: 23/91 (25%)	NR	NR
Ho 2016	SABA LABA Anticholinergic ICS	Mild /moderate	RM + UC: CHD (23%), HF (26%), hypertension (53%), diabetes (21%) UC: CHD (17%), HF (25%), hypertension (62%), diabetes (19%)	RM + UC = 84 UC = 79	males: 81/106 (76%); females: 25/106 (24%)	RM + UC = 19 UC = 17	RM + UC = 16 UC = 19
Lewis 2010	NR	Moderate/very severe	Known comorbidity: RM: 92%, UC: 88%	RM = 70 UC = 73	males: 20/40 (50%); females 20/40 (50%)	NR	RM = median 0 (0 to 1.0) UC = median 0 (0 to 0.8)
McDowell 2015	Flu vaccine	GOLD stage II/III	HADS total Anxiety: RM: 8.3 ± 5.2; UC: 7.9 ± 4.3 Depression: RM: 6.8 ± 3.8; UC: 7.9 ± 3.9	69.8 RM and 70.2 UC	males: 48/110 (44%); females: 62/110 (56%)	NR	RM: 0.82 UC: 1.05
Pinnock 2013	NR	GOLD stage mild/moderate, severe, very severe	1 or more comorbidities: RM: 61%; UC: 71%; HADS total Anxiety: RM: 9.8 ± 5.2; UC: 9.6 ± 4.6 Depression: RM: 8.9 ± 4.4; UC: 8.2 ± 4.1	69.4 RM and 68.4 UC	males: 116/256 (45%); females: 140/256 (55%)	NR	RM+UC = 2.3 UC = 2.5

Table 2. Baseline characteristics of study participants *(Continued)*

Shany 2016	NR	GOLD stage severe	HADS total Anxiety: RM + UC: 7.8 ± 4.7; UC: 6.2 ± 4.0 Depression: RM + UC:6.0 ± 3.0; UC: 6.4 ± 4.5	RM + UC 72.1 UC = 74.2	males: 19/42 (45%); females: 23/42 (55%)	NR	RM+UC = 3 UC = 2.5
Udsen 2017	NR	GOLD stage I, II, III, IV	Diabetes: RM: 10%; UC: 9.8% CHD: RM: 33%; UC: 31% Mental health problems: RM: 4.8%; UC: 4.79% Musculoskeletal disorder: RM: 24.9%; UC: 29% Cancer: RM: 6%; UC: 4.79%	RM = 69.6 UC = 70.3	males: 562/1225 (46%); females: 663/1225 (54%)	NR	NR
Vianello 2016	LABA: RM 97.8% and UC 94.1% LAMA: RM 87.2% and UC 86.3% ICS: RM 83.5% and UC 76.9% Systemic steroid: RM: 6.5% and UC: 4.8%	GOLD stage III, IV	HADS total: Anxiety: RM + UC: 4.68 ± 3.45; UC: 5.4 ± 3.35 Depression: RM + UC: 5.1 ± 4.42; UC: 5.48 ± 4.49 Hypertension: RM + UC: 61%; UC: 64% IHD: RM + UC:38.9%; UC: 35%	RM + UC = 75.96 UC = 76.48	males: 240/334 (72%); females: 94/334 (28%)	NR	NR
Walker 2018	NR	GOLD stage I, II, III, IV	CHF: RM + UC: 12%; UC: 8% IHD: RM + UC: 25%; UC: 23% CHF + IHD: RM + UC: 12%; UC: 13% Hypertension: RM + UC: 72%; UC: 68% Osteoporosis: RM + UC: 17%; UC:15% Hyperlipidaemia: RM + UC: 53%; UC: 58%	71	males: 206/312 (62%); females: 106/312 (34%)	More than 1 exacerbation: RM + UC = 59% UC = 63%	RM = 42% UC = 41%

Table 2. Baseline characteristics of study participants *(Continued)*

			Number of comorbidities per person, median (IQR): RM + UC: 2.0 (1.0 to 3.0); UC: 2.0 (1.0 to 3.0)				
Remote monitoring alone							
Calvo 2014	LAMA + LABA + ICS PDE4 inhibitors Mucolytics Theophylline Oral steroids	Severe /very severe	Charlson comorbidity index score: RM: 3.7 ± 1.4; UC:3.4 ± 2.1	RM = 75 UC = 72.7	males: 44/59 (75%); 15/59 females (25%)	NR	RM = 1.7 UC = 1.9
De San Miguel 2013	Oxygen	NR	NR	RM = 71 UC = 74	males: 37/71 (52%); females: 34/71 (48%)	NR	NR
Jódar-Sanchez 2013	LTOT	Very severe	Adjusted Charlson comorbidity index score: RM: 6.6 ± 2.8; UC: 5.1 ± 2 10% in each group had anxiety/depression	RM = 74 UC = 71	males: 43/45 (96%); females: 2/45 (4%)	NR	NR
Minguez 2017	NR	NR (FEV_1 % = 50 and 51.1)	Charlson comorbidity index score: (median (IQR): RM: 4 (3 to 5); UC: 4.45 (3.6 to 6.2)	RM = 68 UC = 70	males: 77/111 (69%); females: 34/111 (31%)	NR	NR
Pedone 2013	NR	GOLD stage II/III	NR	74.1 RM and 75.4 UC	males: 36/50 and 31/49 (68%); females: 32/99 (32%)	NR	NR
Sink 2020	NR	GOLD stage mild to very severe	NR	RM = 59.8 UC = 61.9	males: 61/168 (36%); females: 107/168 (64%)	NR	NR

Table 2. Baseline characteristics of study participants *(Continued)*

Soriano 2018	LABA (98%), LAMA (98%), ICS (94%), SAA (57%), PDE4 inhibitors (16%), theophylline (14%), oral steroids (4%), β2-adrenergic receptor agonists (5%)	GOLD stage severe (stable)	Charlson comorbidity index score: RM: 2.4 ± 1.5; UC: 2.4 ± 1.5 Goldberg anxiety: RM: 1.5 ± 2.3; UC: 1.8 ± 2.5 Goldberg depression: RM: 2.5 ± 2.4; UC: 2.9 ± 2.5	RM = 71.5 UC = 71.3	males: 184/229 (80%); females: 45/229 (20%)	NR	RM = 2 UC = 2
Stamenova 2020	NR	NR (FEV_1 % 50 and 45)	RM group had lower rates of osteoporosis (P = 0.02), pulmonary hypertension compared to UC group (P = 0.04)	RM = 71.98 UC = 72.78	males: 44/81 (54%); females: 37/81 (46%)	MC = 2 UC = 1	MC = 0 UC = 0
Multi-component or integrated care (where remote monitoring, consultation, or both are components of care)							
Bourbeau 2016	Long-acting anticholinergics LABA Long-acting ICS	GOLD stage III/IV	Overall: severe anxiety (26.7%), severe depression (78.6%) (HADS); age-adjusted Charlson comorbidity index score (4.2 ± 1.8); number of concomitant diseases: 3.5 ± 2.0	MC = 67.3 UC = 66.6	males: 222/319 (70%); females: 97/319 (30%)	1.3	MC = 20 UC = 19
Casas 2006	Influenza and Pneumococcal vaccination	NR (FEV_1 % = 42)	Goldberg score: MC: 8.5 ± 5.6; UC: 8.2 ± 5.9 Mean comorbidities: MC: 1.9 ± 1.4; UC: 1.8 ± 1.5	MC = 70 UC = 72	males: 129/155 (83%); females: 26/155 (17%)	NR	MC = 1 UC = 0.6
Farmer 2017	COPD medication (not described)	Moderate /severe/very severe	IG: 80.9%; SC: 83.9% had comorbidities including high blood pressure, osteoporosis, high cholesterol, diabetes, heart disease, depression	69.8	males: 102/166 (61%); females: 64/166 (39%)	NR	NR
Jakobsen 2015	Corticosteroid (prednisone)	GOLD stage III/IV	NR	NR	males: 22/57 (39%); females: 35/57 (61%)	NR	NR

Table 2. Baseline characteristics of study participants *(Continued)*

	Antibiotics (amoxicillin, clavulanic acid) β_2-agonists Anticholinergics Fenoterol Ipratropium bromide nebuliser O_2 therapy as needed Sedative levomepromazine as needed						
Koff 2009	Flu vaccine	GOLD stage III/IV	NR	RM = 66.6 UC = 65	males: 19/40 (47%); females: 21/40 (53%	NR	RM = 0.55 UC = 0.6
Ringbaek 2015	Oral prednisolone Roflumilast ICS LAMA LABA	GOLD stage severe and very severe	Charlson comorbidity index score: MC: 1.7 ± 1.49, UC: 1.96 ± 1.51	MC = 69.8 UC = 69.4	males 130/281 (46%); females: 151/281 (54%)	NR	MC = 0.91 UC =. 1.22
Ritchie 2016	NR	NR	NR	MC = 63.8 UC = 63.4	males: 73/132 (55%); females: 59/132 (45%)	NR	NR
Rose 2018	Inhaled bronchodilator Inhaled steroid Antihypertensive	NR (FEV_1 % 43 and 45)	CVD: MC: 75%; UC: 76% Diabetes: MC: 18%; UC: 22% Depression: MC: 17%; UC: 20%	71 in both groups	males: 220/470 (47%); females: 250/470 (53%)	NR	MC = 1.3 UC = 1.4

Table 2. Baseline characteristics of study participants *(Continued)*

	Influenza vaccine Pneumonia vaccine		Osteopenia and osteoporosis: MC: 30%; UC: 29% GORD: MC: 14%; UC: 12% Hypothyroidism: MC: 9%; UC: 9% Osteoarthritis: MC: 9%; UC: 9% CKD: MC: 7%; UC: 7% Anxiety: MC: 7%; UC: 7% OSA: MC: 5%; UC: 6% Lung cancer: MC: 6%; UC: 6%				
Sorknaes 2013	NR	GOLD stage severe	Infection: MC: 52%; UC: 55%; HD: MC: 35%; UC: 36%; CVD: MC: 9%; UC: 8%; Depression: MC: 2%; UC: 2% Diabetes: MC: 1% to 4%; UC: 11% Osteoporosis: MC: 17%; UC: 19% Cancer: MC: 0%; UC: 1%	MC = 71 UC = 72	males: 104/266 (39%); females: 162/266 (61%)	NR	MC = 2.75 UC = 2.64
Tabak 2014	NR	NR (FEV_1 % 50 and 36)	NR	MC = 64.1 UC = 62.8	males: 12/24 (50%); females: 12/24 (50%)	NR	NR
Yan 2018	NR	GOLD stage I, II, III, IV	NR	RM = 65.4 UC = 64.6	males: 152/240 (63%); females: 88/240 (37)	NR	NR

CHF: chronic heart failure; **COPD:** chronic obstructive pulmonary disease; **CVD:** cerebrovascular disease; **FEV_1:** forced expiratory volume in one second; **GOLD:** Global Initiative for Chronic Obstructive Lung Disease; **GORD:** gastro-oesophageal reflux disease; **HD:** heart disease; **HF:** heart failure **ICS:** inhaled corticosteroid; **IG:** intervention group; **IHD:** Ischaemic heart disease; **LABA:** long-acting beta-agonist; **LAMA:** long-acting muscarinic antagonist; **LTOT:** long-term oxygen therapy; **MC:** multi-component; **NR:** not reported; **PDE4:** phosphodiesterase 4; **RM:** remote monitoring; **SABA:** short-acting beta-agonist; **SC:** standard care; **UC:** usual care.

Table 3. Details of interventions

&&Study details	Intervention and description
Remote monitoring plus usual care	
Antoniades 2012 52 weeks	**INTERVENTION: remote monitoring using the TeleMedCare system (laptop computer with digital measurement capabilities) and standard best practice** **Participant data entry:** automatic • Home training was given to all participants for completing physiological measurements and questionnaires • Participants measured vital stats using a laptop computer with a digitally integrated blood pressure cuff and stethoscope, pulse oximeter, spirometry, electrocardiogram touch plate, thermometer, and scales • In-home support was available as required **Study administrator:** study nurse, nursing informatics project manager, outreach nurse, study doctor **Data transmission:** automatic • Data were uploaded daily to a central server via Internet connection through the participant's telephone **Data acquisition:** asynchronous • Data were accessed after participant transmitted readings. Study nurse analysed the data 5 days a week to detect anomalous physiological parameters **Clinical alert:** algorithm-dependent • Dependent on whether readings were outside of parameters set for each participant **Feedback from health professional:** yes • Nurse contacted participant, study/local doctor, or outreach nurse for further management
Berkhof 2015 26 weeks	**INTERVENTION: remote in-home monitoring via telephone and usual care practices** **Participant data entry:** based on telephone calls • Regular outpatient visits by pulmonologist at baseline and after 6 months • Fortnightly phone contact by same call centre nurse • Phone calls by centre nurse consisted of a brief introductory conversation and administration of CCQ **Study administrator:** nurse, pulmonologist, pulmonary nurse practitioner **Data transmission:** via telephone call **Data acquisition:** synchronous **Clinical alert:** none **Feedback from health professional:** yes • Total scores were recorded; if above MCID, pulmonologist was reached to contact the patient, who decided on how to proceed, either treatment for exacerbations, or visit to outpatient clinic/GP
Ho 2016 26 weeks	**INTERVENTION: self-monitoring of COPD using a telehealth electronic diary on a website** **Participant data entry:** manual

Table 3. Details of interventions *(Continued)*

	• Prior to hospital discharge, participants assigned to telehealth intervention were trained in use of equipment (pulse oximeter, thermometer, sphygmomanometer) and online diary by study nurse • Specialised phone line for all participants daily from 8 am to 8 pm for medical counselling provided by study nurse • Participants reported symptoms via diary on website daily for 2 months after discharge (diary data included disease symptoms, weight, vital signs) **Study administrator:** primary care physicians, study nurses, study team, attending pulmonologist **Data transmission:** automatic • Participants submitted data through an electronic diary scoring algorithm; based upon the item and data, a score of 1 or 2 was given **Data acquisition:** asynchronous • Data were accessed after participants submitted their readings **Clinical alert:** algorithm dependent • If a symptom diary score ≥ 2 was generated, then an alert was issued **Feedback from health professional:** yes • If an alert was generated, HCPs received a notification to respond to the alert; HCP reviewed participant data and either contacted the participant by phone or referred the participant to the clinic or ED
Lewis 2010 26 weeks	**INTERVENTION: remote in-home monitoring intervention** **Participant data entry:** manual • Telemonitoring done was via a handheld telemonitor (Docobo Health Hub, Docobo Ltd) installed in participants' home and participants given training • Participants answered questions twice daily about chest condition, recorded temperature, and results of pulse oximeter. **Study administrator:** TM training team, chronic disease management team, hospital respiratory nurse **Data transmission:** automatic • Data were transferred to a central server via the telemonitoring device connected to the participant's telephone line **Data acquisition:** asynchronous • Heathcare professionals could access the server via secured Internet connection. A CDMT member called the patient if no data were received for 7 days (or sent a message on monitor screen) **Clinical alert:** algorithm-dependent • If 2 or more occurred, a trigger would alert and be sent to CDMT personnel via email: (1) any question scoring 'much worse than usual', (2) pulse > 120, (3) oxygen saturation < 88%, and (4) temperature < 38.5° C **Feedback from health professionals:** yes • If an alert was triggered, CDMT member contacted participant via telephone. Patients were instructed to contact GP or emergency doctor for urgent care. CDMTs and hospital nurses could liaise with hospital or primary care medical team
McDowell 2015	**INTERVENTION: remote in-home monitoring intervention**

Table 3. Details of interventions *(Continued)*

26 weeks	**Participant data entry:** manual • Home telehealth system (HomMed, Honeywell) connected to telephone line with education provided. Telehealth system was loaded with personal information, monitoring start time, clinical observations (heart rate, oxygen saturation, blood pressure), and symptoms (tiredness, sputum, difficulty breathing, cough) • Home telehealth technician monitored participants using equipment in 1 session (10 minutes). Participants received a call from the Community Respiratory Team within 24 hours of installation, and demonstration was provided further if requested • Participants monitored their observations each morning at the same time for 26 weeks **Study administrator:** community respiratory team, telemonitoring technician, telemonitoring nurse, general practitioner **Data transmission:** automatic • Daily measurements were transmitted via home telehealth system **Data acquisition:** asynchronous • Data were reviewed within 10 minutes of transmitting and were compared to normal baseline set before study **Clinical alert:** algorithm-dependent • Clinical alert was generated if values were outside normal parameters **Feedback from health professionals:** yes • Nurse contacted participants if an alert was triggered to obtain further information. Participants rested for 30 minutes, after which monitoring was resumed. If readings were out of range, this was escalated to the CRT, who decided on a home visit or ED admission
Pinnock 2013 52 weeks	**INTERVENTION: remote in-home monitoring intervention** **Participant data entry:** manual • Remote monitoring equipment and broadband link Installed in patient's home • Patient recorded and transmitted questionnaire responses about symptoms (shortness of breath, mucus, wheeze, cough, fever), use of treatment, and oxygen saturation • Patient responses were scored; received a '2' for symptoms of exacerbation and '1' for all others **Study administrator:** specialist respiratory team in Edinburgh, nurse specialist in Midlothian, trained call handler in East/West Lothian, GP **Data transmission:** automatic • Data were transmitted via secure Internet connection to a password-protected server in the NHS **Data acquisition:** asynchronous • Data were monitored daily by clinical team **Clinical alert:** algorithm-dependent • If daily readings were not received or symptom score was 4 or 5 **Feedback from health professionals:** yes • Participants were contacted via telephone by the clinical team, or by a video link, for further assessment of the patient and decision on further management (recommend treatment, visit patient at home, admit to hospital)

Table 3. Details of interventions *(Continued)*

Shany 2016 52 weeks	**INTERVENTION: remote monitoring intervention RACS-Plus care (home visits, respiratory rehab, telephone)** **Participant data entry:** automatic • RACS-Plus care: urgent home visits, telephone contact, scheduled visits to specialist respiratory rehab outpatient clinic for both groups in the study • Measurement unit was set up in participants' homes so they could record their symptoms (e.g. spirometer, ECG, oximeter, heart rate, blood pressure, weight, glucometer, thermometer linked to the RACS-Plus care system) • Participants recorded their measurements once a day at any time **Study administrator:** respiratory community nurse, nurse at respiratory ambulatory care services **Data transmission:** automatic • Data were automatically sent daily at night via Internet to a central server to the RACS-Plus staff **Data acquisition:** asynchronous • RACS-Plus staff analysed data after they were transmitted by participants **Clinical alert:** algorithm-dependent • Clinical alert was generated in response to readings outside of pre-set parameters **Feedback from health professionals:** unclear • No further information
Vianello 2016 52 weeks	**INTERVENTION: remote monitoring with self-management education and call centre** **Participant data entry:** manual • At setup, patients provided self-management education materials and TM use training was provided by the technician • Participants “spot-checked” their pulse oximetry daily (morning) but recorded and transmitted their heart rate and oxygen saturation every other day, or when there was clinical symptom worsening **Study administrator:** operators, nurse, clinical staff, pulmonary specialist **Data transmission:** automatic • Data were transmitted via telephone linked to the central management eHealth centre **Data acquisition:** asynchronous • Operators viewed data daily; operated from 8 am to 6 pm, Monday to Friday **Clinical alert:** symptom dependent • If values were outside of participant's “normal range,” they took a second reading. If second reading was still outside of range, operator contacted clinical staff to alert them; data were available to the pulmonary specialist via a web-based platform **Feedback from health professionals:** yes • Pulmonary specialist called participant to assess the situation (stabilised or worsened) • Treatment adherence was monitored, and if needed, interventions were put in place. Exacerbations were treated by modification of medication, a visit from a district nurse at home, or an office appointment with the specialist pulmonologist, or participant was taken to the emergency department

Table 3. Details of interventions *(Continued)*

	• Participants were registered in the system within 30 minutes of the outside of range measurement and were examined by specialist within 48 hours
Remote monitoring alone	
Calvo 2014 30 weeks	**INTERVENTION: remote in-home monitoring using telephone line to submit data through a modem (Tele-Modem^{TM}, Aerotel Medical Systems)** **Participant data entry:** manual • Usual health care provided to all patients (office visits and pulmonologist or primary care doctor home calls) • Participants received home monitoring to measure oxygen saturation, blood pressure, temperature, PEF) and spirometry **Study administrator:** nurse, pneumologist, nursing staff, primary care physician **Data transmission:** automatic **Data acquisition:** asynchronous • Data monitored by clinical monitoring centre 5 days a week from 9 am until 5 pm during weekdays. On weekends, data were analysed directly by pneumologist **Clinical alert:** algorithm-dependent • Based on traffic light system: green (measurements within thresholds, no further action taken), yellow (technical alert, measurements taken incorrectly or not received) • Red (clinical alert): measurement exceeded threshold **Feedback from health professional:** yes • Nurse contacted participant to determine medical cause • CMC raised clinical alert, after which it was escalated to the clinical pulmonologist, who determined the severity of the exacerbation and decided the treatment path
De San Miguel 2013 26 weeks	**INTERVENTION: remote in-home monitoring and disease education using Docobo HealthHub** **Participant data entry:** manual • Equipment installed at patient's home by telehealth nurse with training provided • Patients received an educational booklet about COPD and a telehealth manual • Patients measured blood pressure, weight, temperature, pulse, oxygen saturation; asked questions on general health on a daily basis **Study administrator:** telehealth nurse, general practitioner **Data transmission:** automatic • Participants transmitted via telephone to a secure website **Data acquisition:** asynchronous • All consultations were recorded on website, so GPs/specialists could log in and view readings; patients recorded on calendar every time they used the health service info collected by phone each month **Clinical alert:** algorithm-dependent • Alerts were triggered by abnormal result, based on deviation from normal parameters set by GP or specialist **Feedback from health professionals:** yes

Table 3. Details of interventions *(Continued)*

	• Nurse contacted participant to discuss results and provide advice or support or to recommend patient to see General Practitioner
Jódar-Sanchez 2013 17 weeks	**INTERVENTION: remote in-home monitoring via a hub (Tele-Modem, Aerotel Medical Systems)** **Participant data entry:** manual • Spirometer, pulse oximeter, and heart rate and blood pressure monitor were set up in participant's home; training session was provided so nursing staff could show how to use the equipment • Measured vitals were performed 20 minutes after prescribed inhaled therapies were taken, while seated, and while on oxygen. Readings were taken each weekday, and spirometry was performed 2 days a week • Monitoring continued after discharge if participants were admitted **Study administrator:** nurses, clinical call centre team (case manager, specialist in respiratory medicine, nurses) **Data transmission:** automatic • Data were transmitted via a hub through participant's phone line to clinical health centre **Data acquisition:** asynchronous • Participant data went through a triage. Green alert: readings are within defined limits, no action required, Yellow alert: reading is overdue or was not received; further investigation needed, Red alert: reading falls outside defined limits; verification of alert done by staff, then clinical response activated **Clinical alert:** algorithm-dependent • Yellow alert referred to readings that had not been received, so personnel responded, or HCP responded. Red alert referred to readings outside the threshold **Feedback from health professionals:** yes • Red alert triggered a response from CCC staff contacting the participant, followed by a clinical response by case manager and respirologist. Severity of exacerbation resulted in monitoring of symptoms/GP (mild to moderate), referral to specialised care on the same day as the trigger (severe), referral to ED (very severe)
Minguez 2017 26 weeks	**INTERVENTION: remote in-home monitoring intervention** **Participant data entry:** manual • Early assisted discharge from hospital • Remote daily monitoring of vital signs (oxygen saturation, heart rate, respiratory rate, blood pressure, temperature, ECG) • 2 telemonitoring sessions daily (mornings and evenings) • 3 visits minimum, with reinforcement of health education concepts. Extra home visits were scheduled by team depending on RM data (moderate/severe exacerbations) **Study administrator:** pulmonologist, specialist nurses **Data transmission:** automatic • Twice-daily measurements were transmitted via monitoring device linked to a modem **Data acquisition:** asynchronous • Data were reviewed after submitted by participants **Clinical alert:** algorithm-dependent • Alert was generated when readings were outside of pre-set parameters

Table 3. Details of interventions *(Continued)*

	Feedback from health professionals: unclear • Unclear if health professionals contacted participants on clinical alert
Pedone 2013 39 weeks	**INTERVENTION: remote monitoring via Bluetooth using the "SweetAge" monitoring system, which was web-based** **Participant data entry:** automatic • Measurements were taken at baseline and daily • Participants were given a wristband with sensors for heart rate, physical activity, body temp, and galvanic skin response • Bluetooth transmitter could be connected to pulse oximeter and wristband • Participants were instructed to contact GP if needed **Study administrator:** physician (skilled in care of respiratory patients) **Data transmission:** automatic • System was set up to perform 5 measurements every 3 hours daily (continuous) **Data acquisition:** synchronous • Wristband could be coupled to a mobile phone via Bluetooth, which had software to allow transmission of data to monitoring system in real time **Clinical alert:** algorithm-dependent • Clinical alert was displayed on the system when readings were outside of pre-set parameters. Limits for alerts could be tailored to participants by the system user on clinical status of participants; however this was intended for monitoring only **Feedback from health professionals:** yes • Participants were instructed to contact GP if needed. Physician contacted participant if there was a clinical alert or symptoms worsened, and decided on further intervention
Sink 2020 34 weeks	**INTERVENTION: remote monitoring via EpxCOPD system via messaging** **Participant data entry:** based on text message or automated telephone call via monitoring system • If participants reported better or the same for 30 consecutive days, daily messaging went to twice a week (however, if patients ever reported worse, they would return to daily messaging) **Study administrator:** clinic medical residents **Data transmission:** automatic • Participants received a daily message from the system via telephone call or text message, asking them, "Are you breathing better than, worse than, or the same as yesterday?" **Data acquisition:** asynchronous • Only when participant answers indicated worsening symptoms **Clinical alert:** based on symptoms worsening • If participant reported breathing the same or better, nothing was done; if participant reported breathing worse, alert was sent by text to clinic resident **Feedback from health professionals:** yes • Clinic resident then followed up with participant in response to alert text

Table 3. Details of interventions *(Continued)*

Soriano 2018 52 weeks	**INTERVENTION: remote monitoring via Hub Internet connection** **Participant data entry:** manual/automatic • Initial home visit (to install equipment and train patient or caregiver and 4 days of physiological measurements) • Participants measured oxygen saturation, spirometry, heart rate, and blood pressure daily at the same time using the apparatus provided, at rest, after taking medications and with oxygen therapy. Respiratory rate, oxygen use adherence data were automatically collected by the device via oxygen feed from participant's main oxygen source **Study administrator:** nurse, healthcare personnel **Data transmission:** automatic • Readings were uploaded via monitoring device to a secure server via Internet connection **Data acquisition:** asynchronous • Nurses analysed data once transmitted by participant **Clinical alert:** algorithm-dependent • Alerts were triaged using traffic light system; green: measurements are within normal limits; yellow: measurements were not done, were not received, or are missing, triggering a technical alert; red: measurement(s) were out of limits **Feedback from health professionals:** yes • Alerts usually resulted in contact with participant by trained monitoring centre nurse initially, then possible referral to clinic pulmonologist or emergency room or primary care doctor depending on data
Stamenova 2020 26 weeks	**INTERVENTION: remote in-home monitoring intervention** **Participant data entry:** automatic • Cloud DX Connected Health Kit consisted of custom tablet computer (Bluetooth), wireless blood pressure monitor, oximeter, weight scale, thermometer (CAT and MRC were also embedded in the technology) • Written personalised COPD action plan **Study adminstrator:** clinical project specialist (who was a respiratory therapist) **Data transmission:** automatic • Data from all devices were transmitted to a database. Participants and healthcare providers could interact via a web-based portal; data were not monitored 24/7 **Data acquisition:** asynchronous • Participant data thresholds determined by specialist/participant's respirologist; participants contacted 2 weeks after receiving kit for re-assessment of appropriateness of thresholds **Clinical alert:** symptom-dependent • Abnormal reading notifications were sent to clinical project specialist and participant via email • Follow-up calls were made only when readings were abnormal for 2 or more days; calls were made only on weekdays; follow-up call was done within 24 hours of notification **Feedback from health professionals:** yes • Respiratory therapist called once a week in general to check on patients, to prompt action plan use as needed, and to provide education about COPD as needed

Table 3. Details of interventions *(Continued)*

	• Participants could call or email clinic with non-emergency questions • Participants were advised to go to ED if required at any time during study
Udsen 2017 52 weeks	**INTERVENTION: remote monitoring via wireless transmission** **Participant data entry:** automatic • Contact from nurse within 10 days of inclusion into study • Home or health centre appointments for education on use of equipment • Telekit consisted of tablet, blood pressure monitor, pulse oximeter, health precision scale • Patients to measure vital signs daily for first 2 weeks, then 1 to 2 times a week thereafter; GP set patient thresholds • Nurse appointment 3 to 4 weeks after start of study to see if patient had any issues or questions; possible threshold adjustments **Study administrator:** nurses, health assistants, GP **Data transmission:** automatic • Wireless transfer of data with measured vital stats and COPD symptoms went to nurse in participant's residing municipality daily, 7 days a week **Data acquisition:** asynchronous • System provided 1-way communication (i.e. patients were contacted only if readings were not taken properly, or if there was a considerable change in readings) **Clinical alert:** algorithm-dependent • Readings were monitored daily and classified on a colour scale. Green: no thresholds exceeded. Yellow: 1 or more threshold values exceeded. Red: 1 or more threshold values exceeded and not previously documented **Feedback from health professionals:** yes • Nurse could contact participant, GP, or dispatch ambulance when thresholds exceeded
Walker 2018 39 weeks	**INTERVENTION: remote monitoring intervention with set phone calls** **Participant data entry:** automatic • CHROMED: remote monitoring system to monitor health status using wearable devices for measuring blood pressure, oxygen saturation, heart rate, and body temperature. Composed of a touch screen PC RESMON PRO DIARY for measurement of lung mechanical impedance and breathing pattern **Study administrator:** study nurse, physician **Data transmission:** automatic • Participants used platform daily at the same time • Measurements were uploaded and sent to secure server **Data acquisition:** asynchronous • Nurses accessed data once readings were transmitted **Clinical alert:** algorithm-dependent • Alerts were issued if no data were received for > 2 days • If data showed a worsening trend in set parameters, this generated a respiratory alert, which was sent to the study nurse **Feedback from health professionals:** yes

Table 3. Details of interventions *(Continued)*

	• If there were no data for > 2 days, study nurse at local site contacted participant • Study nurse examined data to figure out participant's clinical status and whether an intervention was needed (no action, medication needed, or face-to-face assessment). Reviewing physician determined only if hospitalisation was required
Multi-component or integrated care (where remote monitoring, consultation, or both, were components of care)	
Bourbeau 2016 52 weeks	**INTERVENTION: remote in- home monitoring via telephone/web platform and self-management education** **Participant data entry:** manual • Participants reported clinical status and symptoms via telephone-based questionnaire once a week or on days that symptoms were worse than normal • All patients on LTOT were monitored with NOWOX **Study administrator:** case managers (healthcare professionals), investigator, hospital physician **Data transmission:** automatic • Data were automatically transmitted to a clinical health data system **Data acquisition:** asynchronous • Data were analysed after participants transmitted readings. Clinical alerts were transmitted only to hospital physician for same-day medical assessment and management **Clinical alert:** algorithm-dependent • Scores determined actions to be taken by patient, including contact by health counsellor for reinforcement and support; investigator called patient to provide medical decision from hospital physician **Feedback from health professional:** yes • Case manager called participants in response to clinical alerts
Casas 2006 52 weeks	**INTERVENTION: integrative care intervention with individualized care plan via an ICT platform and web-based call centre** **Participant data entry:** based on telephone calls • During hospitalisations, 2 hours before discharge, participants received 2-hour comprehensive education on disease and disease management • Agreed tailored care plan shared across system between specialist nurse and primary care team; access to specialist nurse and primary care team during follow-up through ICT platform including a web-based call centre • No further scheduled visits; however unscheduled visits allowed through call centre **Study administrator:** specialised nurse case manager, primary care team (physician, nurse, and social worker), specialised respiratory nurse **Data transmission:** • Additional chronic platform (integrated care platform including web-based call centre was available for patients to access specialised nurse case manager) **Data acquisition:** asynchronous • Phone calls after 3 and 9 months were made to get information about healthcare utilisation without further education **Clinical alert:** none

Table 3. Details of interventions *(Continued)*

	Feedback from health professional: yes • Contact between specialist nurse and patient was established via web-based call centre; however, it is not clear whether this was used for managing symptom-based alerts
Farmer 2017 52 weeks	**INTERVENTION: integrated care intervention with individualised self-management: EDGE platform on a tablet computer** **Participant data entry:** automatic • Run-in: initial 6-week period of EDGE platform, symptom diary, and physiological measurements done daily; measurements taken at baseline and at 3, 6, and 12 months • EDGE support system: EDGE platform-based intervention that works on an android tablet computer • Daily symptom diary (overall well-being, cough, sputum, shortness of breath, medication use): daily physiological measurements (heart rate, oxygen saturation) taken by Bluetooth-enabled pulse oximeter were collected on the EDGE platform • Educational modules and support were individualised on the EDGE platform for each participant (techniques on how to use an inhaler, self-management techniques for shortness of breath, pulmonary rehabilitation exercises) • At any time, if patients felt they were deteriorating, they were instructed to contact their GP or the community respiratory nurse **Study administrator:** research nurse, nurse, physiotherapist, doctor **Data transmission:** automatic • Data were transferred to an NHS server, where readings were reviewed by a nurse, a doctor, or a physiotherapist **Data acquisition:** asynchronous • Data were monitored twice weekly to make sure that data transmission was taking place and to deal with any safety alerts **Clinical alert:** physiological parameter-dependent • Alerts were generated if readings were incorrect or were above the safety threshold by which records were assessed for review **Feedback from health professional:** yes • If a clinically important change was identified, participants were contacted via message or telephone. If anxiety and depression scores were above threshold, participant's GP was notified by letter
Koff 2009 13 weeks	**INTERVENTION: integrated care intervention with disease-specific education, teaching of self-management techniques, and remote home monitoring** **Participant data entry:** manual • COPD education by study co-ordinator initially, then Health Buddy System was able to provide education on a daily basis • Participants received direction for COPD self-management: use of pulse oximeter, mini-spirometer, awareness of physical changes/problems to call office • Participants could communicate with study co-ordinators via a direct line • Remote home monitoring using Health Buddy System: monitored weekdays for changes in symptoms, FEV_1, pulse oximetry, steps in 6MWD • Participants spent about 20 minutes each weekday morning using Health Buddy System to receive education, report symptoms based upon questions asked, and enter data measured including 6MWD, FEV_1, and resting pulse oximetry

Table 3. Details of interventions *(Continued)*

	Study adminstrator: study co-ordinator, respiratory therapist, primary care physician **Data transmission:** automatic • Participants transmitted daily measurements via a telecommunication device connected to a telephone **Data acquisition:** asynchronous • Participant data were sent by a silent telephone call each night. Study co-ordinator reviewed results the following morning **Clinical alert:** algorithm-dependent • Participants were placed into 3 groups based upon data received: green, yellow, or red. Green was stable, yellow was caution, and red was a potential change in health **Feedback from health professionals:** yes • Study co-ordinator contacted participant to help to resolve the issue when a red flag was received. Alert could be escalated to primary care physician or other specified contacts
Jakobsen 2015 26 weeks	**INTERVENTION: integrated care intervention, remote telemonitoring with a touch screen with a webcam** **Participant data entry:** manual • Run-in: within 24 hours after hospitalisation, participants were trained with telehealth equipment; a retest of equipment was done when participants were discharged from hospital • Within 24 hours of admission for COPD exacerbation, participants were sent home and remote monitoring apparatus set up. RM consisted of a video conference platform, so participants could transfer information about their vital indicators; equipment was kept until patient met the 5 criteria for discharge • Telemonitoring consisted of a touch screen with a webcam, pulse oximeter, spirometer, thermometer, nebuliser for inhaled medication, O_2 compressor, medicine box containing antibiotics, prednisolone, sedatives, β_2-agonists, and anticholinergics **Study administrator:** nurses, research staff, physicians **Data transmission:** automatic • Data were sent by wireless broadband; daily ward rounds and data review were done by video screen until discharge **Data acquisition:** asynchronous and synchronous • Participants transmitted data wirelessly via broadband for hospital rounds. Outside of hospital rounds, participants could use the equipment for self-management or take readings to observe results **Clinical alert:** none **Feedback from health professionals:** yes • Participants were treated same as standard care group; unscheduled or acute contacts were allowed 24/7 by pushing a button on the touch screen that called the hospital
Ringbaek 2015 26 weeks	**INTERVENTION: integrated care intervention with remote monitoring, pulmonary rehab, and support discharge** **Participant data entry:** manual • Telemonitoring equipment included tablet computer with webcam, microphone, and measurement equipment (pulse oximeter, weight scale, spirometer)

Table 3. Details of interventions *(Continued)*

	• Patient recorded measurements along with any changes in shortness of breath, sputum, or signs of infection. Measurements without video were done 3 times a week for first 4 weeks, then once weekly; video conference with spirometry was done once a week for the first 4 weeks, then once every 4 weeks **Study administrator:** respiratory nurses, respiratory specialist **Data transmission:** automatic • Measurements were transferred to respiratory nurse at the call centre, weekdays 9 am to 3 pm, at the local hospital by each participant **Data acquisition:** asynchronous • Nurse analysed data once transmitted by participants **Clinical alert:** algorithm-dependent • Values/measurements used a colour-coding system (green, yellow, red) **Feedback from health professionals:** yes • 1 measurement with a red code or 2 measurements with a yellow code were received; participants were contacted by the respiratory specialist nurse
Ritchie 2016 12 weeks	**INTERVENTION: E-Coach web-based platform Interactive voice response monitoring system with self-management and education of the disease** **Participant data entry:** manual • Run-in: 1 visit by care transition nurse prior to discharge; measurements at baseline and at 30 days • E-Coach: tailored intervention, in-hospital assessment, web-based platform for patients' post-discharge support (and support for self-management) via telephone call (interactive voice response) and remote monitoring of data recorded by participants while at home • IVR-enhanced care: those randomised to E-Coach received initial coaching in the hospital and were then called by the interactive voice response-supported (IVR) system at specified intervals after discharge for monitoring (initially daily for 7 days, then either daily or every 3 days per patient preference for next 21 days) **Study administrator:** care transition nurse **Data transmission:** automatic • Participants transmitted data via telephone and web-based system **Data acquisition:** asynchronous • Care transition nurse reviewed data after data were transmitted **Clinical alert:** algorithm-dependent • IVR system generated a clinical alert (red flag) based on participant data **Feedback from health professionals:** yes • Participants were contacted in response to red flags by care transition coaches to help to address problems identified
Rose 2018 52 weeks	**INTERVENTION: integrated care intervention with education on living with COPD and individualised care, action plan for self-management, and telephone consultation** **Participant data entry:** based on telephone calls • Standard education on Living Well with COPD at study enrolment along with individualised care and action plans

Table 3. Details of interventions *(Continued)*

	• Telephone consultations initiated by case manager; 21 consultations total over the 9 months (12 weekly and 1 every month) • Consultations were focused on health behaviours, enforced action plan, current problems with disease, monitoring/assessment of symptoms of disease • Communication with physician, hospital specialists; access to ambulatory outpatient clinics • Usual care consisted of outpatient clinic visits, referral to hospital rehab programme, action planning, educational materials; current smokers were referred to smoking cessation resources **Study administrator:** case managers, GP **Data transmission:** not applicable **Data acquisition:** synchronous • Participant data were acquired at the time of telephone-based consultations **Clinical alert:** not applicable **Feedback from health professionals:** yes • Consultations included standard reinforcements/MI including action plan "teach-back" sessions
Sorknaes 2013 26 weeks	**INTERVENTION: integrated care intervention with exacerbation prevention education and remote in-home monitoring with face-to-face video** **Participant data entry:** automatic • Conventional treatment was covered in addition to video tele-consultations at home initiated within 24 hours of discharge • Equipment was installed by a technician in the home within 24 hours of discharge on a weekday and consisted of video equipment, on/off switch, volume button, and alarm switch connected to spirometer and pulse oximeter • Participants had video consultations with respiratory specialist or GP and/or home care system if needed • Face-to-face consultation with nurse at 4 and 12 weeks after discharge **Study administrator:** nurse, respiratory physician, general practitioner **Data transmission:** automatic • Participants measured pulse, saturation, and spirometry daily; this was transferred to hospital via equipment • Tele-consultations took place via Internet, wireless or satellite • Daily tele-consultation for 7 days between 8 am and 3 pm (ranging from 5 to 9 days) with 1 follow-up call after 1 week of TVC **Data acquisition:** synchronous • Nurses evaluated data at the same time as participants provided readings during tele-consultation **Clinical alert:** none **Feedback from health professionals:** yes • Tele-consultations included discussions on treatment, prevention of exacerbations, taking measurements with guidance or independently, and real-time monitoring of measurements by the nurse
Tabak 2014 39 weeks	**INTERVENTION: integrated care intervention using a mobile phone and web portal for exacerbation self-management, web-based exercise programme and activity coaching, tele- consultation via web portal**

Table 3. Details of interventions *(Continued)*

	Participant data entry: based on consultation via web portal • Intervention consists of 4 modules: tele-consultation, web-based exercise, self-management, activity coach • Tele-consultation for comments and questions sent by web portal. Participants and physiotherapist could also ask each other questions via the web portal about general or specific areas about exercise and plan • Web-based exercise was located on the web portal and included relaxation, breathing exercises, endurance and resistance training, and mucus clearing • Self-management module on the web portal taught participants to treat exacerbations without help from medical practitioner. Participants filled out a diary on the web portal. A nurse practitioner provided two 90-minute sessions (in person). If participants needed help, they were instructed to call the study office to consult with a chest physician or a nurse practitioner **Study administrator:** nurse practitioner, chest physician, physiotherapist **Data transmission:** automatic • Participants managed exacerbations themselves with information via web portal, and filled in a digital diary on the web portal daily **Data acquisition:** asynchronous • Health professionals could access diary data via the web portal, prior to a scheduled tele-consultation **Clinical alert:** none **Feedback from health professionals:** yes • Real-time consultation with patient once requested
Yan 2018 52 weeks	**INTERVENTION: remote consultation via mobile telephone with doctor** **Participant data entry:** manual • Educational information using photos and texts was sent to participants • Participants could consult with doctors at any time via text, voice, picture, or video; doctors were familiar with patients contacting them **Study administrator:** doctor **Data transmission:** automatic • Participant information was introduced in the doctor's network consulting room before discharge, and continued management was provided after discharge from hospital **Data acquisition:** synchronous • Doctors adjusted medication if participants showed signs of aggravation and arranged for hospitalisation if needed **Clinical alert:** none **Feedback from health professionals:** yes • Network doctors documented patient diagnosis, medications, and test results; answered patient questions; and sent patient reminders for examinations

6MWD: 6-min walking distance; **B2-agonist**: beta2-agonist; **CAT:** Chronic Obstructive Pulmonary Disease Assessment Test; **CCC:** clinical call centre; **CCQ:** clinical chronic obstructive pulmonary disease questionnaire; **CDMT:** chronic disease management team; **CHF:** congestive heart failure; **CHROMED:** Telemonitoring in Chronic Obstructive Pulmonary Disease in five countries; **CMC:** Clinical Monitoring Centre; **COPD:** chronic obstructive pulmonary disease; **CRT:** community respiratory team; **ECG:** electrocardiogram; **E-Coach:** an in-hospital

assessment and discretionary post-discharge support by a care transition nurse; **ED:** emergency department; **EDGE:** sElf-management anD support proGrammE; **e-Health:** location to central data management, Location Regional e-Health Centre; **EpxCOPD:** Epharmix chronic obstructive pulmonary disease system; **EQ-5D:** EuroQoL 5 Dimensions questionnaire; **FEV1:** forced expiratory volume in 1 second; **GP(s):** general practitioner(s); **HCP(s):** healthcare practitioner(s); **ICT:** information and communication technologies; **IVR:** interactive voice response; **LTOT:** long term oxygen therapy; **MCID:** minimal clinical important difference; **MLHFQ:** Minnesota Living with Heart Failure questionnaire; **MRC:** Medical Research Council dyspnoea score; **NHS:** National Health Service; **NOWOX:** wearable device that records time of oxygen use and respiration rate; **PC:** personal computer; **PEF:** peak expiratory flow; **PHQ-9:** Patient Health Questionnaire-9; **RACS-Plus:** Respiratory Ambulatory Care Service-Plus; **RM:** remote monitoring; **TM:** telemonitoring; **TVC:** telemedicine video consultation
Definitions: synchronous: data acquired in real-time; **asynchronous:** data acquired once transmitted by participant

Table 4. Remote monitoring plus usual care or remote monitoring alone: data not included in analyses

Outcome	Duration and effect estimate (95% CI)	Studies
Remote monitoring plus usual care vs usual care		
Quality of life: CRDQ	26 weeks: MD -1.00 (95% CI -13.47 to 11.47) 52 weeks: MD -5.00 (95% CI -16.71 to 6.71)	1 study (Antoniades 2012)
Quality of life: CCQ*	26 weeks: MD 0.17 (95% CI -0.20 to 0.54)	1 study (Berkhof 2015)
Quality of life: EQ-5D*	26 weeks: MD 0.08 (95% CI -0.04 to 0.20)	1 study (McDowell 2015)
Quality of life: SF-36*	26 weeks: MD -0.04 (95% CI -15.83 to 7.83)	1 study (Antoniades 2012)
Quality of life: SF-36*	52 weeks: MD -0.04 (95% CI -16.15 to 8.15)	1 study (Antoniades 2012)
Quality of life: SF-36 mental composite*	Mean 46 weeks: MD 0.44 (95% CI -2.20 to 3.08)	2 studies (Berkhof 2015; Vianello 2016)
Quality of life: SF-36 physical composite*	Mean 46 years: MD -0.69 (95% CI -2.74 to 1.35)	2 studies (Berkhof 2015; Vianello 2016)
Quality of life: SF-36 general subscale*	Mean 46 weeks: MD 0.03 (95% CI -2.29 to 2.34)	2 studies (Berkhof 2015; Vianello 2016)
Hospital admission: COPD-related hospital admission	52 weeks: rate ratio: 0.89 (95% CI 0.79 to 1.00)	1 study (Vianello 2016)
Remote monitoring vs usual care		
Quality of life: SF-36 mental composite*	52 weeks: MD 0.00 (95% CI -1.50 to 1.50)	1 study (Udsen 2017)
Quality of life: EQ-5D*	17 weeks: MD 0.03 (95% CI -0.13 to 0.18)	1 study (Jódar-Sanchez 2013)
Anxiety/depression: Goldberg anxiety and depression subscales	52 weeks: anxiety: MD -0.10 (95% CI -0.61 to 0.41) 52 weeks: depression: MD -0.40 (95% CI -1.02 to 0.22)	1 study (Soriano 2018)
Quality of life: MLHFQ score*	39 weeks: MD 0.80 (95% CI -3.27 to 4.87)	1 study (Walker 2018)

*Higher = better.
CCQ: Clinical Chronic Obstructive Pulmonary Disease Questionnaire; **CI:** confidence interval; **CRDQ:** Chronic Respiratory Disease Questionnaire; **EQ-5D:** EuroQoL 5 Dimensions Questionnaire; **GIV:** generic inverse variance; **MD:** mean difference; **MLHFQ:** Minnesota Living With Heart Failure Questionnaire; **SF-36:** Short Form 36 quality of life questionnaire.

Table 5. Multi-component interventions: data not included in analyses

Outcome	Effect (95% CI)	Studies
Exacerbations: mean number of days to first exacerbation	MD 0.90 (95% CI -25.65 to 27.45)	1 study (Bourbeau 2016)
Exacerbations: mean number of ED presentations (all-cause)	MD -0.40 (95% CI -0.89 to 0.09)	1 study (Rose 2018)
HA: mean number of hospital admissions (all-cause)	MD -0.11 (95% CI -0.36 to 0.14)	2 studies (Ringbaek 2015; Rose 2018)
HA: mean number of hospital admissions (COPD)	MD 0.01 (95% CI -0.24 to 026)	1 study (Ringbaek 2015)
HA: mean number of re-admissions (all cause)	MD -0.32 (95% CI -0.68 to 0.05)	2 studies (Casas 2006; Sorknaes 2013)
HA: mean number of re-admissions (COPD)	MD -0.06 (95% CI -0.57 to 0.45)	1 study (Sorknaes 2013)

CI: confidence interval; **COPD:** chronic obstructive pulmonary disease; **ED:** emergency department; **HA:** hospital admission; **MD:** mean difference.

APPENDICES

Appendix 1. Sources and search methods for the Cochrane Airways Trials Register

Electronic searches: core databases

Database	Frequency of search
CENTRAL (the Cochrane Library)	Monthly
MEDLINE (Ovid)	Weekly
Embase (Ovid)	Weekly
PsycINFO (Ovid)	Monthly
CINAHL (EBSCO)	Monthly
AMED (EBSCO)	Monthly

Handsearches: core respiratory conference abstracts

Conference	Years searched
American Academy of Allergy, Asthma and Immunology (AAAAI)	2001 onwards
American Thoracic Society (ATS)	2001 onwards
Asia Pacific Society of Respirology (APSR)	2004 onwards

(Continued)

British Thoracic Society Winter Meeting (BTS)	2000 onwards
Chest Meeting	2003 onwards
European Respiratory Society (ERS)	1992, 1994, 2000 onwards
International Primary Care Respiratory Group Congress (IPCRG)	2002 onwards
Thoracic Society of Australia and New Zealand (TSANZ)	1999 onwards

Condition search

1. exp Asthma/

2. asthma$.mp.

3. (antiasthma$ or anti-asthma$).mp.

4. Respiratory Sounds/

5. wheez$.mp.

6. Bronchial Spasm/

7. bronchospas$.mp.

8. (bronch$ adj3 spasm$).mp.

9. bronchoconstrict$.mp.

10. exp Bronchoconstriction/

11. (bronch$ adj3 constrict$).mp.

12. Bronchial Hyperreactivity/

13. Respiratory Hypersensitivity/

14. ((bronchial$ or respiratory or airway$ or lung$) adj3 (hypersensitiv$ or hyperreactiv$ or allerg$ or insufficiency)).mp.

15. ((dust or mite$) adj3 (allerg$ or hypersensitiv$)).mp.

16. or/1-15

17. exp Aspergillosis, Allergic Bronchopulmonary/

18. lung diseases, fungal/

19. aspergillosis/

20. 18 and 19

21. (bronchopulmonar$ adj3 aspergillosis).mp.

22. 17 or 20 or 21

23. 16 or 22

24. Lung Diseases, Obstructive/

25. exp Pulmonary Disease, Chronic Obstructive/

26. emphysema$.mp.

27. (chronic$ adj3 bronchiti$).mp.

28. (obstruct$ adj3 (pulmonary or lung$ or airway$ or airflow$ or bronch$ or respirat$)).mp.

29. COPD.mp.

30. COAD.mp.

31. COBD.mp.

32. AECB.mp.

33. or/24-32

34. exp Bronchiectasis/

35. bronchiect$.mp.

36. bronchoect$.mp.

37. kartagener$.mp.

38. (ciliary adj3 dyskinesia).mp.

39. (bronchial$ adj3 dilat$).mp.

40. or/34-39

41. exp Sleep Apnea Syndromes/

42. (sleep$ adj3 (apnoea$ or apnoea$)).mp.

43. (hypopnoea$ or hypopnoea$).mp.

44. OSA.mp.

45. SHS.mp.

46. OSAHS.mp.

47. or/41-46

48. Lung Diseases, Interstitial/

49. Pulmonary Fibrosis/

50. Sarcoidosis, Pulmonary/

51. (interstitial$ adj3 (lung$ or disease$ or pneumon$)).mp.

52. ((pulmonary$ or lung$ or alveoli$) adj3 (fibros$ or fibrot$)).mp.

53. ((pulmonary$ or lung$) adj3 (sarcoid$ or granulom$)).mp.

54. or/48-53

55. 23 or 33 or 40 or 47 or 54

Filter to identify randomised controlled trials

1. exp "clinical trial [publication type]"/

2. (randomised or randomised).ab,ti.

3. placebo.ab,ti.

4. dt.fs.

5. randomly.ab,ti.

6. trial.ab,ti.

7. groups.ab,ti.

8. or/1-7

9. Animals/

10. Humans/

11. 9 not (9 and 10)

12. 8 not 11

The MEDLINE strategy and RCT filter are adapted to identify studies in other electronic databases.

Appendix 2. Search strategies

Source and date of the last search	Search strategy	Results
Cochrane Airways Trials Register (via Cochrane Register of Studies) Date of most recent search=28 April 2020	#1 MESH DESCRIPTOR Pulmonary Disease, Chronic Obstructive EXPLODE ALL AND INSEGMENT #2 MeSH DESCRIPTOR Bronchitis, Chronic AND INSEGMENT #3 (obstruct*) near3 (pulmonary or lung* or airway* or airflow* or bronch* or respirat*) AND INSEGMENT #4 COPD:MISC1 AND INSEGMENT #5 (COPD OR COAD OR COBD OR AECOPD):TI,AB,KW AND INSEGMENT #6 #1 OR #2 OR #3 OR #4 OR #5 #7 MESH DESCRIPTOR Telemedicine EXPLODE ALL AND INSEGMENT #8 telehealth* or tele-health* AND INSEGMENT #9 telemedicine* or tele-medicine* AND INSEGMENT #10 telemanagement or tele-management AND INSEGMENT #11 telecare* or tele-care* AND INSEGMENT #12 telematic* AND INSEGMENT #13 telepharmacy or tele-pharmacy AND INSEGMENT #14 telenurs* or tele-nurs* AND INSEGMENT #15 tele-homecare or telehomecare AND INSEGMENT #16 teleconsultation or tele-consultation AND INSEGMENT #17 (remote* or distant or distance) NEAR (consult* or monitor* or care or treat* or therap*) AND INSEGMENT #18 (mobile* or digital*) NEXT health* AND INSEGMENT #19 ehealth or e-health AND INSEGMENT #20 mhealth or m-health AND INSEGMENT #21 MESH DESCRIPTOR Technology EXPLODE ALL AND INSEGMENT #22 MESH DESCRIPTOR Telephone EXPLODE ALL AND INSEGMENT #23 MESH DESCRIPTOR Videoconferencing EXPLODE ALL AND INSEGMENT #24 MESH DESCRIPTOR Electronic Mail EXPLODE ALL AND INSEGMENT #25 MESH DESCRIPTOR Text Messaging EXPLODE ALL AND INSEGMENT #26 MESH DESCRIPTOR Software EXPLODE ALL AND INSEGMENT #27 MESH DESCRIPTOR Software EXPLODE ALL AND INSEGMENT #28 MESH DESCRIPTOR Computers, Handheld EXPLODE ALL AND INSEGMENT #29 MESH DESCRIPTOR Computer-Assisted Instruction AND INSEGMENT #30 MESH DESCRIPTOR Decision Making, Computer-Assisted EXPLODE ALL AND INSEGMENT #31 MESH DESCRIPTOR Wireless Technology AND INSEGMENT #32 MESH DESCRIPTOR Internet EXPLODE ALL AND INSEGMENT #33 (internet* or computer* or web* or online*):ti,ab,kw AND INSEGMENT #34 (telephone or phone*):ti,ab,kw AND INSEGMENT #35 (sms or mms or texting or text messag*):ti,ab,kw AND INSEGMENT #36 (video* or skype*):ti,ab,kw AND INSEGMENT	November 2018=1084 April 2020=553

(Continued)

	#37 (email or e-mail or electronic mail):ti,ab,kw AND INSEGMENT #38 interactive* or telecommunication* AND INSEGMENT #39 wireless* or bluetooth* AND INSEGMENT #40 smartphone* or cellphone* AND INSEGMENT #41 (iphone* or ipod* or podcast* or ipad* or android* or blackberr* or palm pilot*):ti,ab,kw AND INSEGMENT #42 (pda* or personal digital assistant*):ti,ab,kw AND INSEGMENT #43 (tablet* or hand-held*) near3 (device or computer) AND INSEGMENT #44 social* near3 (media* or network*) AND INSEGMENT #45 smart watch or smartwatch AND INSEGMENT #46 wearable*:ti,ab,kw AND INSEGMENT #47 #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44 OR #45 OR #46 #48 #47 AND #6	
IEEE Xplore Digital Library (https://ieeexplore.ieee.org/Xplore/home.jsp) Date of most recent search=28 April 2020	((COPD OR "chronic obstructive pulmonary disease" OR "chronic obstructive lung disease" OR "chronic obstructive airways disease" OR emphysema OR "chronic bronchitis" OR AECOPD))	November 2018=105 April 2020=25
ClinicalTrials.gov (https://www.clinicaltrials.gov/) Date of most recent search=28 April 2020	Condition: COPD Study type: Interventional: Intervention: telehealth OR telemedicine OR telemanagement OR telecare OR telematic OR telepharmacy OR telenursing OR telehomecare OR teleconsultation OR telemonitoring OR remote OR distant OR mobile OR digital OR mhealth OR ehealth OR internet OR web OR online OR video OR skype OR text OR SMS OR email OR smartphone OR cellphone OR ipad OR social media OR smartwatch OR wearable	November 2018=132 November 2020=26
WHO ICTRP (https://www.who.int/clinical-trials-registry-platform) Date of most recent search: 21 November 2018	Condition: COPD Intervention: telehealth OR telemedicine OR telemanagement OR telecare OR telematic OR telepharmacy OR telenursing OR telehomecare OR teleconsultation OR telemonitoring OR remote OR distant OR mobile OR digital OR mhealth OR ehealth OR internet OR web OR online OR video OR skype OR text OR SMS OR email OR smartphone OR cellphone OR ipad OR social media OR smartwatch OR wearable	November 2018=51 April 2020: not searched (inaccessible)

HISTORY

Protocol first published: Issue 11, 2018

CONTRIBUTIONS OF AUTHORS

SJ: drafting of background and methods of protocol. Sifting, data extraction, risk of bias assessment, and write-up of full review.

CT: drafting of background and methods of protocol. Sifting, data extraction, risk of bias assessment, and write-up of full review.

SP: critical review of protocol, analysis and interpretation, approval of final draft of full review.

RD: conceptual and clinical advice, drafting of background and methods of protocol. Arbitration of conflicts, analysis and interpretation, and approval of final draft of full review.

DC: sifting, data extraction, risk of bias assessment, and write-up of full review.

Contributions of editorial team

Rebecca Fortescue (Co-ordinating Editor) edited the protocol; advised on methods; approved the protocol prior to publication.

Milo Puhan (Contact Editor): edited the review; advised on methods, interpretation, and content.

Emma Dennett (Managing Editor): co-ordinated the editorial process; advised on interpretation and content; edited the review.

Emma Jackson (Assistant Managing Editor): conducted peer review; obtained translations; edited reference sections and other sections of the protocol and the review.

Elizabeth Stovold (Information Specialist): designed the search strategy; ran the searches; edited the search methods section.

Lucy Goldsmith: checked data entry prior to full write-up of the review.

DECLARATIONS OF INTEREST

SJ: was employed full-time as a systematic reviewer by a National Institute for Health Research (NIHR) Programme Grant to complete work on this review.

DC: has no conflicts of interest related to the review

CT: was employed part-time in 2017-18 by an NIHR Programme Grant to complete work on this Cochrane Review. He is currently a Specialty Registrar in Clinical Pharmacology and Therapeutics and General Internal Medicine.

SP: has received payment for lectures including speaking services from Boehringer Ingelheim, NAPP, Novartis, Pfizer, Nutricia, AstraZeneca, and TEVA, and travel expenses from Nutricia, AstraZeneca, and TEVA. SP has no conflicts of interest related to the review.

RD: has no conflicts of interest. She is supported by an Australian Research Council DECRA Fellowship and by the Australian Government Department of Health Rural Health Multidisciplinary programme as a Senior Research Fellow within an academic unit.

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- All, Other

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DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Under Types of interventions, we included studies in which the intervention was part of a complex multi-component integration care intervention, but we did not include these studies in meta-analyses for the above pre-specified comparisons.

Under Types of participants, we excluded mixed population studies in which the COPD population was less than 50%. If the COPD population was 50% to 80%, we contacted study authors for disaggregated COPD data, if these were not already reported in the publication. If we did not hear from the study authors, we excluded the study. If the COPD population was 80%, we included the study.

Under Methods, we included dyspnoea symptoms, as this was considered an important primary outcome by co-authors of this review.

Owing to the large volume of references, another co-author of this review (DC) helped to screen references, extract data from studies, and perform risk of bias assessments.

We excluded studies of less than 3 months' duration, as effects of interventions would not be observed below this time point.

INDEX TERMS

Medical Subject Headings (MeSH)

Disease Progression; Dyspnea [etiology] [therapy]; *Pulmonary Disease, Chronic Obstructive [drug therapy]; Quality of Life; Referral and Consultation; *Telemedicine

MeSH check words

Female; Humans; Male