Telerehabilitation in Subjects With Respiratory Disease: A Scoping Review

Shunsuke Taito, Kota Yamauchi, and Yuki Kataoka

Considering the current coronavirus disease (COVID-19) pandemic, telerehabilitation may be a viable first-line option for patients with respiratory tract disease. To date, there has been no systematic review on telerehabilitation for respiratory tract diseases, including COVID-19. Therefore, this scoping review aimed to determine what telerehabilitation for patients with respiratory tract diseases consists of, how safe telerehabilitation is for patients with respiratory tract diseases, and how feasible telerehabilitation is for hospitalized patients with COVID-19. In May 2020, we conducted a search of the following publication databases on the use of telerehabilitation in the treatment of respiratory tract diseases: Medical Literature Analysis and Retrieval System Online, Embase, Cochrane Central Register of Controlled Trials, Cumulative Index to Nursing and Allied Literature, and Physiotherapy Evidence Database. Of the 208 articles identified, 23 studies were subsequently included in this scoping review. In 22 of the included studies, subjects had stable COPD and underwent telerehabilitation at home. The final included study was a case series of subjects with severe acute respiratory syndrome coronavirus 2 infection who underwent telerehabilitation in-hospital. Most telerehabilitation programs consisted of aerobic exercises using a cycle ergometer or a treadmill, walking, and muscle-strengthening exercises. The reported number of adverse events was low, and most studies reported that the average session adherence rate was > 70%. The majority of the telerehabilitation programs included a face-to-face rehabilitation assessment. Our findings indicate that, in its current state, telerehabilitation may be safe and feasible and may lead to reduced face-to-face rehabilitation therapy; in addition, remote rehabilitation assessment should be considered during the COVID-19 pandemic. Further research that targets a more diverse range of respiratory tract diseases and considers telerehabilitation in a hospital setting is required. *Key words: chronic obstructive pulmonary disease; coronavirus; pandemic; rehabilitation; respiratory tract diseases; telerehabilitation.* [Respir Care 2021;66(4):686–698. © 2021 Daedalus Enterprises]

Introduction

Pulmonary rehabilitation (PR) is recognized as an important, standard treatment for individuals with chronic respiratory diseases. The goals of PR for chronic respiratory disease include minimizing symptom burden, maximizing exercise performance, and increasing participation in activities of daily living.[1] PR is a first-line management strategy in patients with COPD, and it reduces dyspnea, increases exercise capacity, and improves health-related quality of life.[2,3] It is beneficial to patients with diseases besides COPD such as interstitial lung

disease, cystic fibrosis, bronchiectasis, and asthma.[1] Depending on the disease, PR may become established in the acute phase, such as while a patient is still in the hospital after an exacerbation.[4,5]

Telerehabilitation refers to the delivery of therapeutic rehabilitation at a distance or in out-of-hospital settings using telecommunication technologies.[6] Improving access to PR is one of the most pressing issues in the respiratory community.[1,7] A recent systematic review including only stable subjects with COPD clarified that home-based telehealth care may lead to increased physical activity level.[8] Although PR is provided for patients with other respiratory diseases except for stable COPD, telerehabilitation for respiratory tract disease has not been sufficiently investigated.

Due to the ongoing coronavirus disease (COVID-19) pandemic, redesigning rehabilitation services with the aim of minimizing face-to-face contact in both a timely and evidence-based manner has become important. Telerehabilitation has been suggested as the first-line option for patients with respiratory tract diseases, including those with COVID-19 in the post-acute phase.[9] COVID-19 is a respiratory tract disease that has demonstrated rapid and widespread transmission.[10] This has prompted the use of telerehabilitation systems in hospitals to mitigate the spread of the infection.[11] It is, therefore, necessary to consider telerehabilitation during the acute phase for in-patients as well as during the post-acute phase from the perspective of infection prevention.

Therefore, this scoping review, conducted in the COVID-19 era, aimed to determine what telerehabilitation for patients with respiratory tract disease consists of, how safe telerehabilitation is for patients with respiratory tract diseases, and how feasible telerehabilitation is for hospitalized patients with COVID-19.

Review of the Literature

In accordance with the pre-defined protocol,[12] we conducted a scoping review based on the 5-stage framework outlined by the Joanna Briggs Institute: identifying the research question; identifying relevant studies; study selection; data charting; and collating, summarizing, and reporting the results.[13] This scoping review follows the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews statement[14] (see the supplementary materials at http://www.rcjournal.com).

Eligibility Criteria and Search Strategy

We used the Population, Concept, and Context framework[13] to define the inclusion criteria. All published studies conducted on subjects with respiratory tract diseases, including those with severe acute respiratory syndrome coronavirus 2 infection (SARS-Cov-2), Middle East respiratory syndrome, and coronavirus disease (COVID-19), were included. In this scoping review, the International Classification of Diseases, Tenth Revision, Clinical Modification codes of subjects included J00–J99 for diseases of the respiratory system; A15–16 for respiratory tuberculosis; U04 for SARS-Cov-2 infection; U07.1 for COVID-19, virus identified; and U07.2 for COVID-19, virus unidentified. We reviewed the existing literature on telerehabilitation in subjects with respiratory tract diseases regarding rehabilitation programs, feasibility, and safety. In this review, telerehabilitation was defined as delivery of therapeutic rehabilitation at a distance or offsite using telecommunication technologies.[6] We also included studies on telerehabilitation, remote rehabilitation, and virtual rehabilitation as defined by each study's authors. Studies were included regardless of the setting (including hospitals), phase, country, and follow-up duration. Studies were excluded if they did not fit the conceptual framework of the review.

Comprehensive searches of the following databases were conducted on May 9, 2020: Medical Literature Analysis and Retrieval System Online, Embase, Cochrane Central Register of Controlled Trials, Cumulative Index to Nursing and Allied Literature, and Physiotherapy Evidence Database (see the supplementary materials at http://www.rcjournal.com). In addition, searches were conducted in the World Health Organization International Clinical Trials Registry Platform and ClinicalTrials.gov to identify ongoing clinical trials. We also identified additional relevant research by hand-searching the reference lists of the included studies and relevant reviews (based on the citation information from the Web of Science).

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Supplementary material related to this paper is available at http://www.rcjournal.com.

The authors have disclosed no conflicts of interest.

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DOI: 10.4187/respcare.08365

All published randomized controlled trials (RCTs), crossover trials, cluster-randomized trials, quasi-randomized trials, non-randomized trials, observational studies with controls, case reports, and case series were included. Studies in any language and from any country were accepted. Conference abstracts and review articles were excluded from this study, following the pre-defined protocol.[12]

Study Selection

The selection of studies was conducted independently by 2 researchers (ST and KY). The 2 researchers compared their lists, and any differences in opinion were resolved by discussion; where this failed, resolution was reached through arbitration by a third researcher (YK).

Data Extraction and Synthesis

Data extraction was conducted by 1 researcher (ST) using standard data-extraction forms including diagnosis, setting, study type, number of subjects, telerehabilitation program, control, outcomes, adverse events, and feasibility as in the pre-defined protocol.[12] Another researcher (KY) confirmed the extracted data. Where necessary, we contacted the authors of the reviewed publications. We organized the extracted data described above as a qualitative synthesis.

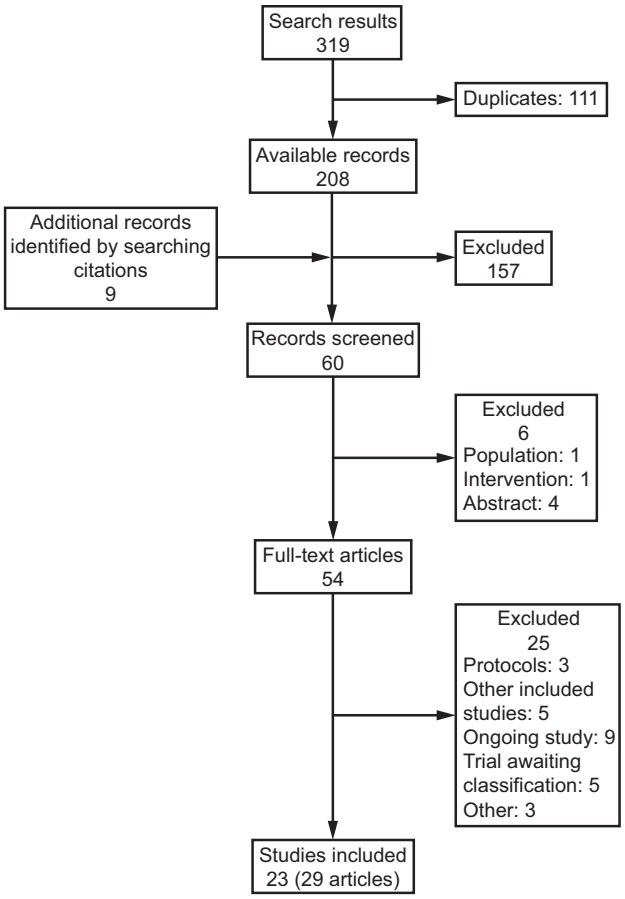

Fig. 1. Flow chart.

Results

Of the 208 articles identified, 29 articles (23 studies) were included in this scoping review.[11,15-42] The study selection process is shown in Figure 1. Fifteen studies were conducted in Europe, including Denmark,[16,27,40,42] United Kingdom,[31,32,39] Italy,[26,30] the Netherlands,[22,23] Norway,[20,34] Germany,[37] and Greece[33] (see the supplementary materials at http://www.rcjournal.com). Regarding the study design, this review included 8 RCTs,[16,22,28,30-33,42] 6 case-control studies,[15,23,25,26,38,39] and 9 case series.[11,19-21,27,34,36,37,40]

Subjects in 22 of the 23 included studies (95.7%)[15,16,19-23,25-28,30-34,36-40,42] had stable COPD who underwent telerehabilitation at home (Table 1). One case series[11] reported subjects with SARS-CoV-2 infection in Japan who underwent telerehabilitation in the hospital. Although most ongoing studies and studies awaiting classification included subjects with COPD,[43-52] 2 RCTs in subjects with COVID-19[53,54] were ongoing, and 2 studies including subjects with idiopathic pulmonary fibrosis[55] and cystic fibrosis[56] were awaiting classification (see the supplementary materials at http://www.rcjournal.com).

Telerehabilitation programs in 14 of the studies consisted of both aerobic exercise, performed with a cycle ergometer or a treadmill or by walking, and muscle strength exercises (Table 1).[15,18,19,23,25-28,30,32,34,36,38,40] The rehabilitation programs of 4 studies included stretching and breathing exercises.[15,26,29,38] Thirteen studies used pulse oximetry to monitor oxyhemoglobin saturation and pulse rate.[11,19,21,25-27,29,30,33,34,36,38,40] Sixteen studies[11,15,16,19-21,23,25-28,34,38-40,42] used a web camera system and a laptop or tablet computer for video conferencing. Three studies used internet-based or smartphone applications to encourage subjects to exercise.[32,36,39] The frequency of the programs varied from daily to twice per week. The duration of the majority of the programs was < 12 weeks[15,19-23,25-28,30-32,36-39,42] without excluding 1- or 2-y programs.[33,34]

Seventeen studies[11,15,16,20,21,25-28,30-32,36,38-40,42] reported that the number of adverse events was low (Table 2). The median ratio of subject withdrawal from the included studies was 5.0% (range 0–56.9%). The most reported average rate of adherence to telerehabilitation sessions was $> 70\%$ (Table 2).[11,15,21,25,27,28,31,33,36,38,40,42] Most telerehabilitation programs did not include a face-to-face rehabilitation session but included a face-to-face rehabilitation assessment.[15,19,21,25,26,28,30-32,34,36,38-40,42]

Table 1. Telerehabilitation for Subjects With Respiratory Diseases

Study	Country	Diagnosis	Setting	Study Type	Subjects, *N*	Telerehabilitation Program	Control	Outcomes
Stickland et al[15]	Canada	COPD	At home	Case-control study	409	F: 2 times/wk for 8 wk I: personalized based on the patient's symptoms and baseline exercise capacity T: 2-h group exercise and 1-h group educationt: group exercise included aerobic exercise (treadmill walking, cycling, and arm ergometer training), resistance exercise using hand weight or elastic bands/tubes, and flexibility and breathing retraining	Standard PR: 2/wk; 2-h group exercise and 1-h group -education	SGRQ, 12-min walk distance
Dinesen et al[16]	Denmark	COPD	At home	RCT	111	F: 2 times/wk for 16 wk I: NA T: 2 h t: stretching of neck muscles, exercises for the legs, standing exercises for arms and chest cavity, and walking exercise	NA	Admission rates, costs, qualitative interviews with subjects
Tousignant et al[19]	Canada	COPD	At home	Case series	3	F: 3 times/wk for 8 wk I: NA T: depended on subject conditiont: cycle ergometer, strength exercise	Not applicable	6MWD, CRQ, adherence
Burkow et al[20]	Norway	COPD	At home	Case series	5	F: 1 time/wk for 6 wk at home I: NA T: 30 min: exercise program intended to strengthen upper and lower extremities and to increase thorax flexibility	Not applicable	Interviews
Holland et al[21]	Australia	COPD	At home	Case series	8	F: 2 times/wk for 8 wk I: 60% of peak work T: up to 30 min t: cycle ergometer	Not applicable	Adverse events, 6MWD, CRQ, mMRC
Tabak et al[22]	The Netherlands	COPD	At home	RCT	34	F: ≥ 4 d/wk for 4 wk I: NA T: NA t: walking	Usual care	Activity level, CCQ, MRC, MFI-20
Jansen-Kosterink et al[23]	The Netherlands	COPD	At home	Case-control study	50	F: 3 times/wk for 12 wk; it was a partial replacement telerehabilitation service: 1 d at the clinic was	3 times/wk for 12 wk, conventional outpatient rehabilitation	CRQ, dyspnea, 6MWT, SUS

(Continued)

Table 1. Continued

Study	Country	Diagnosis	Setting	Study Type	Subjects, *N*	Telerehabilitation Program	Control	Outcomes
						replaced with 1 d of rehabilitation in subject's own environment after 4 wk of out-patient rehabilitation I: NA T: average 38.1 min/wk of telerehabilitationt: exercises for endurance, strength, breathing, and balance		
Marquis et al[25]	Canada	COPD	At home	Case-control study	26	F: 3 times/wk for 8 wk I: moderate intensity (~ 60% of the maximum work rate or between 3 and 4 on Borg dyspnea perception scale) T: 10–40 min for aerobic exercise, depending on subject's physical conditiont: aerobic exercise using cycle ergometer, strengthening exercise using weight and rubber band	Without treatment	Lung function, 6MWT, CET, CRQ, satisfaction, adherence
Paneroni et al[26]	Italy	COPD	At home	Case-control study	36	F: 28 sessions (for a maximum period of 40 d) I: individually tailored T: 100 min per session t: cycle ergometer, stretching and relaxation, strength muscle exercises	Standardized out-patient rehabilitation program	6MWT, mMRC, SGRQ, physical activity, adverse event
Minet et al[27]	Denmark	COPD	At home	Case series	50	F: 3 times/wk for 3 wk I: 60–90% of maximum capacity T: 30–45 min/sessiont: thoracic mobilization exercises, cardio training (swing exercises, seated walking exercise, stair workout), strength training (elastic exercise, standing squats, stand and sit chair exercise), breathing exercises (pursed-lip breathing diaphragmatic breathing)	Not applicable	Safety (falls), CCQ, TUG, FTSST
Tsai et al[28]	Australia	COPD	At home	RCT	37	F: 3 times/wk for 8 wk I: 60% or 80% peak cycle work rate, 80% of 6MWT speed	No exercise trainingeducation; usual medical management, including	Pulmonary function test, 6MWT, ISWT, ESWT, CRQ, physical activity, (Continued)

Table 1. Continued

Study	Country	Diagnosis	Setting	Study Type	Subjects, *N*	Telerehabilitation Program	Control	Outcomes
						T: 1-h sessions (30–40 min training) t: cycle ergometer, walking, strength exercise	optimal pharmacologic intervention and an action plan	FPI-SF, CAT, mMRC, HADS, PRAISE, CSQ-8
Bourne et al[31]	United Kingdom	COPD	At home	RCT	90	F: 2–5 times/wk for 6 wk I: each week, the length of each exercise increased by 30 s (starting from 60 s in week 1 to 3.5 min in week 6) T: NA t: 10 exercises (biceps curls, squats, push-ups against a wall, leg extensions in the sitting position, upright row with weights, sit-to-stand, arm swings with a stick, leg kicks to the side, arm punches with weights, step-ups)	Face-to-face PR: 2 supervised sessions for 6 wk, then subjects were asked to carry out the exercise at home (for an additional 3 times/wk)	6MWD, CAT, SGRQ, HADS, adverse event
Chaplin et al[32]	United Kingdom	COPD	At home	RCT	103	F: daily, anticipated for 6–7 wk I: 85% of baseline performance T: progressed maintaining a VAS rating of 4–7 t: walking, strength exercise	Conventional PR: 2 times/wk, 2-h sessions (1 h for exercise training, 1 h for education)	ISWT, ESWT, CRQ, HADS, PRAISE, BCKQ, Euro-QOL, adverse event
Vasilopoulou et al[33]	Greece	COPD	At home	RCT	150	F: 3 times/wk for 12 months I: depending on fitness level as assessed with mean daily step count, subjects were divided into 3 levels (A: $< 2{,}000$ steps, B: 2,000–6,000 steps, C: $> 6{,}000$ steps) and given exercise programs of graded difficulty based on their weekly mean number of steps T: 1 h per sessiont: physical exercise	Hospital-based rehabilitation or usual care	Severe exacerbation of COPD, hospitalization, emergency department visits, lung function, 6MWT, daily physical activity, SGRQ, CAT, mMRC, adherence
Zanaboni et al[34]	Norway	COPD	At home	Case series	10	F: individual program (eg, 3 times/wk) for 2 y I: modified by the physiotherapist	Not applicable	Number of hospital admissions, long-term exercise maintenance, (Continued)

Table 1. Continued

Study	Country	Diagnosis	Setting	Study Type	Subjects, *N*	Telerehabilitation Program	Control	Outcomes
						according to subject's condition T: NA t: treadmill and strength exercise		adherence, hospital LOS, health care cost, EQ-5D, PGIC
Bernocchi et al[30]	Italy	COPD + CHF	At home	RCT	112	F: 3–7 d/wk for 4 months I: number/intensity of training sessions depended on subject's progress T: personalized for each subject t: aerobic exercise (ergometer and walking), muscle reinforcement exercise (weights)	Standard care program	6MWD, time to event (re-hospitalization for all causes, death), dyspnea, physical activity profile, Barthel index, CAT, MLHFQ
Benzo et al[36]	USA	COPD	At home	Case series	12	F: ≥ 6 d/wk for 8 wk I: low-intensity exercise, slow walking T: at least 12 min of walkingt: full-body exercise, walking	Not applicable	Adherence, WAI-SR, 5-question follow-up questionnaire
Rassouli et al[37]	Germany	COPD	At home	Case series	56	F: daily for 20 dI: automatically recommended by the app T: automatically recommended by the app t: strength training, mobility training, patient education, mindfulness techniques	Not applicable	CAT, CRQ
Bhatt et al[38]	USA	COPD	At home	Case-control study	240	F: 3 times/wk for 12 wkI: 60–80% of maximum record on baseline 6MWT for aerobic exercise T: 20 min of aerobic exercise t: aerobic exercise (using a portable foot pedal, treadmills, exercise bike), resistance training (using resistance band), stretching, breathing exercises (pursed lips breathing, paced breathing, diaphragmatic muscle strength training)	Controls did not receive the telehealth PR intervention	30-d all-cause readmission rate, 30-d readmissions due to exacerbation of COPD, time to first readmission due to any cause
Knox et al[39]	United Kingdom	Chronic lung disease (mainly COPD)	At spoke site	Case-control study	21	F: 2 times/wk for 7 wk I: personalized T: 1–1.5-h exercise sessiont: aerobic exercise	Same program at the hospital	HADS, mMRC, CAT, ISWT, adverse event
Simonï et al[40]	Denmark	COPD	At home	Case series	16	F: 3 times/wk for 26 wk (including group-based educational sessions)	Not applicable	6MWD, 30-STST, CAT

(Continued)

Table 1. Continued

Study	Country	Diagnosis	Setting	Study Type	Subjects, *N*	Telerehabilitation Program	Control	Outcomes
						I: 60–80% maximum working capacity for endurance training; maximum of 10 repetitions for resistance training T: 75 min (50-min endurance or resistance training)t: endurance training (walking, arm rowing), resistance training		
Hansen et al[42]	Denmark	COPD	At home	RCT	134	F: 3 times/wk for 10 wk I: 40–80% of 1 repetition maximum, 4–7 self-rated Borg scaleT: 35-min exercise sessionst: protocolized exercise using dumbbells (sit-to-stand, biceps curl-shoulder press, step-up, bent-over rowing, static-dynamic squat, front raise dumbbells); patient education session for 20 min after the exercise session	Conventional out-patient hospital-based PR program, 2 times/wk for 10 wk; exercise session lasted 60 min, patient education session lasted 60–90 min once a week	6MWD, CAT, HADS, EQ-5D, 30-STST, CCQ, PAL
Mukaino et al[11]	Japan	SARS-CoV-2 infection	Hospital	Case series	4	F: depending on subject's conditionI: depending on subject's conditionT: 20 mint: stretching, muscle strengthening, balance exercise	Not applicable	Overall satisfaction, meaningfulness of program, recommendation program

*Program components: Frequency (F), Intensity (I), Time (T), and type (t).

CHF = congestive heart failure; PR = pulmonary rehabilitation; SGRQ = St George Respiratory Questionnaire; RCT = randomized controlled trial; NA = not available; 6MWD = 6-min walk distance; CRQ = Chronic Respiratory Disease Questionnaire; mMRC = modified Medical Research Council Scale; CCQ = Clinical COPD Questionnaire; MFI-20 = Multidimensional Fatigue Inventory; 6MWT = 6-min walk test; SUS = System Usability Scale; CET = Cycle Endurance Test; TUG = timed up and go test; FTSST = 5 times sit-to-stand test; VAS = visual analog scale; ISWT = incremental shuttle walk test; ESWT = endurance shuttle walk test; FPI-SF = Functional Performance Inventory-Short Form; CAT = COPD assessment tool; HADS = hospital anxiety and depression scale; PRAISE = PR Adapted Index of Self-Efficacy; CSQ-8 = Client Satisfaction Questionnaire-8; MLHFQ = Minnesota Living with Heart Failure Questionnaire; BCKQ = Bristol COPD Knowledge Questionnaire; QOL = quality of life; LOS = length of stay; EQ-5D = Euro-QOL 5-Dimension Questionnaire; PGIC = Patient Global Impression of Change Scale; WAI-SR = Working Alliance Inventory-Short Revised; 30-STST = 30-s sit-to-stand test; PAL = physical activity level; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2

Table 2. Safety and Feasibility of Telerehabilitation for Subjects With Respiratory Diseases

Study	Country	Diagnosis	Adverse Event	Withdrawals	Adherence	Face-to-Face Rehabilitation Evaluation	Face-to-Face Rehabilitation Session	Telerehabilitation Portion of All Rehabilitation Sessions, %
Stickland et al[15]	Canada	COPD	0	20 / 147	Sessions attended: 78.6% (average)	Yes	No	100
Dinesen et al[16]	Denmark	COPD	0	3 / 61	NA	Yes	Yes	NA
Tousignant et al[19]	Canada	COPD	NA	0/3	NA	Yes	No	100
Burkow et al[20]	Norway	COPD	0	NA	NA	NA	No	100
Holland et al[21]	Australia	COPD	Minor adverse events: S_{pO_2} < 88%: 1; heart rate > 150: 6	0/8	Sessions attended: 76%; subjects who completed program: 67%	Yes	No	100
Tabak et al[22]	The Netherlands	COPD	NA	4/18	NA	NA	No	100
Jansen-Kosterink et al[23]	The Netherlands	COPD	NA	7/36	NA	Yes	Yes	22.2
Marquis et al[25]	Canada	COPD	9	1/23	Sessions attended: 90% (average)	Yes	No	100
Paneroni et al[26]	Italy	COPD	0	0/18	NA	Yes	No	100
Minet et al[27]	Denmark	COPD	0	13/50	Sessions attended: 83.3% (average)	NA	No	100
Tsai et al[28]	Australia	COPD	0	1/20	Sessions attended: 92% (average)	Yes	No	100
Bourne et al[31]	United Kingdom	COPD	2	4/64	72% of both face-to-face sessions	Yes	No	100
Chaplin et al[32]	United Kingdom	COPD	5	29/51	Average of 4/wk	Yes	No	100
Vasilopoulou et al[33]	Greece	COPD	NA	0/47	93.5%	No	No	100
Zanaboni et al[34]	Norway	COPD	NA	0/10	NA	Yes	No	NA
Bernocchi et al[30]	Italy	COPD + CHF	0	11/56	NA	Yes	No	100
Benzo et al[36]	USA	COPD	0	0/12	Overall study adherence: 87%	Yes	No	100
Rassouli et al[37]	Germany	COPD	NA	22/56	NA	No	No	100
Bhatt et al[38]	USA	COPD	0	0/80	82.5% of subjects completed ≥ 20 sessions of telehealth pulmonary rehabilitation	Yes	No	100
Knox et al[39]	United Kingdom	Chronic lung disease (mainly COPD)	0	NA	61.9% of subjects attended ≥ 12 sessions	Yes	No	100
Simonï et al[40]	Denmark	COPD	0	1/16		Yes	No	100

(Continued)

Table 2. Continued

Study	Country	Diagnosis	Adverse Event	Withdrawals	Adherence	Face-to-Face Rehabilitation Evaluation	Face-to-Face Rehabilitation Session	Telerehabilitation Portion of All Rehabilitation Sessions, %
Hansen et al[42]	Denmark	COPD	0	10/67	Sessions attended: 85.9% (average) 83.3% of sessions (median)	Yes	No	100
Mukaino et al[11]	Japan	SARS-CoV-2 infection	0	0/4	Sessions attended: 100	No	100	100

CHF = congestive heart failure
NA = not available
SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2

Summary

This study is the first scoping review of telerehabilitation for treating respiratory tract diseases. The review included 23 studies involving a total of 1,717 subjects. In this study, we clarified that the available evidence on the use of telerehabilitation for subjects with respiratory tract diseases is primarily based on PR for patients with stable COPD; that telerehabilitation for subjects with respiratory tract diseases is safe; and that telerehabilitation would reduce the need for face-to-face rehabilitation programs, although face-to-face assessments are still required. This scoping review is the first to clarify the lack of evidence for the telerehabilitation of patients with other respiratory tract diseases beyond stable COPD.

Studies included in this review focused on stable COPD, except for a case series on COVID-19. The exercise types included in these studies were in accordance with the PR guidelines shown in Table 1. Ongoing studies have tried to recruit subjects with other respiratory tract diseases, including those with COVID-19, idiopathic pulmonary fibrosis, and cystic fibrosis. No study, except the case series of subjects with COVID-19,[11] reported telerehabilitation in a hospital setting. As optimal rehabilitation may vary with disease and setting, studies conducted on other diseases and in hospital settings are needed during the era of COVID-19.

For patients with respiratory tract diseases, telerehabilitation at home, using telemonitoring systems including measurements of S_{pO_2} and pulse rate, has been shown to be feasible and safe. The withdrawal rate of subjects from telerehabilitation was comparable to the reported rate in other studies (10–31.8%).[57] In addition, no serious adverse events were reported for subjects with COPD[58] and idiopathic pulmonary fibrosis,[59] and resistance training can be successfully performed during PR without increasing adverse events.[60] The number of adverse events was reported to be low in all included studies; thus, telerehabilitation is likely to be feasible and safe in patients with respiratory diseases such as stable COPD. As the majority of the studies did not specify the criteria for starting and discontinuing rehabilitation sessions, further studies are required to clarify whether the criteria used in telerehabilitation differ from those used in face-to-face rehabilitation.

Telerehabilitation for patients with COVID-19 in hospital settings may be feasible and help to reduce the need for face-to-face rehabilitation treatment. However, most evaluations determining the intensity of rehabilitation program before the implementation of telerehabilitation and the effectiveness of the program were conducted in a face-to-face manner. The guidelines for the field test to setting the exercise intensity state that the test should be performed in a location where a rapid and appropriate response to an emergency is possible.[61] To prevent infection and transmission during the COVID-19 pandemic, remote assessment of

telerehabilitation for hospitalized patients with COVID-19 is desirable.[11] Further research is needed to determine how rehabilitation assessments can be conducted remotely to deliver effective interventions.

This review has several strengths and limitations. Regarding its strengths, the results of this review are based on the currently available evidence, following a comprehensive literature search. Furthermore, we employed a rigorous methodology that followed a written protocol that was developed a priori. A limitation is the limited extent to which the findings of the present review can be generalized beyond stable COPD. However, this scoping review is also the first report to clarify the lack of evidence for telerehabilitation in respiratory tract diseases besides stable COPD.

In conclusion, previous studies regarding telerehabilitation in patients with respiratory tract diseases primarily included stable patients with COPD. Current telerehabilitation is safe and feasible and helps reduce face-to-face rehabilitation treatment; remote rehabilitation assessment should be considered during the COVID-19 pandemic. Further research that targets in-hospital telerehabilitation and other respiratory tract diseases apart from stable COPD is needed.

ACKNOWLEDGMENTS

The authors thank Editage (http://www.editage.jp) for English language editing.

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