European Respiratory Society statement on long COVID follow-up

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Shareable abstract (@ERSpublications)
Follow-up care of patients infected with SARS-CoV-2 is crucial and may improve their quality of life. More evidence and research is emerging to understand the causes, mechanisms and risks of long COVID consequences. https://bit.ly/3J1WMWy

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Abstract

Patients diagnosed with coronavirus disease 2019 (COVID-19) associated with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection frequently experience symptom burden post-acute infection or post-hospitalisation. We aimed to identify optimal strategies for follow-up care that may positively impact the patient's quality of life (QoL). A European Respiratory Society (ERS) Task Force convened and prioritised eight clinical questions. A targeted search of the literature defined the timeline of "long COVID" as 1–6 months post-infection and identified clinical evidence in the follow-up of patients. Studies meeting the inclusion criteria report an association of characteristics of acute infection with persistent symptoms, thromboembolic events in the follow-up period, and evaluations of pulmonary physiology and imaging. Importantly, this statement reviews QoL consequences, symptom burden, disability and home care follow-up. Overall, the evidence for follow-up care for patients with long COVID is limited.

Scope of document

The European Respiratory Society (ERS) Task Force identified the need for a statement to identify approaches to optimise clinical follow-up care in patients with long COVID.

A multidisciplinary Task Force of ERS members, specialists in pneumonology, radiology and outcomes assessment, convened on 23 December 2020. Key clinical questions relating to the follow-up of patients with long COVID were identified and prioritised by consensus. The Task Force was approved as part of ERS TF-2020-14 ("The European Respiratory Society Guideline for Management of COVID-19"; Chairs J. Chalmers and N. Roche) and follows other ERS COVID-19 initiatives [1–3]. The Task Force reviewed features of acute disease that could predict long-term consequences, data on thromboembolic event risk, as well as infection control during the long COVID period. Further, the Task Force reviewed the evidence for

cardiopulmonary and imaging techniques, and techniques for cognitive, psychological, disability and home care follow-up.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has infected over 300 million people and resulted in the deaths of over 6 million [4]. The natural history of COVID-19 and the long-term sequelae, with adverse health outcomes and impact on health-related quality of life (HRQoL), are not fully understood [5, 6].

Many patients who suffered from COVID-19 recover their baseline health status, but an uncertain proportion of COVID-19 survivors have persistent symptoms presenting a challenge for patients and physicians [7, 8]. These longer term consequences, thought to occur in ∼10% of people infected [9], appear to vary in severity, often impacting multiple organs. While the primary symptoms are often breathlessness, fatigue and sleeping difficulties, low-grade fever, depression, anxiety, and cardiac, pulmonary and renal anomalies have been reported [5], and there is no established nomenclature on how to define the lasting sequelae of COVID-19. Those proposed lack clear criteria of how to define this "condition" or how to stratify patients [10–13].

Guidelines

The National Institute for Health and Care Excellence, Scottish Intercollegiate Guidelines Network, and Royal College of General Practitioners in the UK published a rapid guideline on the management of the long-term effects of COVID-19 in December 2020 (updated November 2021) [14]. This guideline defines post-COVID-19 syndrome as "signs and symptoms that develop during or after an infection consistent with COVID-19, continue for more than 12 weeks and are not explained by an alternative diagnosis". Referral to post-COVID-19 syndrome assessment clinics is recommended when symptoms persist for 6–12 weeks. Acute COVID-19 signs and symptoms are characterised to occur up to 4 weeks following diagnosis, while "long COVID" describes signs and symptoms that continue or develop after acute COVID-19, and "post-COVID-19 syndrome" encapsulates those with symptoms persisting >12 weeks [14].

The UK National Institute for Health Research (NIHR) [15] suggests that people experiencing long COVID may exhibit distinct clinical entities, such as post-intensive care syndrome (equivalent to the acute post-COVID-19 phase), post-viral fatigue syndrome (if fatigue is the predominant post-COVID-19 symptom), permanent organ damage (an underlying mechanism explaining long-term symptoms) and long-term COVID-19 syndrome (equivalent to long and persistent post-COVID-19 phases) based on the hypothesis that post-COVID-19 symptoms vary in intensity and duration and are not linear or sequential [16]. In this statement we use the term "long COVID" to incorporate elements most in need of clinical follow-up and to include subgroups with ongoing symptomatic COVID-19 and post-COVID-19 syndrome.

Guidelines for the follow-up of long COVID

The clinical management of long COVID is challenging due to a lack of evidence-based guidelines and standardisation in the pulmonary definition/terminology of the post-COVID-19 "condition". The French Respiratory Medicine Society propose a complete lung evaluation in patients with symptoms persisting ⩾12 weeks following infection (day 0 defined as the day of hospital admission or beginning of symptoms) [17]. The British Thoracic Society guidance supports algorithms for evaluating COVID-19 survivors in the first 3 months after hospital discharge based on the severity of acute COVID-19 and whether intensive care unit (ICU)-level care was delivered [18]. Algorithms for both severe and mild-to-moderate COVID-19 groups recommend clinical assessment and cardiopulmonary evaluation in all patients at 12 weeks, according to clinical judgement. Based on the findings of the 12-week assessment, patients either have further evaluation or are discharged. Prior to this, an earlier clinical assessment for respiratory, psychiatric and thromboembolic sequelae and rehabilitation needs is recommended at 4–6 weeks post-discharge for those with severe acute COVID-19, defined as those needing ICU- or high dependency unit-level care or those hospitalised with severe pneumonia, the elderly and all those with comorbidities [18]. Parameters for "elderly" were not defined. Interim guidance on rehabilitation in hospital and post-discharge published by an ERS/American Thoracic Society (ATS)-coordinated international Task Force recommends early bedside rehabilitation for patients affected by severe COVID-19, assessment of oxygen needs at discharge and more comprehensive assessment of rehabilitation needs including physical as well as mental status 6–8 weeks post-discharge [2].

Monitoring patients with COVID-19 after discharge is necessary to understand the extent and severity of long-term effects. In this statement, we will focus on long COVID follow-up 1–6 months post-acute COVID-19 infection. We define day 0 as the day of discharge or the day of the beginning of symptoms. We aim to address questions about potent predictors of long-term consequences, as well as optimal

post-hospital assessment related to thromboembolic events, pulmonary physiology, imaging and infection control, based on current data. Further, we will appraise appropriate follow-up concerning cognitive and psychological functioning, quality of life (QoL), disability, and home care.

Methods

The Task Force consisted of 12 members (including an Early Career Member), experts in respiratory medicine, pulmonary physiology, radiology and outcomes assessment. Task Force members were selected by the Chairs based on their expertise and international representation.

The Chairs composed a list of 16 clinically important topics relevant to the follow-up of COVID-19 infection. Two meetings of Task Force members were convened and eight topics were selected according to clinical urgency and by consensus of the Task Force (table 1). Task Force members were divided into subgroups to address the topics. All questions were addressed following the ERS rules for statements. Statements are based on systematic literature searches (conducted by information specialists). A full systematic review with meta-analyses and grading of the evidence was not performed, and as a result this document does not contain recommendations for clinical practice. Individual literature searches for every question were designed by professional librarians, with the input of Task Force members. Systematic searches were conducted up to 26 March 2021 in MEDLINE and Cochrane CENTRAL. For the full search strategies, see appendix A in the supplementary material.

Studies meeting the inclusion criteria were published in English, reporting in adult populations, and on outcomes 1–6 months post-discharge in hospitalised and non-hospitalised patients. Case reports and case series were excluded, unless otherwise specified (supplementary table S1 in appendix B in the supplementary material). The study selection was finalised in April 2021. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagrams for each question are provided in appendix C in the supplementary material. Preliminary individual subsections were further discussed in a virtual meeting (May 2021) and revised until consensus among all co-authors was reached (June 2021). All co-authors critically revised and approved the final statement.

This ERS statement combines an evidence-based approach, clinical expertise of Task Force members, systematic search of the literature and critical discussions from virtual meetings. The statement summarises relevant literature and current practice by topic. It does not provide *de novo* recommendations for clinical practice but indicates where the Task Force members are in agreement with published guidance. Figure 1 illustrates the current practice of Task Force members. All members of the Task Force disclosed their conflicts of interest before initiation of the project and upon submission of the manuscript.

Clinical Question 1. Are there features of the acute disease characteristics which predict long-term consequences?

Evidence overview

Few data are available on predictors of long-term consequences of COVID-19. They mainly include pulmonary fibrosis, as described by reduced single breath diffusing capacity of the lung for carbon monoxide (D_{LCO}), restrictive syndrome and persistent ground-glass opacities (GGO), and fatigue and/or anxiety 1–8 months post-COVID-19. Initially, 4524 records were identified. 12 eligible studies were included (one retrospective cohort study and 11 prospective studies) [8, 19–29], focusing directly on predicting factors of pulmonary fibrosis and/or persistent symptoms after a COVID-19 episode (appendix C in the supplementary material). Of the 12 studies, the majority reported on hospitalised patients and three reported on both hospitalised and non-hospitalised. No studies included non-hospitalised patients only.

TABLE 1 The eight clinical priorities and questions addressed by this Task Force

1	Are there features of the acute disease characteristics which predict long-term consequences?
2	Which follow-up strategies relate to thromboembolic events?
3	Which follow-up strategies relate to pulmonary physiology?
4	Which follow-up strategies relate to imaging?
5	Which follow-up strategies relate to infection control?
6	Which follow-up strategies relate to cognitive, psychological and quality-of-life consequences?
7	Which follow-up strategies relate to disability?
8	Which follow-up strategies relate to home care follow-up (tele-medicine/tele-rehabilitation)?

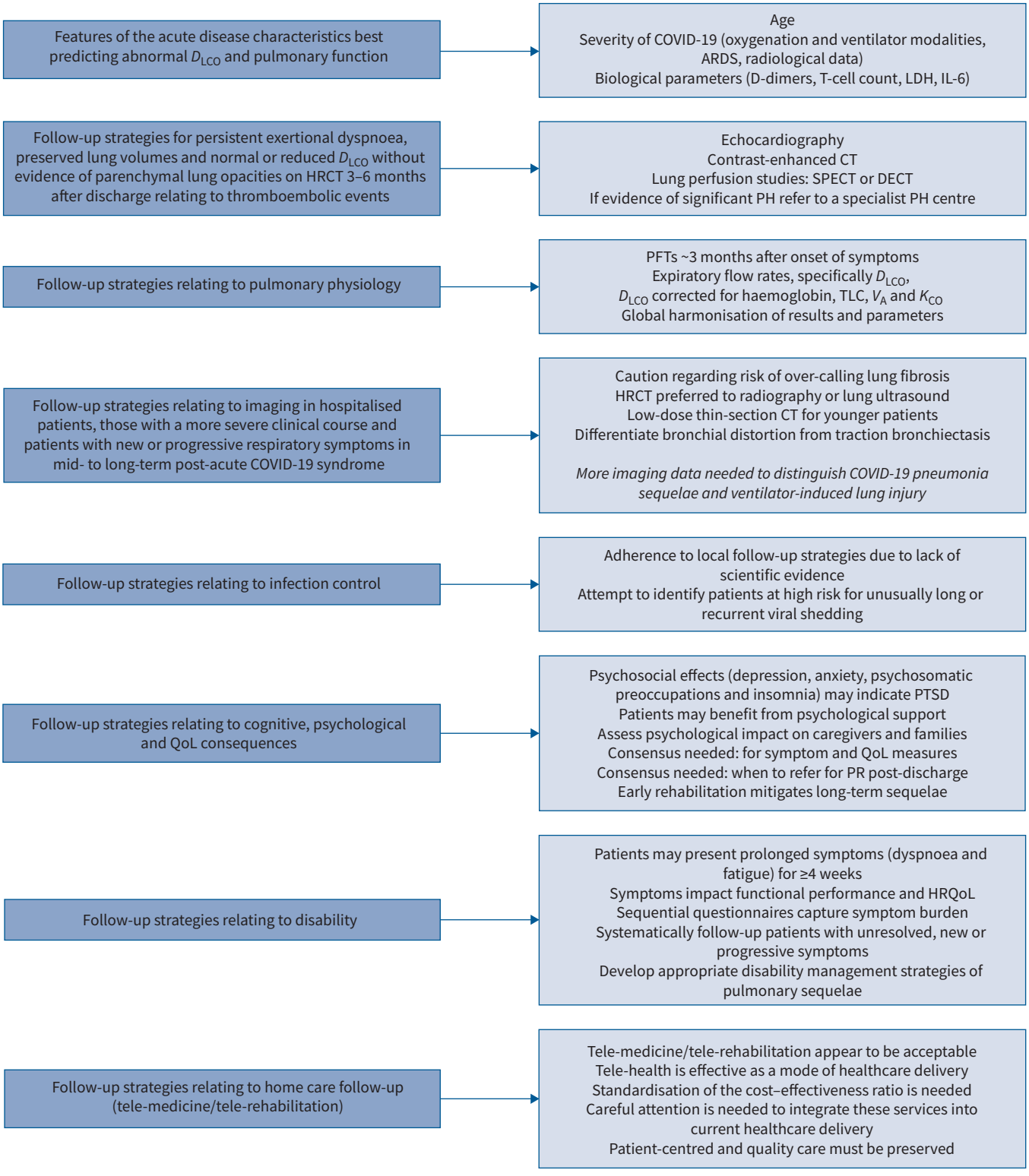

FIGURE 1 Current practice of the Task Force members on their management of patients with long COVID-19, 1–6 months post-acute COVID-19 infection (based on the eight clinical priorities and questions listed in table 1). This figure describes the current practice of how the members of the Task Force treat patients with COVID-19 and is not intended as a recommendation for clinical practice. D_{LCO}: diffusing capacity of the lung for carbon monoxide; ARDS: acute respiratory distress syndrome; LDH: lactate dehydrogenase; IL: interleukin; (HR)CT: (high-resolution) computed tomography; SPECT: single-photon emission computed tomography; DECT: dual-energy computed tomography; PH: pulmonary hypertension; PFT: pulmonary function test; V_A: alveolar volume; K_{CO}: transfer coefficient of the lung for carbon monoxide; PTSD: post-traumatic stress disorder; (HR)QoL: (health-related) quality of life; PR: pulmonary rehabilitation.

The main persistent symptoms reported in the included studies were fatigue (50–65% of patients) and anxiety/depression (20–40%). Risk factors for COVID-19 persistent symptoms, especially fatigue, were not associated with initial severity [19], but with age, female gender and the number of symptoms during the first week of infection [19]. These results were not found in all studies [20]. Few studies focused on olfactory and gustatory late resolution. The initial grade of dysfunction (total or partial), gender and presence of nasal congestion appeared as potential predictive factors [21].

The vast majority of the studies included in this analysis focused on pulmonary fibrosis and reduced D_{LCO}. The size of the cohorts and/or the design does not permit the calculation or estimation of the pulmonary fibrosis risk. HAN *et al.* [22] reported (in 114 hospitalised patients) that one-third of patients had fibrotic-like lesions on a computed tomography (CT) scan done 6 months after discharge.

Among all possible factors, age was the most frequent predictor of long-term consequences [8, 22], possibly because the ageing lung is more susceptible to the development of a fibrotic response or elderly people may have a subclinical interstitial lung disease exacerbated by acute infection [30]. Presence of acute respiratory distress syndrome (ARDS) (OR 13, 95% CI 3.3–55) at the acute phase of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and severity of the initial disease [8, 22, 23] were two predictive factors of pulmonary fibrosis, but these data are also demonstrated in other causes of ARDS. According to these studies, COVID-19 severity, as a predictor of pulmonary fibrosis, is evaluated by need for mechanical ventilation, ventilation duration, opacity score at discharge and hospitalisation duration [8, 22]. Some biological parameters have been found to be associated with higher risk of pulmonary fibrosis: high lactate dehydrogenase (LDH) level on admission, low level of T-cells and prolonged elevation of interleukin-6 [24]. These parameters again reflect disease severity and indicate the dysregulated immune response [25]. LDH has already been considered as a marker of pulmonary injury [26].

In the studies focusing on D_{LCO} decrease, the time to evaluate pulmonary function was variable between 1 and 8 months, so the long-term outcome of these abnormalities remains unknown. As for pulmonary fibrosis, initial disease severity [23, 27, 28], often evaluated by oxygenation modalities, sometimes by intensive care severity score and/or by other organ failure (*e.g.* renal failure), appeared as the main risk factor. High-flow oxygen therapy and mechanical ventilation (invasive and non-invasive ventilation) are associated to a higher risk of diffusion impairment (OR 4.6 in HUANG *et al.* [8]). Biologically, a higher level of D-dimer at admission in a small cohort of 55 patients was an independent predictor of abnormal D_{LCO} at 3 months [29].

Concluding remarks

Age, severity of COVID-19 (evaluated by a range of variables: oxygenation and ventilator modalities, ARDS, and radiological data) and some biological parameters (D-dimers, T-cell count, LDH and interleukin-6) appeared to be the best predictors of abnormal D_{LCO} and pulmonary fibrosis occurrence. On the contrary, severity of initial disease was not associated with the persistence of symptoms, which appeared to be linked to gender, age or the number of symptoms during the first week. These data are based on a few small studies and will need to be confirmed in new, larger studies.

Clinical Question 2. Which follow-up strategies relate to thromboembolic events?

Evidence overview

Hypercoagulability is a frequent haematological alteration in hospitalised patients with COVID-19. Clinical manifestations include venous thromboembolism (VTE), disseminated intravascular coagulation, thrombosis of the lung microvascular circulation and arterial thrombosis. The systematic literature search identified 1181 studies on long-term consequences and patient follow-up. Six eligible studies (three prospective studies, two retrospective studies and one strategy proposition) [31–36] were included (appendix C in the supplementary material).

Four studies examined the rate of thrombosis after discharge. In an Italian follow-up study of 767 patients with COVID-19, 51% still reported symptoms at a median time of 81 days after discharge, with 38% of those having an elevated D-dimer level [31], including two with asymptomatic pulmonary thrombosis discovered by investigating striking D-dimer elevation. In a retrospective cohort study of 163 post-discharge patients with confirmed COVID-19 not receiving anticoagulation, the cumulative incidence of thrombosis (including arterial and venous events) at day 30 following discharge was 2.5% (95% CI 0.8–7.6%); the cumulative incidence of VTE alone was 0.6% (95% CI 0.1–4.6%). As the rate of haemorrhage appeared to be of the same magnitude, universal post-discharge thromboprophylaxis was not recommended [32]. Similar figures were demonstrated at 42 days follow-up in a cohort of 152 patients [33]. In a 6-week follow-up study of 33 patients discharged without anticoagulation, all patients with elevated D-dimer levels

underwent ultrasound duplex scanning and a ventilation/perfusion scan to rule out VTE [34]. There were no thromboembolic complications and no echocardiographic impairments. Consequently, in the absence of other thrombotic risk factors, patients with COVID-19 are mostly discharged without prophylactic anticoagulation. If diagnosed with pulmonary embolism *de novo* during follow-up, patients should be treated in line with pulmonary embolism guidelines [37].

Only one of the identified studies reported on the long-term outcomes of patients with COVID-19 and VTE. This prospective observational study evaluated a composite of major bleeding and death at 90 days in 100 consecutive patients with VTE in the setting of COVID-19 (66 patients were hospitalised, 23 of them in the ICU; 64% pulmonary embolism) [35]. Mortality (24%) and major bleeding (11%) were high. The majority of complications occurred in the first 30 days. Most patients received direct oral anticoagulants (52%) or low-molecular-weight heparin (28%) at discharge. There were no VTE recurrences. The follow-up evaluation of patients with pulmonary embolism during acute COVID-19 draws from pulmonary embolism guidelines [37].

Concluding remarks

At this stage it is still unclear if pulmonary thromboembolism and inflammatory pulmonary microangiopathy [36] demonstrated in patients with severe COVID-19 will lead to sequelae such as chronic thromboembolic pulmonary hypertension (CTEPH) or pulmonary arterial hypertension. In patients with persistent exertional dyspnoea without evidence of parenchymal lung opacities on high-resolution CT 3–6 months after discharge and with pulmonary function tests (PFTs) documenting preserved lung volumes and normal or reduced D_{LCO}, follow-up evaluation should include echocardiography and contrast-enhanced CT to identify significant pulmonary vascular involvement, as per proposed guidance [18]. As contrast-enhanced CT cannot exclude CTEPH [38], lung perfusion studies with single-photon emission CT or dual-energy CT are proposed to exclude vascular involvement in symptomatic post-COVID-19 patients, even in the absence of pulmonary embolism history during the acute illness [39]. As suggested by previous ERS/ATS guidelines, if there is evidence of significant pulmonary hypertension, patients should be considered for referral to a specialist pulmonary hypertension centre [40, 41].

Clinical Question 3. Which follow-up strategies relate to pulmonary physiology?

Evidence overview

Although SARS-CoV-2 can theoretically infect various organs after binding to the ubiquitous angiotensin-converting enzyme 2 cell membrane receptor, the respiratory system is the most frequently impacted due to the airborne nature of the infective agent. Regarding PFTs after the acute phase, 1578 records were identified (appendix C in the supplementary material). 39 eligible studies (one randomised controlled trial (RCT), three systematic reviews, 11 prospective cohort studies, seven retrospective studies, 15 cross-sectional studies and two case series) [8, 23, 27–29, 34, 42–74] were included. Two studies were longitudinal [56, 57] and 11 were prospective [23, 44–48, 56, 57, 59, 60, 74], including four multicentre [23, 45, 46, 56].

When measuring PFTs at rest, all investigators sought three main features, *i.e.* the existence of 1) the obstructive pattern, 2) the restrictive pattern and 3) lung gas exchange impairment [8, 23, 27–29, 34, 42–60, 66–68, 73, 74]. Some investigators also looked at more integrative responses to physical exercise, either using the 6-min walk test (6MWT) [8, 23, 34, 42–51, 61, 62, 73, 74] or cardiopulmonary exercise testing (CPET) [51, 63–65]. The main parameter used to define the bronchial obstructive pattern is the forced expiratory volume in 1 s (FEV_1)/forced vital capacity (FVC) ratio. The restrictive pattern was deemed to be present based on either reduction of total lung capacity (TLC) or the combination of low FVC and high FEV_1/FVC ratio when TLC could not be measured. In some studies, reduced residual volume was also considered as part of the restrictive pattern. Lung gas exchange was mostly assessed using D_{LCO} [8, 23, 27–29, 34, 42–50, 52–60, 73, 74]. Only one study examined diffusing capacity of the lung for nitric oxide (D_{LNO}) combined with D_{LCO} [69]. The earliest time-point after the acute phase of the disease was 1 month [27, 42, 73], with a majority of the studies reporting PFTs from 6 weeks to 4 months [23, 28, 29, 42–51, 53–60, 66, 67], with very few at 6 months [8, 52, 64] post-discharge or onset of disease. Patient inclusion criteria were inconsistent between studies. The majority of the studies included hospitalised patients, while two studies involved both hospitalised and non-hospitalised, and only one was performed on non-hospitalised patients. Patients with pre-existing chronic lung disease were not differentiated, thus making it difficult to relate abnormal PFTs results to either COVID-19 lung injury or possible pre-existing disease. There were disparities in reporting data either as absolute values or percentage of predicted values, with only a few reporting both absolute and percentage. Few studies adopted the Global Lung Function Initiative approach using the lower limits of normal threshold to distinguish abnormal values, while the majority retained 80% of predicted values for TLC, FVC and

D_{LCO}. Correcting D_{LCO} for haemoglobin was not consistent. All studies reported a relatively high prevalence of reduced D_{LCO} in 40–65% of patients compared with a medium to high prevalence of the restrictive pattern and an exceptionally low prevalence, if not absence, of the obstructive pattern. If the high prevalence of altered D_{LCO} found at 1 month after discharge or the onset of the disease partly results from ongoing residual inflammation related to the initial lung injury, the persistent low values of D_{LCO} at 3 and 6 months, even in patients with normalised chest CT, raise the need for further discussion [75]. D_{LCO} is the product of the accessible alveolar volume (V_A) and the transfer coefficient of the lung for carbon monoxide (K_{CO}); altered D_{LCO} can theoretically occur when either V_A or K_{CO}, or both, are reduced [76]. Deciphering between V_A and K_{CO} as the causal factor for reduced D_{LCO} is therefore critical to infer the underlying lung structural changes with either interstitial abnormalities or pulmonary vascular abnormalities. If D_{LCO} had been measured in all studies assessing PFTs, V_A and K_{CO} were seldom reported, thus compromising key messages regarding the pathological nature of impaired lung gas transfer. Another way to dissect the underlying mechanisms of reduced D_{LCO} could be the simultaneous measurement of D_{LNO} and D_{LCO}. This test is only available in a small number of centres, which may explain the scarcity of D_{LNO} papers in patients with COVID-19.

Concluding remarks

From the currently available literature [70–72], PFTs were performed on average 3 months after onset of COVID-19. PFT measurements including at least static lung volumes with ideally TLC measurement, expiratory flow rates and D_{LCO} assessment are regarded as useful tools to assess long-term lung function sequelae in patients with COVID-19 by most investigators. An effort of global harmonisation to 1) express results, 2) choose criteria defining any anomaly, 3) refine patients' inclusion criteria, 4) prospectively investigate lung function in 5) multiple centres is still insufficient. There is agreement in all studies on the high prevalence of altered lung gas exchange in patients with COVID-19 as the main feature of PFT anomalies. Most Task Force members provide D_{LCO} results after correction for haemoglobin, and together with V_A and K_{CO}, this helps the reader to decipher the underlying causes of altered lung gas exchange. A large, international multicentre trial using D_{LNO} and D_{LCO} simultaneous measurement could provide more useful information.

Clinical Question 4. Which follow-up strategies relate to imaging?

Evidence overview

14 eligible studies (nine prospective cohort studies, four retrospective studies and one cross-sectional study) [19, 22, 43, 45, 47, 52, 77–84] were included on imaging follow-up of patients with COVID-19, following a search of 1300 initial records (appendix C in the supplementary material). A small number of studies reported high rates of persisting abnormalities on radiology at discharge, despite absence of symptoms [19, 52, 77–80]. Indeed, we know that radiological healing of pneumonitis is slower than clinical conversion. Further studies aimed to report the frequency of pulmonary abnormalities at 3- and 6-month CT [22, 43, 45, 52, 81, 82]. Studies of radiological abnormalities on CT at 3–6 months may overestimate the true frequency of persistent abnormalities as studies without systematic follow-up will be biased towards patients with severe disease and persistent symptoms. Only four of the studies also included non-hospitalised patients. In fact, residual lung lesions are more frequently observed in CT scans of patients who had extensive imaging abnormalities as well as severely altered clinical-laboratory markers of disease severity (including ICU admission and longer hospitalisation) during the acute phase [22, 52, 83].

The longitudinal behaviour of CT abnormalities mostly reflects the temporal evolution of diffuse alveolar damage and organising pneumonia, *i.e.* the main pathological patterns underlying COVID-19 pneumonia [84]. GGO is the most frequent finding at 3-month CT, followed by parenchymal bands, perilobular opacities and scant interlobular septal thickening. It was observed that these CT abnormalities diminish with time [22], while complete waning is still under investigation as more longitudinal data accumulate. Intriguingly, GGO may gradually increase in extent and reduce in density [22]. Terms such as "fibrosis" or "fibrotic-like" changes entered the literature, yet are still not justified for practical use and interpretation of patient management. CT features of lung fibrosis were interpreted in up to 47.1% at the 3-month follow-up [47]. Han *et al.* [22] reported a prospective cohort of 114 patients undergoing a 6-month follow-up CT scan [22]. This included 35% of the total cohort with "fibrotic-like" features (*e.g.* parenchymal bands, traction bronchiectasis, *etc.*). Indeed, it is unlikely that lung fibrosis occurs in such a large proportion of subjects who have had COVID-19 pneumonia and most of those "fibrotic-like" changes might be reversible at later follow-up.

Concluding remarks

Despite the current data, it is unclear if "fibrotic-like" CT features represent irreversible disease (*e.g.* post-ARDS) or slowly regressive infiltrate secondary to organising pneumonia, also seen with mild distortion mimicking actual fibrosis. The risk of over-calling lung fibrosis on follow-up CT scan seems

more frequent in the presence of bronchial distortion within the areas of organising pneumonia features. Task Force members do not call such bronchial distortion traction bronchiectasis, which, by definition, represents an established CT feature of irreversible lung fibrosis. Therefore, most Task Force members are cautious when calling out fibrosis, especially in the early follow-up CT where parenchymal changes are encountered frequently and are more prone to resolve. Given the high proportion of subjects who either develop ARDS or undergo mechanical ventilation, the development of lung fibrosis remains a concern. More imaging data are needed to clearly distinguish between COVID-19 pneumonia sequelae and ventilator-induced lung injury. Guidelines are awaited to inform when and how imaging should be referred. Task Force members consider imaging follow-up in patients that were hospitalised and/or showed a more severe clinical disease course, or in patients presenting with new or progressive respiratory symptoms in the mid- to long-term after acute COVID-19 syndrome. There are recommendations to repeat CT scans at 12 weeks post-discharge in patients with persistent symptoms, to complement clinical assessment [18].

CT is the most utilised imaging technique to follow-up subjects who had COVID-19 pneumonia. In fact, it is undisputed that fine residual abnormalities such as GGO are best depicted with CT, rather than chest radiography or lung ultrasound. As this disease involves a sizeable proportion of younger subjects who might need repeated follow-up, it is worth underscoring that a low-dose thin-section CT protocol is used by the Task Force members.

Clinical Question 5. Which follow-up strategies relate to infection control?

Evidence overview

A large number of reports on COVID-19 have been published since the start of the pandemic, yet evidence regarding the dynamics of SARS-CoV-2 shedding in patients with COVID-19 in general and in specific patient subgroups in particular is scarce. Five eligible studies were included (two retrospective, two case studies and one guideline) [85–89] following a search of 815 initial studies (appendix C in the supplementary material). One further systematic review and meta-analysis [90] identified by the authors after completion of the literature searches is also included in this review.

In susceptible individuals, viral replication starts to increase rapidly only a few days after SARS-CoV-2 exposure. Viral load usually peaks ∼1 week after infection, in most patients ∼24 h before COVID-19 symptoms commence. In immune-competent patients, replication-competent SARS-CoV-2 can be isolated from the respiratory tract for 1 to several weeks after the onset of symptoms. More specifically, a recent meta-analysis of 79 reports on SARS-CoV-2 found that the mean duration of SARS-CoV-2 RNA shedding was 17.0 (95% CI 15.5–18.6) days in upper respiratory tract, 14.6 (95% CI 9.3–20.0) days in lower respiratory tract, 17.2 (95% CI 14.4–20.1) days in stool and 16.6 (95% CI 3.6–29.7) days in serum samples [90]. SARS-CoV-2 shedding duration was positively associated with age and COVID-19 severity. While these numbers suggest that after 3 weeks viral shedding usually concludes, it is noteworthy that the same meta-analysis reported a maximum shedding duration of 83 days in the upper respiratory tract, 59 days in the lower respiratory tract, 126 days in stools and 60 days in serum [90]. Importantly, viral shedding does not necessarily provide active infectious virus. Many studies did not detect live virus beyond day 9 of illness despite persistently high viral mRNA loads. One study observed shedding of infectious SARS-CoV-2 up to 70 days after initial diagnosis from an asymptomatic immunocompromised patient with cancer [85]. Other conditions of constitutive or acquired immunosuppression may predispose to prolonged shedding of live SARS-CoV-2 or reactivation of infection, such as cancer-directed therapies [86]. Further, time to SARS-CoV-2 clearance among cancer patients varies substantially depending on the criteria used [87]. Most evidence has been derived from other virus variants than the currently widespread delta variant; however, there is no evidence available for significant differences in the time course of viral load between SARS-CoV-2 variants.

Of note, positive SARS-CoV-2 PCR tests following temporary PCR negativity have been described in recovered patients with COVID-19. Several causes of recurrent positive tests for SARS-CoV-2 are suggested, including false-negative and false-positive PCR tests, detection of viral particles rather than replication-competent virus, and reactivation and re-infection with SARS-CoV-2, the latter two being more likely in immunocompromised patients than in healthy individuals. Depending on the specific healthcare setting, recurrent SARS-CoV-2 test positivity may preclude patients from treatment of underlying diseases over a longer time period. Considering the risk of increased morbidity and mortality of the underlying disease resulting from treatment delay, the Task Force members advocate for interpretation of the cycle threshold (C_t) value of real-time PCR in the clinical context. This will enable treatment of high-risk underlying disease, despite ongoing positive SARS-CoV-2 testing [88, 89].

Concluding remarks

The majority of Task Force members perform recurrent PCR testing after acute COVID-19 in specific subgroups of patients, on a case-by-case decision, given the lack of scientific evidence and universally agreed follow-up strategies for infection control in COVID-19. Particularly for immunodeficient patients including, but not restricted to, haematological, oncological, T- or B-cell incompetent patients, it is useful to undergo repetitive testing with individual frequency (*e.g.* once weekly) due to protracted high-risk status or recurrent viral shedding.

Clinical Question 6. Which follow-up strategies relate to cognitive, psychological and quality-of-life consequences?

Evidence overview

Published studies attempt to measure a range of symptoms occurring as a consequence of COVID-19, the impact of long COVID and evaluate the outcome measures used. 1402 studies were screened (appendix C in the supplementary material) and 19 studies were included (two reviews (one systematic), nine prospective cohort studies, three survey designs, three retrospective studies, one ambi-directional cohort study and one cross-sectional study) [8, 34, 49, 61, 70, 74, 91–103] reporting on symptom burden and QoL. All studies included hospitalised patients. The survey conducted by Machado *et al.* [97] extended to non-hospitalised patients and a small RCT (n=72) investigating the impact of rehabilitation on the elderly post-COVID-19 [74] did not differentiate hospitalisation status.

The spectrum of symptoms reported include fatigue [8, 61, 91–93], dyspnoea, cough [34, 91, 93], dysphagia [95], frailty [96], loss of memory [92], concentration [92], sleep disorders [8, 92, 97], anxiety and/or depression [8, 34, 74, 91, 98, 99], and pandemic-related stress factors [91, 94, 98], with several studies reporting on HRQoL [34, 49, 74, 93, 94, 99–101], specifically functional status [97, 102] or level of independence with activities of daily living (ADLs) [95]. A prospective cohort study of 183 patients (median age 57 years; 61.5% male, 54.1% White) reported older participants (aged 65–75 years: OR 8.666 (95% CI 2.216–33.884); p=0.0019) and women (male *versus* female: OR 0.462 (95% CI 0.225–0.949); p=0.0356) had statistically significant higher odds of experiencing persistent symptoms at 5 weeks post-discharge [93].

At 6 months post-acute COVID-19, survivors continued to experience fatigue, muscle weakness, sleep difficulties and anxiety or depression. A cross-sectional study of 1696 consecutive patients (mean±SD age 71.8±13.0 years; 56.1% female, 82.3% with comorbidities) reported that independence for ADLs was lower in those admitted to the ICU than the ward group (61.1% (95% CI 55.8–66.2%) *versus* 72.7% (95% CI 70.3–75.1%); p<0.001). Conversely dependence for ADLs was also more frequent in the ICU group (84.6% (95% CI 80.4–88.2%) *versus* 74.5% (95% CI 72.0–76.8%); p<0.001) [95]. Patients who were more severely ill during their hospital stay had more impaired D_{LCO} and were the main target population for interventions of long-term recovery [8]. Those admitted to the ICU required more oxygen therapy (25.5% *versus* 12.6%; p<0.001), and experienced more dyspnoea during routine (45.2% *versus* 34.5%; p<0.001) and non-routine activities (66.3% *versus* 48.2%; p<0.001) [95].

Persistent symptoms of fatigue and sleep disturbance following severe COVID-19 pneumonia impacted HRQoL, productivity, physical activity and mental ill-health, and were associated with high rates of positive screening tests for anxiety, depression and post-traumatic stress disorder (PTSD) [91, 94, 98]. A systematic review and narrative synthesis recommended a prompt "general clinical" evaluation and risk assessment of patients presenting with neurological symptoms to minimise cognitive impairment and mental health, thereby improving prognosis and outcomes [103]. Causative mechanisms for adverse mental health outcomes following COVID-19 infection have not yet been established. Biological pathophysiological mechanisms, relating to cerebral vascular inflammation and thrombosis, survivor guilt, and isolation in COVID-19 survivors are cited as contributory factors of adverse mental health outcomes [91].

There is a lack of consistency in the selection of instruments to measure symptom burden, cognitive impairment, psychological wellbeing and QoL. A systematic review identified 33 outcome measures from 36 studies [70]. Most commonly used were the Hospital Anxiety and Depression Scale, Short Form-36 and St George's Respiratory Questionnaire (SGRQ). A summary of a broad range of instruments reported on in this review is provided in supplementary table S2. According to standardised questionnaires, patients experienced reduced QoL mainly due to decreased mobility (median (interquartile range (IQR)) SGRQ activity score 54 (19–78)) [34].

The battery of outcome measures implemented in some studies is recognised as being impractical for routine clinical use. Focused patient interviews were suggested as an alternative substitute for

questionnaires [91]. Further, recommendations included a call to rationalise the approach to the selection/combination of outcome measures to capture all elements of COVID-19 to better understand the impact on survivors, and to plan timely and appropriate interventions to maximise functional return [70].

Few differences were observed between HRQoL for patients cared for on the ward and ICU [92]. Hospitalised individuals presented high levels of disability, dyspnoea, dysphagia and dependence [95]. Social disconnect appeared to predict the presence of post-traumatic stress symptoms (PTSS) (β 0.59 (95% CI 0.37–0.81); p<0.001) 1 month after hospitalisation but the severity of COVID-19 symptoms was not predicative for PTSS [98]. Depressive and anxiety symptoms decreased 1 month following hospitalisation. However, higher levels of anxiety (standardised β 1.15 (95% CI 0.81–1.49); p<0.001) and depression (β 0.97 (95% CI 0.63–1.31); p<0.001) during the first week of hospitalisation, feeling socially disconnected and longer hospitalisation period (β 0.25 (95% CI 0.03–0.47); p=0.026) predicted higher PTSS scores 1 month post-hospitalisation [98]. The need for social support during hospitalisation with a more robust approach to managing uncertainty regarding health status and family concerns is identified. Few studies explored the cognitive, psychological and QoL consequences of long COVID in non-hospitalised patients.

Concluding remarks

Few differences were observed between HRQoL for patients cared for on the ward and ICU; more in-depth exploration in larger cohorts of patients including more severe ICU patients is needed. A need was identified to target the reduction and avoidance of PTSD. The long-term psychosocial effects (*e.g.* depression, anxiety, psychosomatic preoccupations and insomnia) and an awareness of symptoms indicative of PTSD require prompt clinical follow-up as suggested by earlier guidelines [94]. Early rehabilitation helps to reduce PTSD and mitigates the long-term sequelae [102]. To date, pulmonary rehabilitation has been informed by experiences in other chronic respiratory conditions. Further studies and consensus on the approach are needed. Consensus is also needed on the selection of outcome measures to minimise clinical burden and standardise research.

Psychosocial implications should not be ignored, and particular attention should be paid to caregiver burden, family support, and the impact of recurrent and cross-infection.

HRQoL captures symptom experience and disease impacts that may result in disability. Further discussions on symptoms associated with disability are reviewed in Clinical Question 7.

Clinical Question 7. Which follow-up strategies relate to disability?

Evidence overview

1121 studies were screened (appendix C in the supplementary material) and 15 eligible studies were included (one RCT, one systematic review, 12 prospective studies and one retrospective study) [19, 23, 28, 43, 45, 47, 56, 74, 91, 104–110]. Nine studies included hospitalised patients, two included non-hospitalised patients, and four included both hospitalised and non-hospitalised. All studies report on disability (a physical or mental condition that limits a person's movements, senses or activities) due to persistent symptoms after recovering from acute COVID-19 infection, including fatigue and dyspnoea. Evidence is emerging of patients experiencing more than one symptom, resulting in disability with psychological and cognitive symptoms reported to affect functional abilities in the long term [19, 23, 28, 43, 45, 47, 56, 74, 91, 104–110].

In COVID-19 survivors, dyspnoea and associated disability is the most frequent persistent respiratory symptom regardless of the need for hospitalisation, ranging from 5.5% to 54% at 1–4 months [28, 45, 47, 56, 91, 105–107]. Tenforde *et al.* [108] reported shortness of breath at 3 weeks in 29% of patients never hospitalised. The most used measure to assess dyspnoea was the modified Medical Research Council scale [19, 23, 43, 45, 47, 56] followed by the modified Borg dyspnoea scale [19] and the Borg category dyspnoea scale [91, 106].

Follow-up and management of COVID-19 survivors presenting symptoms and subsequent disability is an urgent priority. There is emerging evidence of debilitating disability months after COVID-19 infection. Disability with limited physical performance due to dyspnoea or fatigue, or both, measured with at least one of the Short Physical Performance Battery (SPPB) score, 2-min walk test or 1-min sit-to-stand test (1MSTST), was found in 35% of COVID-19 survivors at 6 weeks [91], 14% at 3 months [105], 53.8% at 4 months [28] and 32% at 6 months [109]. The 6-min walk distance (6MWD) was within normal values at 75 days with only 3% of patients experiencing documented oxygen saturation <90% (median (IQR) modified Borg dyspnoea scale 3 (2–5)) [19, 104]. At 3 months follow-up, 6MWD was within normal

values [45] and only one out of 62 patients had oxygen saturation <90% [47]. The 6MWT showed a significant reduction in distance walked and oxygen saturation levels in severely impaired COVID-19 patients compared to those with mild/moderate disease [23]. In a prospective observational study at 3 months after discharge [43], 22% of patients had 6MWD <80% predicted and 16% desaturated on exertion.

Disability persisted after a multidisciplinary rehabilitation programme: 1MSTST below normal value in 33.3% and SPPB in 53.3%. The Barthel Index showed poor performance in ADLs in 47.5% of COVID-19 survivors [110]. In an RCT [74], exercise capacity (6MWD) and ADLs (assessed with the Functional Independence Measure scale) were evaluated 6 months after COVID-19 infection: patients undergoing a 6-week rehabilitation programme (including respiratory muscle training, cough exercise, diaphragmatic training, stretching exercise and home exercise, but without specific training and whole body exercises) showed improvement in 6MWD when compared to the control group. Results on ADLs have also been reported in a prospective follow-up study [106] on 116 post-COVID-19 ICU patients which documented no limitations after 2 months from infection.

Concluding remarks

Evidence on follow-up of COVID-19 survivors suggests that patients recovering after the acute phase may present with prolonged symptoms for ⩾4 weeks, causing disability with reduced functional performance and ADLs. This impacts some if not all aspects of HRQoL. Most Task Force members evaluate and systematically follow-up COVID-19 survivors with unresolved or new or progressive symptoms with related disability. Decline in exercise tolerance, weakness or reduced mobility define the assistance needed for ADLs (*e.g.* feeding, dressing, bathing, toileting, driving, housekeeping and grocery shopping) and help clinicians to develop appropriate disability management strategies of pulmonary sequelae. Rehabilitation programmes including exercise training could mitigate longer term disability. Long COVID clinics offer a one-stop shop for assessment and monitoring of disability. Longitudinal cohort studies are needed to determine the most effective interventions.

Clinical Question 8. Which follow-up strategies relate to home care follow-up (tele-medicine/ tele-rehabilitation)?

Evidence overview

Patients with post-acute COVID-19 are at risk of long-term functional impairment and the rehabilitation community is calling for action preparing for a large increase of the rehabilitation needs in this patient population [94]. We screened 2057 records that were initially identified (appendix C in the supplementary material). According to the 29 eligible studies included (four systematic reviews, 15 prospective cohort studies, eight retrospective studies and two suggestion documents) [94, 95, 111–137], tele-health, often used as a broad term to include tele-visit, tele-medicine, tele-coaching, tele-nursing and tele-rehabilitation, offers an opportunity to follow-up patients while reducing the burden of travel for those patients affected by COVID-19, those with positive COVID-19 tests and those with COVID-19 sequelae. Virtual services may include asynchronous clinical communications, real-time virtual care, messaging, telephone or video conferencing, virtual health assessments and medication review. The COVID-19 pandemic forced a rapid adoption of tele/digital approaches over traditional in-person visits, although uptake is reported to be lower in communities with higher rates of poverty [111]. Tele-medicine/tele-rehabilitation have been proposed in COVID-19 patients who suffer from exercise dyspnoea, adequate stable condition, residual disability, displaced or isolated [112] provided they can ambulate independently, use technology, require minimal supplemental oxygen and are cognitively intact [113]. Tele-health may improve access and reduce barriers to healthcare access, overcome financial costs, increase medical care and follow-ups, and, most importantly, reduce the risk of COVID-19 transmission [114]. Approaches can monitor vital parameters (peripheral oxygen saturation, heart rate, blood pressure and respiratory rate). Specifically, pocket oximeters and smartphone-based systems need particular accuracy to avoid errors in pulse oximetry [115]. In selected cases, breath sounds can be analysed using advanced signal processing and analysis in tandem with new deep/machine learning [116]. Tele-health implemented in response to the COVID-19 pandemic in general resulted in high patient and provider satisfaction [114, 117–124]. Tele-medicine/ tele-rehabilitation acceptance is related to increased accessibility, enhanced care, usefulness, ease of use and privacy/discomfort, whereas anxiety about COVID-19 is not [125]. Being male, having a history of both depression and anxiety, lower patient activation [120], and technical and administrative challenges [121] were significantly associated with a poor tele-health experience.

Mobile apps have been proposed for citizens, health professionals and decision makers to reduce the burden on hospitals, provide access to credible information, and track the symptoms and mental health of individuals [126–128], and help patients to improve their emotional resilience and subsequently their

ability to cope with the trauma of their COVID-19 experiences [129]. During the pandemic the percentage of visits *via* tele-medicine increased 23-fold compared with the pre-pandemic period [111, 130]. As a majority of chronic respiratory patients are elderly and have multiple comorbidities, they are notably susceptible to severe complications of COVID-19 and, as such, have been advised to minimise social contact. This increased patients' vulnerability to physical deconditioning, depression and social isolation. To address this major gap in care, some clinic-centred pulmonary rehabilitation programmes converted some or all of their educational packages to home-based tele-rehabilitation [131]. Tele-rehabilitation offers positive clinical results, even comparable to conventional face-to-face rehabilitation approaches [132], with general guides prepared in some countries [133]. In post-ICU patients, tele-rehabilitation consisted mostly of second opinions of psychologists (11.8%), physical therapists (8.0%), dietitians (6.8%) and speech language pathologists (4.6%) [95]. Tele-health has been used for patients experiencing depression and isolation to maintain sufficient relationships [134]. Barriers to medicine at distance have been described as: advanced age, poor confidence with technology, lack of communication, reduced confidence in doctors, additional burden for complex care, ethical issues and scepticism [114, 120, 135–137]. Several obstacles must be overcome for a wide use of tele-health: 1) the technology must be usable by the largest possible number of patients, 2) clarity on medico-legal liability and data privacy, 3) lack of economic reimbursement, 4) proper training of health professionals involved, 5) adequate caregiver support, and 6) infrastructure, operational challenges, regulatory, communication and legislative barriers [112, 118, 131].

Concluding remarks

Tele-health appointment experiences were often comparable to traditional in-person medical appointment experiences. Although tele-medicine/tele-rehabilitation appear to be acceptable, the level of agreement on standardisation remains unclear, in particular the cost–effectiveness ratio. Tele-health was effective as a mode of healthcare delivery during the pandemic and may be sustainable [112, 120]. Careful attention will be needed to integrate these services into current healthcare delivery systems while preserving patient-centred and quality care [122]. Further high-quality studies to enable the successful implementation of these modalities are needed [131].

Discussion

It is evident that long COVID is a substantial global public health problem with severe consequences for affected individuals. Emotional wellbeing and QoL are particularly impacted [103]. A standardised minimum set of outcomes for clinical care of patients with COVID-19 has recently been published by the International Consortium for Health Outcomes Measurement and is categorised into five domains: 1) functional status and QoL, 2) mental functioning, 3) social functioning, 4) clinical outcomes, and 5) symptoms [138]. While these outcomes may need some adjustment for specific comorbidities, treatment approaches and demographics, consensus recommendations could help guide clinical services and enable data comparison of patient-centric clinical outcomes.

Active management and strategies for the prevention of persistent symptoms and potential long-term complications continue to be explored as a more comprehensive understanding of COVID-19 sequelae emerges. The Post-hospitalisation COVID-19 study (PHOSP-COVID), a multicentre, long-term follow-up study of adults discharged in the UK with a clinical diagnosis of COVID-19, was published in October 2021 [139]. PHOSP-COVID determined that severe mental and physical impairments are independent of the degree of acute lung injury and could be related to persisting systemic inflammation. The investigators suggest a proactive approach and holistic clinical care that is stratified and personalised with access to interventions to improve mental, physical and cognitive health. At 6 months post-discharge, morbidity was more prevalent in females, the middle aged, and those with two or more comorbidities and more acute severe illness. Given the multisystemic nature of the post-COVID-19 condition, a multidisciplinary response is likely to be the optimal approach. Many post-COVID-19 multidisciplinary clinics are emerging globally [103], with post-COVID-19 clinical programmes designed to meet the needs of individuals characterised according to previous hospitalisation with COVID-19, non-hospitalisation with persistent respiratory symptoms post-COVID-19 and pre-existing lung disease complicated by COVID-19 [140].

Long COVID appears to overlap with complications of acute COVID-19, making it hard to define. Further evidence and research from multidisciplinary teams is crucial to understanding the causes, mechanisms, risks and consequences of long COVID [141]. The ultimate goal is to develop preventive measures, rehabilitation techniques and clinical management strategies. Individualised interventions in long COVID clinics with multiple specialties, including graded exercise, physical therapy, continuous check-ups and cognitive behavioural therapy, should be designed to address long COVID care [142]. Sensitivity to gender and age, and screening all patients regardless of COVID-19 severity across a range of physical and mental

health symptoms, particularly anxiety and cognitive impairment, will be required to target interventions at an individual level and to groups of patients with similar post-COVID-19 profiles.

Preliminary reports confirm the feasibility and safety of a dedicated tele-rehabilitation programme for survivors of COVID-19 pneumonia with a clear improvement in exercise tolerance and dyspnoea [143]. Adapting tele-rehabilitation to the usual practice of physical therapy can be achieved through a paradigm change to ensure effective patient-based tele-rehabilitation [144].

From the clinical perspective, physicians should be aware of the symptoms, signs and biomarkers present in patients previously affected by COVID-19 to promptly assess, identify and halt long COVID progression, and to minimise the risk of chronic effects. Identification of possible biomarkers or laboratory tests would be useful, similar to those available for acute infection or post-acute hyperinflammatory illness [145]. Data showing that almost one-third of COVID-19 survivors will present with lung abnormalities 6 months after initial infection [22] raise questions. Does this high proportion of patients have clinically significant interstitial lung disease or should we interpret these findings with more scepticism [146]? Ongoing monitoring and regular follow-up will enable physicians to assess clinically significant pulmonary sequelae, identifying long COVID manifestations early and improving management.

This ERS statement intended to describe the evidence regarding eight clinical questions about long COVID consequences. The systematic search was completed in March 2021. Papers meeting the inclusion criteria but published after the cut-off date were not included. The aim of this document was to provide a rapid first overview of the clinical questions identified to help clinicians consider important aspects of follow-up care for patients with COVID-19. This statement is primarily focused on the respiratory system. Given the volume of publications related to COVID-19, we plan to update this statement and to further inform a clinical practice guideline with recommendations.

Recommendations for research

Post-acute sequelae COVID-19 research is a global priority, with the US National Institutes of Health investing USD 1.15 billion over 4 years and the UK NIHR investing GBP 38.5 million. Predisposing factors and symptom patterns associated with long-term sequelae remain difficult to determine. Importantly, the COVID-19 ERS Clinical Research Collaboration, END-COVID, aims to merge national long COVID initiatives in Europe. END-COVID intends to study the long-term effects of COVID-19 in post-hospitalisation survivors, both in those with pre-morbid lung conditions and in those with no previous lung disease and comorbidities.

It is a priority to identify determinants of those more likely to experience prolonged sequelae following SARS-CoV-2 infection. Some studies are under way to identify those at greatest risk [147], but the existence of intrinsic, extrinsic (biological, psychological and social) and factors associated with hospitalisation and interventions requires deeper investigation. Research on the respective contributions of physical/biological and functional somatic mechanisms to the expression of long COVID depending on the characteristics of this expression and of the acute disease is urgently needed. Histopathological phenotyping and genotyping are crucial, enabling deeper insights into the differences in pathogenesis and underlying immunological and tissue regenerative response patterns. The design of genetic association studies may unravel potent genetic correlations [148].

Large, multicentre studies will evaluate the long-term consequences of pulmonary physiology and imaging alongside patient factors, particularly disability and QoL. Further data are needed to determine the impact of COVID-19 vaccines for those diagnosed with long COVID.

Summary statements

- Age and initial disease severity appear to correlate with long-term consequences, but not necessarily with the persistence of symptoms (larger studies required).
- In patients with persistent exertional dyspnoea not explained by CT or PFT abnormalities 3–6 months after discharge, most Task Force members include echocardiography and contrast-enhanced CT in the follow-up evaluation to identify pulmonary vascular involvement.
- PFT measurements, including static lung volumes, expiratory flow rates and D_{LCO} assessment, are regarded as useful tools to assess long-term lung function sequelae in patients with COVID-19.
- Task Force members agree with the proposed recommendations to repeat CT scans at 12 weeks after discharge in patients with persistent symptoms, as a complement to clinical-functional assessment. However, Task Force members are cautious when interpreting CT abnormalities taking into consideration the risk of over-calling lung fibrosis.

- The majority of Task Force members perform recurrent PCR testing after acute COVID-19 in specific subgroups of patients, on a case-by-case decision, given the lack of scientific evidence.
- Task Force members do not ignore the long-term psychological and psychosocial implications of infectious diseases, and most of them use symptom and QoL measures. There is a need for consensus on pulmonary rehabilitation that helps to reduce PTSD and mitigates long-term sequalae.
- Based on current evidence, patients recovering after the acute phase may present prolonged symptoms affecting functional performance and daily life activities. Most Task Force members evaluate and systematically follow-up COVID-19 survivors with unresolved or new or progressive symptoms.
- Tele-medicine and tele-rehabilitation appear to be acceptable, and tele-health was effective during the pandemic. Integration of these services into current healthcare delivery systems must preserve patient-centred and quality care.

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