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Review Article

Short and Long-Term Impact of COVID-19 Infection on Previous Respiratory Diseases



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ABSTRACT

On March 11, 2020, the World Health Organization declared Coronavirus Disease 2019 (COVID-19) a pandemic. Till now, it affected 452.4 million (Spain, 11.18 million) persons all over the world with a total of 6.04 million of deaths (Spain, 100,992). It is observed that 75% of hospitalized COVID-19 patients have at least one COVID-19 associated comorbidity. It was shown that people with underlying chronic illnesses are more likely to get it and grow seriously ill. Individuals with COVID-19 who have a past medical history of cardiovascular disorder, cancer, obesity, chronic lung disease, diabetes, or neurological disease had the worst prognosis and are more likely to develop acute respiratory distress syndrome or pneumonia. COVID-19 can affect the respiratory system in a variety of ways and across a spectrum of levels of disease severity, depending on a person's immune system, age and comorbidities. Symptoms can range from mild, such as cough, shortness of breath and fever, to critical disease, including respiratory failure, shock and multi-organ system failure. So, COVID-19 infection can cause overall worsening of these previous respiratory diseases, such as asthma, chronic obstructive pulmonary disease (COPD), interstitial lung disease, etc. This review aims to provide information on the impact of the COVID-19 disease on pre-existing lung comorbidities.

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Impacto a corto y largo plazo de la infección por COVID-19 en las enfermedades respiratorias previas

RESUMEN

El 11 de marzo de 2020, la Organización Mundial de la Salud declaró la enfermedad por coronavirus 2019 (COVID-19) como pandemia. Hasta ahora, ha afectado a 452,4 millones (en España, 11,18 millones) de personas en todo el mundo, con un total de 6,04 millones de muertes (en España, 100.992). Se observa que el 75% de los pacientes hospitalizados por COVID-19 tienen al menos una morbilidad concomitante a esta enfermedad. Se ha demostrado que las personas con enfermedades crónicas subyacentes tienen más probabilidades de contraerla y enfermar gravemente. Los individuos con COVID-19 con antecedentes de trastorno cardiovascular, cáncer, obesidad, enfermedad pulmonar crónica, diabetes o enfermedad neurológica tienen el peor pronóstico, y son más propensos a sufrir el síndrome de dificultad respiratoria

Palabras clave:

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aguda o neumonía. La COVID-19 puede afectar al sistema respiratorio de diversas maneras y en un espectro de gravedades de la enfermedad, dependiendo del sistema inmunitario de la persona, la edad y las comorbilidades. Los síntomas pueden ir desde los más leves, como tos, dificultad para respirar y fiebre, hasta los más graves, como insuficiencia respiratoria, *shock* y fallo multiorgánico. Así, la infección por COVID-19 puede generar un empeoramiento general de estas enfermedades respiratorias previas, como asma, enfermedad pulmonar obstructiva crónica, enfermedad pulmonar intersticial, etc. Esta revisión tiene como objetivo proporcionar información sobre el impacto de la enfermedad por COVID-19 en las comorbilidades pulmonares preexistentes.

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Introduction

The coronavirus disease 2019 (COVID-19) pandemic, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has led to high morbidity and mortality worldwide. SARS-CoV-2 predominantly affects the lung, but it can also affect other organs such as the brain, heart, and gastrointestinal system. It is observed that 75% of hospitalized COVID-19 patients have at least one COVID-19 associated comorbidity. Although the mean age of COVID-19 infected subjects has changed from older to younger patients¹⁻³ based on current evidence, risk factors for developing and having poor prognosis of COVID-19 in adults are smoking habits, demographic factors, such as older age, male sex, and ethnicity, and the presence of underlying diseases such as cardiovascular diseases, hypertension, and chronic obstructive pulmonary disease (COPD).⁴⁻⁶ Being a younger children and specific comorbidities such as obesity or being a smoker is at higher risk for infection and potentially more severe consequences of COVID-19. In addition to these factors, changes in laboratory indices and pro-inflammatory cytokines, as well as possible complications, could indicate the progression of COVID-19 into a severe and critical stage.⁷⁻¹¹

An important percentage of subjects has important clinical, functional or radiological sequelae (long-term COVID-19 syndrome) months after the acute infection, especially those who suffered from a severe pneumonia admitted to the intensive care unit (ICU).¹²⁻¹⁶ Finally, many treatments both pharmacological (especially antivirals, immunomodulators and anti-inflammatories) and non-pharmacological treatments has been used during this pandemic era at different moments and severities of the disease, sometimes with controversial results.¹⁷⁻²⁴

On the other hand, what effects does COVID-19 disease have on previous lung diseases? After COVID-19 disease recovery time appears to be around 2 weeks for mild infection and 3–6 weeks for severe disease; however, this is variable and depends on a patient's pre-existing comorbidities in addition to illness severity. A major issue with COVID-19 is with gas exchange in the alveolus. Usually, there is a very tight connection between the alveolar epithelium (type-1 cells) and the capillary. COVID-19 infects AT2 cells, kills them and floods the alveolus. In addition, there is evidence for microthrombosis,²⁵ which may block the vascular side. COVID-19 can cause permanent lung damage with higher risk of long-term complications (chronic inflammation has been considered as the main cause of pulmonary fibrosis and may lead to epithelial damage and fibroblast activation).²⁶ This review aims to provide information on the impact of the COVID-19 on pre-existing lung comorbidities.

Obstructive sleep apnea

Just as sleep apnea syndrome (OSA) is a risk factor for pneumonia,²⁷ observational studies show that OSA can be a risk factor for both COVID-19 infection and unfavorable outcome.²⁸

Labarca et al.²⁹ conducted a case-control study among patients with acute respiratory distress syndrome (ARDS) secondary to COVID-19 and mild or moderate disease, showing that, in surviving patients, the prevalence of undiagnosed OSA was statistically significant compared to patients with mild or moderate disease. After adjusting for other confounders, OSA was independently associated with ARDS. Moreover, undiagnosed OSA presented more pulmonary sequelae in the medium term, in addition to being associated with variables such as male gender, ARDS, and total days on invasive mechanical ventilation (IMV).

In the CORONADO observational study, untreated OSA was an independent risk factor for 7-day mortality, with an odds ratio (OR) of 2.8.³⁰ In a study that included 46 patients hospitalized for COVID-19, OSA was diagnosed in 75% of the sample,³¹ and another observational study showed that patients with OSA presented an OR of 1.53 for mortality and 1.29 for ICU admission.³²

A recent meta-analysis³³ of a total of 21 studies with 54,276 COVID-19 patients showed that OSA was associated with composite poor outcome and its subgroup which comprised of severe COVID-19, ICU admissions, the need for IMV and mortality.

There is an interaction between obesity and OSA, and in this sense, a greater number of obese patients required admission to the ICU and up to 7 times more IMV, with a body mass index (BMI) ≥ 35 ^{34,35} being an independent factor of mortality.³⁶

OSA and COVID-19 are proinflammatory states, so prior chronic systemic inflammation from untreated OSA would be a predisposing factor.³⁷ In addition, sleep fragmentation and chronic intermittent hypoxia can trigger an inflammatory response and sympathetic activation.³⁸ Both COVID-19, obesity, and OSA increase hypoxia-inducible factor 1- α levels, which increase the cytokine storm³⁹ that occurs in COVID-19 pneumonia patients and in those with subsequent multi-organ failure.⁴⁰

Hypoxemia and altered hemodynamics in OSA can precipitate a pro-coagulant state, which could further accentuate coagulopathy related to COVID-19.⁴¹ The angiotensin converting enzyme 2 (ACE2) has been identified as the entry receptor of SARS-CoV-2.⁴² Both in OSA and in obese patients, there is an increased expression of ACE2 receptors, which would favor the union of the virus.⁴³ In turn, OSA may lead to an increase in blood pressure through stimulation of the renin-angiotensin-aldosterone system.⁴⁴ Cardiac complications in COVID-19 include myocarditis, ischemic heart disease, heart failure, and arrhythmias,⁴⁵ factors also associated with OSA, which can increase morbidity and mortality.⁴⁶

Extra care and close monitoring should be provided to patients with OSA to minimize the risk of infections. Simple questionnaires such as STOP-Bang questionnaire can be used for screening patients who may be at risk for severe adverse outcomes.

Finally, changes in the adherence to continuous positive airway pressure machine (CPAP) treatment have been seen during the pandemic period. New technologies and telemedicine should help us to improve the efficacy and control of treated patients and the adherence to treatment.

Lung cancer

Since the World Health Organization (WHO) declared the SARS-CoV-2 pandemic (COVID-19), the care of lung cancer (LC) patients has been particularly compromised. The International Agency for Research on Cancer (ARC) estimated more than 2 million new cases of LC by 2020,⁴⁷ and some countries have changed the trend in the LC mortality.⁴⁸ However, these estimates are made without including the effects of the pandemic, so the number of diagnosed cases is likely to be lower.⁴⁹

This is due to several reasons; firstly, because LC screening programs (which have demonstrated several beneficials in the context of the high prevalence of LC)^{50–53} are interrupted due to the existing health care bottleneck and to avoid transmission of infection to both patients and health care workers.^{54,55} This delay in screening may not have an impact on survival as long as it does not extend beyond 18 months.^{56,57} On the other hand, the number of consultations decreases either because users do not come to the hospital because of fear of contracting the disease, or because they are not referred to the hospital due to both the health care overlap and the overlap of symptoms between COVID-19 and LC.^{58,59}

With the advent of the pandemic, the ARC's projected LC mortality of 18% by 2020 is also likely to change.⁴⁷ Patients with LC are more susceptible to contracting COVID-19^{60,61} and to developing complications from the disease. Rogado et al.⁶² estimate an incidence of 0.9% compared to 0.5% in the general population. Because of this, higher hospitalization and mortality rates have also been observed,^{63,64} which in the study by Rogado et al.⁶² was 52.3% in patients with LC compared to 10.2% in the general population. Retrospective studies have reported a rate of COVID-19 infection and serious complications up to 2.31 times higher than the general population or patients with other cancers.^{65–67} In an Italian study, a 4-fold increased risk of dying from COVID-19 infection was observed. Specifically, 2/3 of patients with LC required hospitalization and a quarter of them died.⁶⁸ In the TERAVOLT study, the mortality rate was 33%, and the risk of death was associated with older age, presence of comorbidities and active smoking,⁶⁴ although in a recent meta-analysis,⁶⁹ where mortality was higher in COVID-19 patients (RR, 1.66 vs 1.33) as well as the risk of ICU admission (RR, 1.56 vs 1.31), no increased risk of death or serious complications was found in relation to advanced age.

Fear of contracting the disease has also led to a significant delay in the diagnosis of these patients. In a study on the participation of cancer patients in social networks during the pandemic, the highest level of participation was among LC patients (38.3%) followed by breast cancer patients (23.8%). The most predominant emotion related to COVID-19 and cancer was fear,⁷⁰ and is primarily linked to the fear of contracting the disease and not being admitted to the ICU if necessary.^{71,72} In a study by Garassino et al.,⁶⁴ 75% of patients with LC and COVID-19 were admitted to hospitals, but only 10% were admitted to the ICU. Thus, the delay in diagnosis has led to an increase in the diagnosis of more advanced cases. A retrospective study analyzed 161 LC patients of whom 29.19% had a delay in their scheduled appointment, compared to 5% of delays before the pandemic. In addition, 18.18% of the delayed patients had advanced disease.⁶⁵ A study carried out in England⁷³ estimates that delay in diagnosis leads to an increase in years of life lost and an increase in mortality of 4.8% at 5 years after diagnosis.

Treatment with chemotherapy in the months prior to diagnosis of COVID-19 has also been associated with an increased risk of serious infection with complications (hazard ratio [HR] 1.71).^{64,66,74,75} A recent meta-analysis⁷⁶ of 3558 patients shows an increased risk of death in patients with active chemotherapy compared to those without (OR 1.60). Although there may be confusion between symptoms caused by COVID-19 and chemotherapy-related chemical pneumonitis, it is important to assess the risk-benefit of

discontinuing treatment⁷⁷ as the use of immunotherapy improves the prognosis of patients with few side effects, so it is recommended to prioritize its use over conventional chemotherapy.^{60,78}

Not only the delay in treatment but also the suspension of consultations, surgery and treatments such as chemotherapy or immunotherapy⁷⁹ have had an impact on patients with LC, as they have led to disease progression and increased mortality from LC.⁵⁴ In a study of 288 hospitalised patients with COVID-19 and LC, disease progression was estimated in 10.7% of cases due to discontinuation of radiotherapy and 26% due to discontinuation of chemotherapy and/or immunotherapy.⁸⁰ Regarding surgery, in the first publication of the CovidSurg Cohort Study, a mortality of 42.9% was observed in resection surgery.⁸¹ However, in a subsequent multicentre, prospective study involving 140,231 patients, the same authors observed that the 30-day mortality rate in resection surgery was higher at 2, 4 and 6 weeks after diagnosis of COVID-19 (OR 4.1, 3.9 and 3.6, respectively), but was similar at 7 weeks (OR 1.5), except in those who still had symptoms, where mortality was still higher than if they were asymptomatic (6% vs. 1.3%).⁸² Therefore, some authors recommend stereotactic body radiation therapy as a first curative option if surgery has to be delayed due to lack of operating theaters.⁸³ Therefore, the treatment strategy must be adapted to different factors, such as the incidence of COVID-19 or the risk of delaying surgery beyond 3 weeks. In this regard, the American Society for Thoracic Surgery makes recommendations that cover all these aspects.⁸⁴

The impact on the family and social support usually provided to these patients has had a negative impact on their quality of life. Depression in cancer patients, especially in women, has increased during the pandemic.⁶⁵

A balance needs to be struck between healthcare for COVID-19 patients and care for LC patients. The role of telemedicine is crucial to avoid unnecessary hospital visits,⁸⁵ but without losing the human aspect of medicine, which in these LC patients is as important as traditional oncology treatment.⁸⁶

Bronchiectasis

Radiological detection of bronchiectasis is frequent in the acute phase of COVID-19, and may even represent a factor of its severity.^{87–89} In addition, there are frequent sequelae in patients who have overcome the infection,^{90,91} although their long-term clinical repercussion is unknown.⁹² The literature on the incidence or severity of COVID-19 in patients with pre-existing bronchiectasis is scarce, probably due to the low proportion of these patients in the published series on COVID-19 patients.^{93,94}

Table 1 lists the main publications that have in some way addressed the relationship between bronchiectasis and COVID-19, of which only two were specifically designed to answer clinical questions in this population.^{95–98} Although the results of these studies are very disparate, and even contradictory, it could be highlighted that when comparing COVID-19 patients with and without bronchiectasis, the former have an increased risk of developing severe forms of the infection, requiring oxygen therapy or hospitalization, and possibly also an increased risk of requiring admission to an intensive care unit or even death. These series lack relevant data that could allow a more in-depth interpretation of these findings, such as severity or chronic bronchial colonization.

On the other hand, as in other chronic respiratory diseases, a notable decrease (nearly 50%) in exacerbations of bronchiectasis has been observed.⁹⁵ Given the important prevalence of both bronchiectasis and chronic bronchial infection,^{99,100} this supposes a great epidemiological impact. This is probably due to a reduction in viral infections motivated by social distancing measures, which this population has taken to the extreme, both due to the fear

Table 1
Publications that have examined the relationship between bronchiectasis (BE) and COVID-19.

Authors	Country	Year(s)	Type of study	n	Aims of the study	Results
Choi et al.	South Korea	January–May 2020	Nested case-control study using data from the national COVID-19 cohort and a matched non-COVID cohort	8070 COVID-19 patients 132 (1.6%) had BE	To evaluate whether the prevalence of BE is higher in the COVID-19 cohort than in the matched cohort To compare the clinical course and mortality of COVID-19 in patients with BE and those without BE	Rate of BE: 1.6% in the COVID-19 cohort and 1.4% in the matched cohort ($P = .030$) Comparing COVID-19 patients with and without BE: Patients with BE were significantly older, with more pulmonary and extra-pulmonary comorbidities ($P < .001$) The proportion of patients with severe COVID-19 was higher in patients with BE (30.3% vs 13.1%; $P < .001$) BE patients needed significantly more oxygen therapy (29.6% vs 12.3%; $P < .001$) and ECMO (1.5% vs 0.3%; $P = .012$), and had a significantly higher mortality (8.3% vs 2.8%; $P < .001$)
Guan et al.	China	December 2019–May 2020	Retrospective cohort study, data derived from the Chinese national COVID-19 reporting system	39,420 COVID-19 patients 313 (0.8%) had BE	To explore the association between chronic respiratory diseases and the clinical outcomes of hospitalized COVID-19 patients	Patients with COPD and asthma, but not BE, were more likely to reach the composite endpoint (needing invasive ventilation, admission to ICU or death within 30 days after hospitalization) compared with those without those diseases, after adjusting for age, sex, and other systemic comorbidities Patients with chronic respiratory diseases did not have an increased risk of death compared with those without After full adjustment, people with respiratory diseases had an increased hospitalization risk: HR 1.54 for COPD, 1.18 for asthma, 1.29 for severe asthma, 1.34 for BE After full adjustment, there was no evidence that people with asthma, COPD, or BE were more likely to be admitted to ICU than the people without these conditions After full adjustment, COPD was associated with a 54% increase in the risk of death due to COVID-19 (HR = 1.54; 95%CI, 1.42–1.67). There was no significant evidence that people with BE (HR = 1.12; 0.94–1.33) were at an increased risk of death
Aveyard et al.	England	January 24–April 30, 2020	Population cohort study on patients from 1205 general practices Data derived from various English Public Health databases	8,256,161 COVID-19 patients 41,271 (0.5%) had BE	To assess whether chronic lung disease or use of inhaled corticosteroids affects the risk of contracting severe COVID-19	After full adjustment, COPD was associated with a 54% increase in the risk of death due to COVID-19 (HR = 1.54; 95%CI, 1.42–1.67). There was no significant evidence that people with BE (HR = 1.12; 0.94–1.33) were at an increased risk of death
Crichton et al.	Scotland	March 2020–March 2021	Prospective	147	To evaluate if social distancing during 2020 would be associated with reduced reported BE exacerbations, but no change in the chronic symptoms	Significant reduction in the number of exacerbations/patient ($P < .001$): 2.08 in 2018/2019; 2.01 in 2019/2020; 1.12 in 2020/2021 Increase in the number of patients without exacerbations over a 12-month period: 22.4% in 2018/2019; 25.6% in 2019/2020; 52.3% in 2020/2021 After adjusting for prior exacerbation history, patients with more severe symptoms were more likely to experience exacerbations Respiratory symptoms were unchanged from the pre-pandemic period to the pandemic period

of suffering severe COVID-19, and the stigmatization that chronic cough entails in many of these patients.¹⁰¹ Finally, there are publications on patients with bronchiectasis generating diseases, such as common variable immunodeficiency¹⁰² or ciliary dyskinesia,¹⁰³ which show a low incidence of COVID-19. In these diseases, the severity of COVID-19 is associated with the concomitant presence of respiratory diseases, such as bronchiectasis or interstitial lung disease.

Cystic fibrosis

The impact of SARS-CoV-2 infection in patients with cystic fibrosis (CF) was lower than expected,^{104–107} but older patients, those with lower lung function, CF-related diabetes and those who

received a solid organ transplant^{108–110} experienced a more unfavorable evolution.

The cumulative incidence was variable across the different series analyzed, between 2.7/1000 CF patients,¹¹⁰ 3.2/1000 CF patients,¹¹¹ and 17.2/1000 CF patients.¹¹² Both short and long-term effects of the pandemic were observed in patients with CF (Table 2).

During the COVID-19 pandemic, there was a significant decrease in exacerbations and hospitalizations,¹¹³ likely as a result of the use of barrier measures and the reduction of other viral infections. Nevertheless, rapid changes were required in the healthcare systems¹¹⁴ to prevent these patients from being exposed to the virus. Also, for this reason patients reduced their physical activity,^{115,116} with the resulting muscular damage and increased anxiety-depression symptoms^{117–119} that will lead to a need for future medical attention.

Table 2
Short and long-term changes in cystic fibrosis patients in relation to the COVID-19 pandemic.

Major and rapid changes were necessary for the health care system
The lower number of in-person visits
Lower risk of cross-infection
Preventive measures such as using face masks and hand hygiene were reinforced
Decrease in the exacerbations number (absence of other viral infection)
Patients reduced their physical activity during lockdown periods
Increased anxiety and depression symptoms
Decrease in the number of lung function tests made at the hospital
Spirometry and oxygen saturation data were recorded at home
Sputum for microbiological cultures was recorded at home
Fewer lung transplantation was performed
Reduced clinical trials: Multiple challenges for recruiting and following patients
It was necessary to implement telehealth and other monitoring systems for the future
It will be a challenge how to achieve appropriate levels of immunization in CF patients with a lung transplant
The long-term effects of COVID-19 on the CF population remain unknown

Procedures such as respiratory function tests have been drastically reduced and remote attention such as telehealth,^{120–123} home spirometry,¹⁰⁸ home collection of sputum samples,¹²⁴ home delivery of medication from the hospital pharmacy, and long-distance electronic monitoring¹²³ were required. This provided an opportunity to take new approaches to improving CF patients care with new and effective models, with durable changes in the future CF health care (Fig. 1).

It is also important to highlight that fewer transplant^{125,126} were performed although, in CF patients, the use of triple modulatory therapy just at the beginning of the pandemic was able to minimize the impact and severity of these patients.^{123,127}

Finally, clinical trials were significantly reduced due to the difficulties in the recruitment and the follow-up visits to patients, having a negative impact on future treatment options.^{108,123,128}

At that moment, the long-term effects of COVID-19 on the CF population remain unknown. In the near future, possible

cardiovascular symptoms, cognitive deficit and fatigue may appear in CF patients who have passed the infection. Another important issue concerns vaccination for CF transplant patients.^{108,129} Maybe, it should be explored to use extra doses or using different combination vaccines to achieve appropriate levels of immunization.

Chronic obstructive pulmonary disease

Since the description of the first cases of SARS-CoV-2 infection, advanced age and several chronic diseases have been associated with a higher risk of unfavorable evolution.^{130–132} In our setting, a higher incidence of COVID-19 has been described in chronic obstructive pulmonary disease (COPD) patients (2.51%; 95%CI, 2.33–2.68) compared to the general population over 40 years of age (1.16%; 95%CI, 1.14–1.18; $P < .001$), with a worse prognosis, assessed by the number of hospitalizations and higher mortality.¹³³ Patients with COPD and COVID-19 were predominantly male, smoked more frequently, and had more comorbidities than patients without COPD.¹³⁴ Using various adjustment models, COPD itself posed a higher risk of COVID-19, regardless of age and the associated comorbidities that these patients frequently present¹³⁵ (Table 3). Before vaccines were available, most COPD patients admitted for COVID-19 had pulmonary infiltrates compatible with pneumonia, causing a higher rate of hospitalizations and in-hospital mortality. This evolution contrasts with the findings observed in patients with COPD exacerbations due to other viral etiologies.¹³³

At present, there is no data that the treatment of COPD or its comorbidities has a negative impact on prognosis.¹³⁶ Although a study described that the use of inhaled corticosteroids in COPD increased the risk of developing COVID-19, this result is conditioned by an indication bias due to severity.¹³⁷ For this reason, patients should continue with their usual treatment without changes, avoiding the use of nebulizers as much as possible, especially if they do not have a filter in the expiratory branch.¹³⁸

Given the increased risk that COPD patients have, it is recommended that they strictly follow self-care measures that help

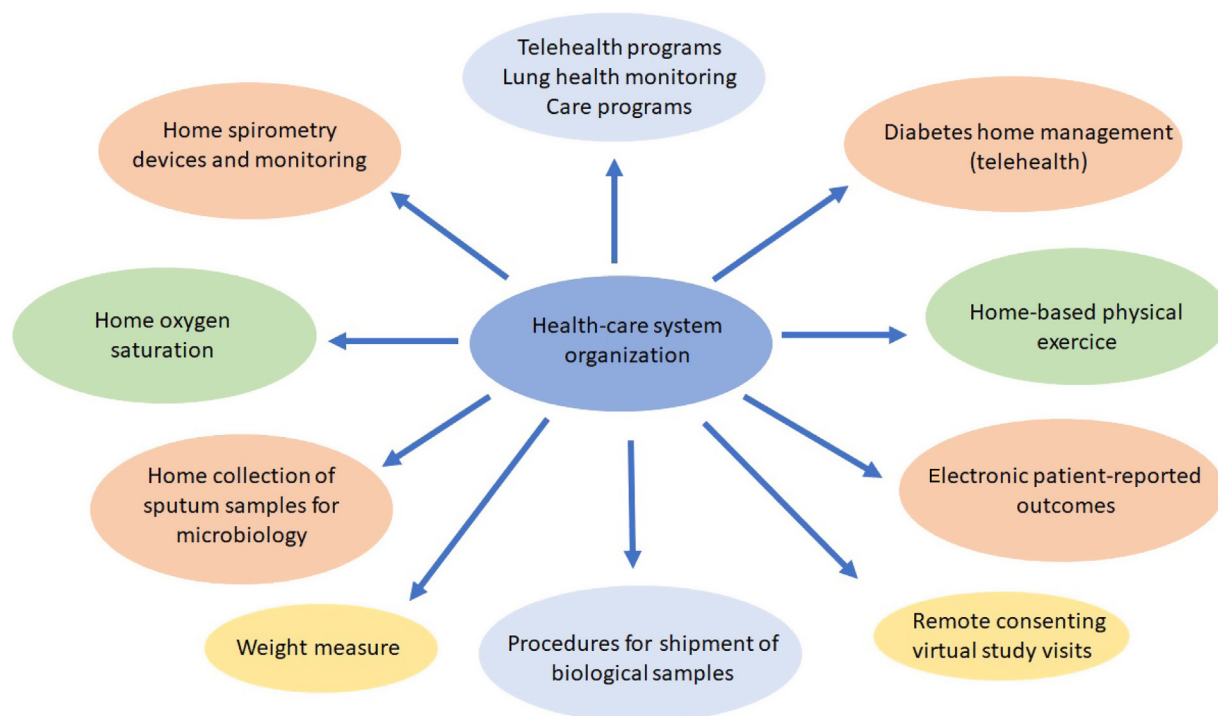


Fig. 1. Health-care system changes in relation to COVID-19 pandemic in cystic fibrosis patients.

Table 3

OR (95%CI) for risk of death in COVID-19 patients with COPD versus those without COPD, adjusted for most relevant covariates, in three models of multivariate logistic regression analysis.¹³³

	Model 1		Model 2		Model 3
COPD	1.70 (1.29–2.23)	COPD	1.52 (1.15–2.00)	COPD	1.42 (1.07–1.88)
Sex	1.86 (1.53–2.26)	Sex	1.87 (1.54–2.28)	Sex	1.82 (1.49–2.22)
Age	1.06 (1.05–1.07)	Age	1.05 (1.04–1.06)	Age	1.05 (1.04–1.06)
		HF	1.65 (1.33–2.03)	HF	1.46 (1.17–1.81)
		HBP	1.59 (1.24–2.04)	HBP	1.43 (1.10–1.84)
				Stroke	1.02 (0.78–1.32)
				Arrhythmia	1.30 (1.01–1.71)
				IHD	1.05 (0.81–1.36)
				Diabetes	1.23 (1.01–1.50)
				Dislipidaemia	1.03 (0.81–1.31)
				AOS	1.27 (0.85–1.90)
				PTE	1.72 (1.08–2.75)
				Smoking	1.31 (0.99–1.71)

95%CI: 95% confidence interval; COPD: chronic obstructive pulmonary disease; HBP: high blood pressure; HF: heart failure; IHD: ischemic heart disease; OR: odds ratio; OSA: obstructive sleep apnea; PTE: pulmonary thromboembolism.

prevent SARS-CoV-2 infection, including the use of a face mask.¹³⁹ There is currently no data indicating that the effect of the vaccine is different in COPD patients than in the general population.

Vascular pulmonary diseases

The ability of SARS-CoV-2 to invade vascular endothelial cells leads to endothelial inflammation, thrombin generation, and platelet and leukocyte recruitment causing a predisposition to thrombotic phenomena in different sites.^{140–142} Thromboembolism rates of COVID-19 were high and associated with higher risk of death in hospitalized patients.^{143–145} Pulmonary embolism (PE) prediction in COVID-19 patients is challenging. Some factors independently associated with PE were tachypnea, absence of infiltrates in the chest X-ray and elevated D-dimer levels,¹⁴⁶ which per se are already high in patients with a worse prognosis.¹⁴⁷

Anticoagulation for prophylactic purposes is recommended in COVID-19 patients. In addition, low molecular weight heparin (LMWH) has also been suggested to have anti-inflammatory and antiviral properties.¹⁴⁸ Up to now, findings provide comprehensive and high-quality evidence for the use of standard-dose prophylactic anticoagulation over an escalated-dose regimen as routine standard of care for hospitalized COVID-19 patients irrespective of disease severity.¹⁴⁹ However, a new paradigm has been opened and some clinical guidelines¹⁵⁰ consider a treatment dose of LMWH for COVID-19 patients who need low-flow oxygen and who do not have an increased bleeding risk.

Treatment patterns have also been modified during the pandemic because there has been an increase in the use of direct oral anticoagulants (DOACs) and prolongation of days with LMWH. Although the long-term outcomes in survivors of COVID-19 are unknown at present, thrombotic sequelae have the potential to become a clinically significant problem.¹⁵¹ Routine post-COVID-19 follow-up pathways should include lung perfusion imaging and cardiopulmonary exercise test.^{152,153}

The reasons of an unexpected favorable incidence of COVID-19 in patients with pulmonary hypertension (PH) and chronic thromboembolic pulmonary hypertension (CTEPH) are not yet clarified.¹⁵⁴

The usefulness of telemedicine during the pandemic in all medical specialties has been demonstrated, both in acute episodes and after hospital discharges¹⁵⁵ (Fig. 2).

Asthma

Chronic inflammation (typically T2) and bronchial remodeling, usual features of asthma, could increase the susceptibility

to COVID-19. Besides, it has been shown that a T1 predominant inflammatory pattern—and not T2—is associated with higher expression of ACE2 receptor.¹⁵⁶ It has been controversial whether asthma augments the risk of becoming infected but, in the light of the recently published studies, it might be argued that the risk is restricted to severe forms of the disease.^{97,137,157–162} The EAVE II study showed that adults with asthma had an increased risk of COVID-19 hospital admission (adjusted HR 1.27; 95%CI, 1.23–1.32) compared with those without asthma, and that those who have required ≥ 2 oral corticosteroids bursts in the previous 2 years are at increased risk of ICU admission or death, even accounting for vaccination status.¹⁶³ In children, a recent meta-analysis concluded that asthma does not appear to be a risk factor for hospitalization or ICU admission caused by COVID-19.¹⁶⁴ On the other hand, unscheduled asthma visits appeared to be significantly reduced during COVID-19 pandemic,¹⁶⁵ likely owing to reduced viral upper respiratory tract infections.

Inhaled corticosteroids (ICS) might potentially favor viral replication and delay viral clearance but, on the contrary, they might reduce the epithelial expression of ACE2 and TMPRSS2 (viral entry receptors)¹⁶⁶ and also the levels of potentially harmful cytokines such as IL-6 and IL-8.^{167,168} Investigations on the therapeutic effect of ICS in COVID-19 patients yielded controversial—although mostly favorable—results.^{169–173} A meta-analysis supports ICS use to short the duration of the disease and, maybe, to prevent hospitalizations.¹⁷⁴

Biologics can negatively impact B lymphocytes differentiation into plasma cells and the generation of plasma memory cells through eosinophil depletion,¹⁷⁵ and, in fact, humoral vaccine response is lower in patients who are receiving this treatment.¹⁷⁶ By contrast, omalizumab has been shown to restore the capacity of plasmacytoid dendritic cells to produce alpha interferon (IFN- α), promoting their antiviral activity.¹⁷⁷ According to results from large databases and several national registries, biologic therapy does not increase risk for severe COVID-19 in asthma patients.^{178–180}

Interstitial lung diseases

The pandemic of COVID-19 has significantly impact on patients with interstitial lung diseases (ILDs). In general, patients with pre-existing respiratory disease, including interstitial lung diseases, have an increased risk of severe SARS-CoV-2 infection^{97,181} and increased risk of mortality.¹⁸² Recent publications have focused specifically on the impact of COVID-19 infection in ILDs.^{183–186} A recent national Korean study compared two cohorts of patients with and without COVID-19, observing that the proportion of

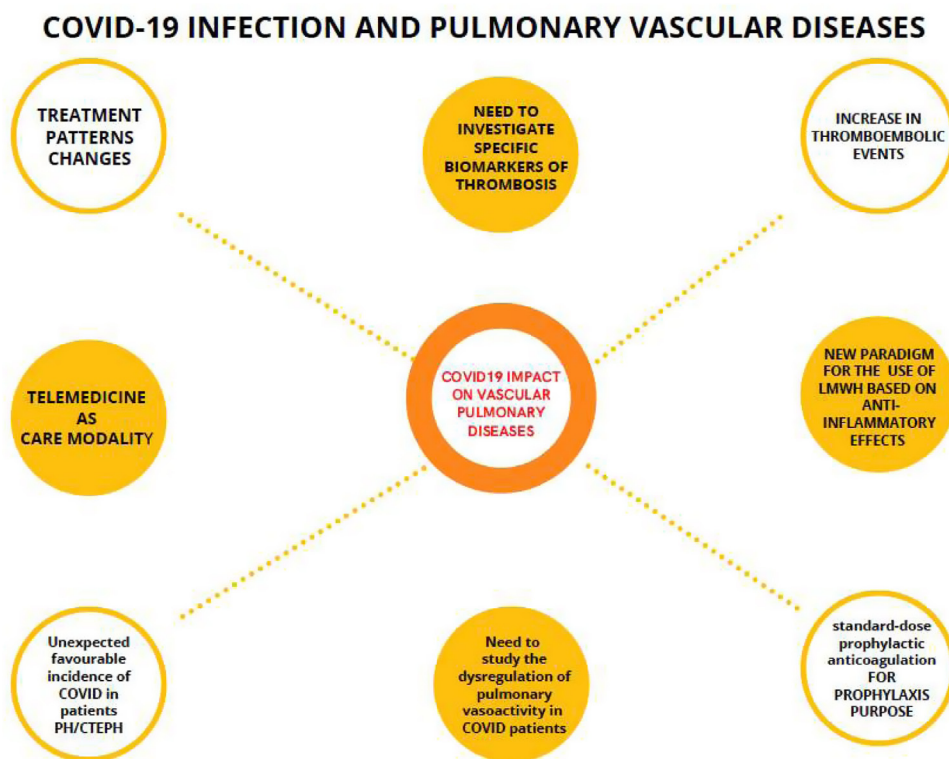


Fig. 2. Mind map of the impact of COVID-19 on pulmonary vascular diseases. Connected by dashed lines, the evidences in relation to COVID-19 and pulmonary vascular diseases. Unconnected circles are thoughts of the COVID-19 pandemic. LMWH: low molecular weight heparin; PH/CTEPH: pulmonary hypertension and chronic thromboembolic pulmonary hypertension.

patients with ILDs was significantly higher in the COVID-19 cohort than in the matched cohort (adjusted OR 2.02; 95%CI, 1.54–2.61). Mortality is also higher in patients with ILDs compared to general population.^{183–186} In addition, patients with fibrotic ILDs have probably higher rates of hospitalization and mortality compared to other ILDs.^{183,185}

After severe COVID-19 infection, pulmonary sequelae could be a long-term complication, including lung fibrosis.^{187,188} The consequences after COVID-19 infection in patients with ILDs are not clear. The possibility of acute exacerbation after COVID-19 infection has been described.¹⁸⁹ Viral infections could be the trigger of lung fibrosis exacerbation/progression. The potential fibrotic effect of SARS-CoV-2 infection in a fibrotic environment could have a huge impact in the prognosis of ILDs.¹⁹⁰ The real long-term impact of COVID-19 infection in ILD patients must be elucidated in the future.

General prevention measures (masks, social distance) and vaccination have been recommended to avoid risk of infection. Surprisingly, some cases of acute exacerbation after COVID-19 vaccination have been described in ILDs.^{191–193} The benefit of vaccination is over the potential side effects of the vaccine, but physicians must monitor closely those patients that present respiratory worsening after vaccination.

As patients with ILDs are a fragile population in the context of COVID-19 pandemic, the management of these diseases has been consequently affected. Major issues for patients with ILDs have been described: restricted access to the diagnostic process, uncertainties in the use of common ILDs pharmacotherapies, limited ability to monitor both disease severity and medication adverse effects, and significantly curtailed research activities.¹⁹⁴ The development of telematic technologies rapidly raised during this period. Telehealth and home monitoring could be an option in the future for ILDs,^{195,196} but it still needs more development to be fully included in the habitual clinical management.

Smoking

Given the statement that some authors have made as to whether nicotine could be a therapeutic option, even protective, for COVID-19 infection,¹⁹⁷ Takagi¹⁹⁸ performed a meta-regression in which he demonstrated a positive association between the smoking prevalence and COVID-19 infection, independent of other co-variables; therefore, the hypothesis that the prognosis of the disease is better for being a smoker is not supported. Conversely, in this moment it is no doubt that current and past smoking produces a more severe clinical form of COVID-19 and more frequently leads these patients to be admitted to ICU, are intubated, and die.^{199,200} This association was more significant for former smokers than in current smokers,²⁰¹ although some studies have found an evident trend toward a worse progression in smokers.²⁰⁰ Clearly, smoking is an independent risk for having progression of COVID-19, including mortality,²⁰² and people who smoke are at an increased risk of developing symptomatic COVID-19.²⁰³

Findings in the same line have been found between the consumption of electronic cigarettes (EC) and the infection by COVID-19: Vapers experience higher frequency of COVID-19 related symptoms when compared with age and gender matched non-vapers.²⁰⁴

Another question is, has the COVID-19 infections impacted smokers? A United Kingdom study²⁰⁵ in adults investigated changes in cigarette and EC use during the COVID-19 pandemic and what factors were associated with the changes. They found that many smokers and vapers tried to quit and a high proportion succeeded, others cut down or stayed the same. The pandemic provided motivation to quit smoking and on the other hand prompted vapers to return to cigarette smoking.^{205,206} In Pakistan²⁰⁷ like in Jordan,²⁰⁸ while many people stopped, reduced, or tried quitting smoking, some increased smoking, and some relapsed after quitting. Smokers in China²⁰⁹ on average reduced their tobacco

consumption after the nationwide viral outbreak had been contained, but there were differences: men, those with a longer history of consumption or residing in urban areas were less able to reduce their consumption. Some authors found that a majority of smokers were not affected by the pandemic in their consumption even knowing the effect of this association,^{210,211} and it has even been reported that many smokers have smoked more to calm down and deal with negative feelings and social impacts.²¹² It is recognized that in the pandemic the motivation to quit smoking has increased slightly, correlating the above with social and well-being changes, but there were no changes in final abstinence or in the willingness to quit cigarettes, although the tendency to try an electronic cigarette increased.^{213,214}

Conclusions

COVID-19 can affect the respiratory system in a variety of ways and across a spectrum of levels of disease severity, depending on a person's immune system, age and comorbidities. It is important that patients who have underlying lung disease can certainly have worsening of those conditions with contraction or exposure to COVID-19. Global public health effort is required to increase awareness about minimizing the burden of these comorbidities conditions that cause fatalities in COVID-19 infected peoples.

Conflict of interests

The authors declare that they have no conflict of interest.

References

- Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, et al. Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med*. 2020;382:1708–20, <http://dx.doi.org/10.1056/NEJMoa2002032>.
- Soriano JB, Ramón Villagrana J, Ancochea J. COVID-19 in youth and the fifth wave. *Arch Bronconeumol (Engl Ed)*. 2021, <http://dx.doi.org/10.1016/j.arbres.2021.08.019>.
- Muñoz-Rodríguez JR, Gómez-Romero FJ, Pérez-Ortiz JM, López-Juárez P, Santiago JL, Serrano-Oviedo L, et al. Characteristics and risk factors associated with mortality in a multicenter spanish cohort of patients with COVID-19 pneumonia. *Arch Bronconeumol*. 2021;57:34–41, <http://dx.doi.org/10.1016/j.arbres.2021.02.021>.
- Dessie ZG, Zewotir T. Mortality-related risk factors of COVID-19: a systematic review and meta-analysis of 42 studies and 423,117 patients. *BMC Infect Dis*. 2021;21:855, <http://dx.doi.org/10.1186/s12879-021-06536-3>.
- Posso M, Comas M, Román M, Domingo L, Louro J, González C, et al. Comorbidities and mortality in patients with COVID-19 aged 60 years and older in a university hospital in Spain. *Arch Bronconeumol (Engl Ed)*. 2020;56:756–8, <http://dx.doi.org/10.1016/j.arbr.2020.06.010>.
- Golpe R, Blanco N, Castro-Añón O, Corredoira J, García-Pais MJ, Pérez-de Llano LA, et al. Factors associated to hospital admission in a care protocol in COVID-19. *Arch Bronconeumol (Engl Ed)*. 2020;56:676–7, <http://dx.doi.org/10.1016/j.arbres.2020.05.038>.
- Zhang JJ, Dong X, Liu GH, Gao YD. Risk and protective factors for COVID-19 morbidity, severity, and mortality. *Clin Rev Allergy Immunol*. 2022;19:1–18, <http://dx.doi.org/10.1007/s12016-022-08921-5>.
- Tazerji SS, Shahabinejad F, Tokasi M, Rad MA, Khan MS, Safdar M, et al. Global data analysis and risk factors associated with morbidity and mortality of COVID-19. *Gene Rep*. 2022;26:101505, <http://dx.doi.org/10.1016/j.genrep.2022.101505>.
- Kaur G, Lungerella G, Rahman I. SARS-CoV-2 COVID-19 susceptibility and lung inflammatory storm by smoking and vaping. *J Inflamm (Lond)*. 2020;17:21, <http://dx.doi.org/10.1186/s12950-020-00250-8>.
- Muus C, Luecken MD, Eraslan G, Sikkema L, Waghay A, Heimberg G, et al. Single-cell meta-analysis of SARS-CoV-2 entry genes across tissues and demographics. *Nat Med*. 2021;27:546–59, <http://dx.doi.org/10.1038/s41591-020-01227-z>.
- Ahmad Malik J, Ahmed S, Shinde M, Hajjaj Saeid Al-Marmash M, Alghamdi S, Hussain A, et al. The impact of COVID-19 on the comorbidities: a review of recent updates for combating it. *Saudi J Biol Sci*. 2022, <http://dx.doi.org/10.1016/j.sjbs.2022.02.006>.
- Torres-Castro R, Solis-Navarro L, Sitjà-Rabert M, Vilaró J. Functional limitations post-COVID-19: a comprehensive assessment strategy. *Arch Bronconeumol*. 2021;57:7–8, <http://dx.doi.org/10.1016/j.arbres.2020.07.025>.
- Sibila O, Albacar N, Perea L, Faner R, Torralba Y, Hernandez-Gonzalez F, et al. Lung function sequelae in COVID-19 patients 3 months after hospital discharge. *Arch Bronconeumol*. 2021;57:59–61, <http://dx.doi.org/10.1016/j.arbres.2021.01.036>.
- Martínez-García MA, Aksamit TR, Aliberti S. Bronchiectasis as a long-term consequence of SARS-CoV-2 pneumonia: future studies are needed. *Arch Bronconeumol*. 2021;57:739–40, <http://dx.doi.org/10.1016/j.arbr.2021.04.017>.
- Han Q, Zheng B, Daines L, Sheikh A. Long-term sequelae of COVID-19: a systematic review and meta-analysis of one-year follow-up studies on post-COVID symptoms. *Pathogens*. 2022;11:269, <http://dx.doi.org/10.3390/pathogens11020269>.
- Taberner E, Urrutia A, Ruiz LA, Serrano L, Marina N, Iriberrí M, et al. Pulmonary function in early follow-up of patients with COVID-19 pneumonia. *Arch Bronconeumol*. 2021;57:75–6, <http://dx.doi.org/10.1016/j.arbres.2020.07.017>.
- Khan MSI, Khan MSI, Debnath CR, Nath PN, Mahtab MA, Nabeka H, et al. Ivermectin treatment may improve the prognosis of patients with COVID-19. *Arch Bronconeumol*. 2020;56:828–30, <http://dx.doi.org/10.1016/j.arbr.2020.08.011>.
- González-Gay MA, Castañeda S, Ancochea J. Biologic therapy in COVID-19. *Arch Bronconeumol*. 2021;57:1–2, <http://dx.doi.org/10.1016/j.arbres.2020.06.007>.
- Griesel M, Wagner C, Mikolajewska A, Stegemann M, Fichtner F, Metzendorf MI. Inhaled corticosteroids for the treatment of COVID-19. *Cochrane Database Syst Rev*. 2022;3, <http://dx.doi.org/10.1002/14651858.CD015125>.
- Amati F, Aliberti S, Misuraca S, Simonetta E, Bindo F, Vigni A, et al. Lung recruitability of COVID-19 pneumonia in patients undergoing helmet CPAP. *Arch Bronconeumol*. 2021;57:92–4, <http://dx.doi.org/10.1016/j.arbres.2020.09.017>.
- Delorme M, Leroux K, Boussaid G, Leuret M, Prigent H, Leotard A, et al. Protective recommendations for non-invasive ventilation during COVID-19 pandemic: a bench evaluation of the effects of instrumental dead space on alveolar ventilation. *Arch Bronconeumol*. 2021;57:28–33, <http://dx.doi.org/10.1016/j.arbres.2021.01.012>.
- Winck JC, Scala R. Non-invasive respiratory support therapies in COVID-19 related acute respiratory failure: looking at the neglected issues. *Arch Bronconeumol*. 2021;57:9–10, <http://dx.doi.org/10.1016/j.arbres.2021.02.007>.
- Wang Z, Wang Y, Yang Z, Wu H, Liang J, Liang H, et al. The use of non-invasive ventilation in COVID-19: a systematic review. *Int J Infect Dis*. 2021;106:254–61, <http://dx.doi.org/10.1016/j.ijid.2021.03.078>.
- Sryma PB, Mittal S, Madan K, Mohan A, Hadda V, Tiwari P, et al. Re-venting the wheel in ARDS: awake proning in COVID-19. *Arch Bronconeumol*. 2020;56:747–9, <http://dx.doi.org/10.1016/j.arbr.2020.06.013>.
- Ruiz de Gopegui Miguelena P, Peiro Chamorro M, Claraco Vega LM. COVID-19-related endothelial injury in lung cryobiopsy. *Arch Bronconeumol*. 2021;57:65, <http://dx.doi.org/10.1016/j.arbres.2020.06.010>.
- Radchenko C. Short- and Long-Term Lung Damage from COVID-19. UC Health. Available from: <https://www.uchealth.com/en/media-room/covid-19/short-and-long-term-lung-damage-from-covid-19> [accessed 13.3.22].
- Chiner E, Llombart M, Valls J, Pastor E, Sancho-Chust JN, Andreu AL, et al. Association between obstructive sleep apnea and community-acquired pneumonia. *PLOS ONE*. 2016;11, <http://dx.doi.org/10.1371/journal.pone.0152749>, e0152749.
- Miller MA, Cappuccio FP. A systematic review of COVID-19 and obstructive sleep apnoea. *Sleep Med Rev*. 2020;55, <http://dx.doi.org/10.1016/j.smrv.2020.101382>, 101382.
- Labarca G, Henriquez-Beltrán M, Llerena F, Ericas G, Lastra J, Enos D, et al. Undiagnosed sleep disorder breathing as a risk factor for critical COVID-19 and pulmonary consequences at the midterm follow-up. *Sleep Med*. 2021, <http://dx.doi.org/10.1016/j.sleep.2021.02.029>, S1389-9457(21)00128-3.
- Cariou B, Hadjadj S, Wargny M, Pichelin M, Al-Salameh A, Allix I, et al. Phenotypic characteristics and prognosis of inpatients with COVID-19 and diabetes: the CORONADO study. *Diabetologia*. 2020, <http://dx.doi.org/10.1007/s00125-020-05180-x>.
- Perger E, Soranna D, Pengo M, et al. Sleep-disordered breathing among hospitalized patients with COVID-19. *Am J Respir Crit Care Med*. 2021;203, <http://dx.doi.org/10.1164/rccm.202010-3886LE>, 239e41.
- Cade BE, Dashti HS, Hassan SM, et al. Sleep apnea and COVID-19 mortality and hospitalization. *Am J Respir Crit Care Med*. 2020;202, <http://dx.doi.org/10.1164/rccm.202006-2252LE>, 1462e4.
- Hariyanto TI, Kurniawan A. Obstructive sleep apnea (OSA) and outcomes from coronavirus disease 2019 (COVID-19) pneumonia: a systematic review and meta-analysis. *Sleep Med*. 2021;82:47–53, <http://dx.doi.org/10.1016/j.sleep.2021.03.029>.
- Causy C, Pattou F, Wallet F, Simon C, Chalopin S, Telliam C, et al. Prevalence of obesity among adult in patients with COVID-19 in France. *Lancet Diabetes Endocrinol*. 2020;8:562–4, [http://dx.doi.org/10.1016/S2213-8587\(20\)30160-1](http://dx.doi.org/10.1016/S2213-8587(20)30160-1).
- McSharry D, Malhotra A. Potential influences of obstructive sleep apnea and obesity on COVID-19 severity. *J Clin Sleep Med*. 2020;16:1645, <http://dx.doi.org/10.5664/jcsm.8538>.
- Berenguer J, Ryan P, Rodríguez-Baño J, Jarrín I, Carratalá J, Pachón J, et al. Characteristics and predictors of death among 4035 consecutively hospitalized patients with COVID-19 in Spain. *Microbiol Infect*. 2020;26:1525–36, <http://dx.doi.org/10.1016/j.cmi.2020.07.024>.
- Unnikrishnan D, Jun J, Polotsky V. Inflammation in sleep apnea: an update. *Rev Endocr Metab Disord*. 2015;16, <http://dx.doi.org/10.1007/s11154-014-9304-x>, 25e34.

38. Labarca G, Gower J, Lamperti L, Dreys J, Jorquera J. Chronic intermittent hypoxia in obstructive sleep apnea: a narrative review from pathophysiological pathways to a precision clinical approach. *Sleep Breath*. 2020;24:751–60. <http://dx.doi.org/10.1007/s11325-019-01967-4>.
39. AbdelMassih A, Yacoub E, Hussein RJ, Kamel A, Hozaian R, El Shershaby M, et al. Hypoxia-inducible factor (HIF): the link between obesity and COVID-19. *Obes Med*. 2021;22:100317. <http://dx.doi.org/10.1016/j.obmed.2020.100317>.
40. Jose RJ, Ari Manuel A. COVID-19 cytokine storm: the interplay between inflammation and coagulation. *Lancet Respir Med*. 2020. [http://dx.doi.org/10.1016/S2213-2600\(20\)30216-2](http://dx.doi.org/10.1016/S2213-2600(20)30216-2).
41. Bikov A, Meszaros M, Schwarz El. Coagulation and fibrinolysis in obstructive sleep apnoea. *Int J Mol Sci*. 2021;22:2834. <http://dx.doi.org/10.3390/ijms22062834>.
42. South AM, Diz DI, Chappell MC. COVID-19, ACE2, and the cardiovascular consequences. *Am J Physiol Heart Circ Physiol*. 2020;318. <http://dx.doi.org/10.1152/ajpheart.00217.2020>.
43. Iannelli A, Favre G, Frey S, Esnault V, Gugenheim J, Bouam S, et al. Obesity and COVID-19: ACE 2, the missing link. *Obes Surg*. 2020;30:4615–7. <http://dx.doi.org/10.1007/s11695-020-04734-7>.
44. Jin Z-N, Wei Y-X. Meta-analysis of effects of obstructive sleep apnea on the renin-angiotensin-aldosterone system. *J Geriatr Cardiol*. 2016;13. <http://dx.doi.org/10.11909/j.issn.1671-5411.2016.03.020>.
45. Bandyopadhyay D, Akhtar T, Hajra A, Gupta M, Das A, Chakraborty S, et al. COVID-19 pandemic: cardiovascular complications and future implications. *Am J Cardiovasc Drugs*. 2020;20:311–24. <http://dx.doi.org/10.1007/s40256-020-00420-2>.
46. Cappuccio FP, Siani A. Covid-19 and cardiovascular risk: susceptibility to infection to SARS-CoV-2, severity and prognosis of Covid-19 and blockade of the renin-angiotensin-aldosterone system. An evidence-based viewpoint. *Nutr Metab Cardiovasc Dis*. 2020;30. <http://dx.doi.org/10.1016/j.numecd.2020.05.013>.
47. World Health Organization. Global Cancer Observatory. International Agency for Research on Cancer 2022. Available from: <https://gco.iarc.fr/> [accessed 18.3.22].
48. Cayuela L, López-Campos JL, Otero R, Rodríguez Portal JA, Rodríguez-Domínguez S, Cayuela A. The beginning of the trend change in lung cancer mortality trends in Spain, 1980–2018. *Arch Bronconeumol*. 2021;57:115–21. <http://dx.doi.org/10.1016/j.arbres.2020.04.025>.
49. de-Torres JP, Wisnivesky JP. Lung cancer screening in patients with chronic obstructive pulmonary disease: do the benefits outweigh the risks? *Arch Bronconeumol*. 2021. <http://dx.doi.org/10.1016/j.arbres.2021.04.020>.
50. Mesa-Guzmán M, González J, Alcaide AB, Bertó J, de-Torres JP, Campo A, et al. Surgical outcomes in a lung cancer-screening program using low dose computed tomography. *Arch Bronconeumol*. 2021;57:101–6. <http://dx.doi.org/10.1016/j.arbres.2020.03.026>.
51. Sociedad Española de Oncología Médica (SEOM). Las cifras del cáncer en España 2022. Available from: <https://seom.org/images/LAS.CIFRAS.DEL.CANCER.EN.ESPANA.2022.pdf> [accessed 18.3.22].
52. de-Torres JP, Wisnivesky JP, Bastarrika G, Wilson DO, Celli BR, Zulueta JJ. Exploring the impact of lung cancer screening on lung cancer mortality of smokers with obstructive lung disease: analysis of the NLS-ACRIN cohort. *Arch Bronconeumol*. 2021;57:36–41. <http://dx.doi.org/10.1016/j.arbres.2020.03.023>.
53. Seijo LM, Trujillo JC, Zulueta JJ. Screening in lung cancer: the latest evidence. *Arch Bronconeumol*. 2020;56:7–8. <http://dx.doi.org/10.1016/j.arbres.2019.04.019>.
54. Round T, L'Esperance V, Bayly J, Brain K, Dallas L, Edwards JG, et al. COVID-19 and the multidisciplinary care of patients with lung cancer: an evidence-based review and commentary. *Br J Cancer*. 2021;125:629–40.
55. Huber RM, Cavic M, Kerpel-Fronius A, Viola L, Field J, Jiang L, et al. Lung cancer screening considerations during respiratory infection outbreaks, epidemics or pandemics: an international association for the study of lung cancer early detection and screening committee report. *J Thorac Oncol Off Publ Int Assoc Study Lung Cancer*. 2022;17:228–38.
56. Passaro A, Addeo A, Von Garnier C, Blackhall F, Planchard D, Felip E, et al. ESMO Management and treatment adapted recommendations in the COVID-19 era: lung cancer. *ESMO Open*. 2020;5 Suppl. 3. e000820.
57. Mazzone PJ, Gould MK, Arenberg DA, Chen AC, Choi HK, Detterbeck FC, et al. Management of lung nodules and lung cancer screening during the COVID-19 pandemic: CHEST expert panel report. *Chest*. 2020;158:406–15.
58. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*. 2020;395:497–506.
59. Isea de la Viña J, Mayol J, Ortega AL, Alcázar Navarrete B. Lung cancer patients on the waiting list in the midst of the COVID-19 crisis: what do we do now? *Arch Bronconeumol*. 2020;56:602–4. <http://dx.doi.org/10.1016/j.arbres.2020.05.004>.
60. Vivarelli S, Falzone L, Grillo CM, Scandurra G, Torino F, Libra M. Cancer management during COVID-19 pandemic: is immune checkpoint inhibitors-based immunotherapy harmful or beneficial? *Cancers*. 2020;12:2237.
61. Zhang H, Quek K, Chen R, Chen J, Chen B. Expression of the SAR2-Cov-2 receptor ACE2 reveals the susceptibility of COVID-19 in non-small cell lung cancer. *J Cancer*. 2020;11:5289–92.
62. Rogado J, Pangua C, Serrano-Montero G, Obispo B, Marino AM, Pérez-Pérez M, et al. Covid-19 and lung cancer: a greater fatality rate? *Lung Cancer Amst Neth*. 2020;146:19–22.
63. Wang H, Zhang L. Risk of COVID-19 for patients with cancer. *Lancet Oncol*. 2020;21. e181–e181.
64. Garassino MC, Whisenant JG, Huang L-C, Trama A, Torri V, Agustoni F, et al. COVID-19 in patients with thoracic malignancies (TERAVOLT): first results of an international, registry-based, cohort study. *Lancet Oncol*. 2020;21:914–22.
65. Sha Z, Chang K, Mi J, Liang Z, Hu L, Long F, et al. The impact of the COVID-19 pandemic on lung cancer patients. *Ann Palliat Med*. 2020;9.
66. Dai M, Liu D, Liu M, Zhou F, Li G, Chen Z, et al. Patients with cancer appear more vulnerable to SARS-CoV-2: a multicenter study during the COVID-19 outbreak. *Cancer Discov*. 2020;10:783–91.
67. Luo J, Rizvi H, Preeshagul IR, Egger JV, Hoyos D, Bandlamudi C, et al. COVID-19 in patients with lung cancer. *Ann Oncol Off J Eur Soc Med Oncol*. 2020;31:1386–96.
68. Ruge M, Zorzi M, Guzzinati S. SARS-CoV-2 infection in the Italian Veneto region: adverse outcomes in patients with cancer. *Nat Cancer*. 2020;1:784–8.
69. Giannakoulis VG, Papoutsis E, Siempos II. Effect of cancer on clinical outcomes of patients with COVID-19: a meta-analysis of patient data. *JCO Glob Oncol*. 2020;6:799–808.
70. Moraliyage H, De Silva D, Ranasinghe W, Adikari A, Alahakoon D, Prasad R, et al. Cancer in lockdown: impact of the COVID-19 pandemic on patients with cancer. *Oncologist*. 2021;26:e342–4.
71. de Joode K, Dumoulin DW, Engelen V, Bloemendal HJ, Verheij M, van Laarhoven HWM, et al. Impact of the coronavirus disease 2019 pandemic on cancer treatment: the patients' perspective. *Eur J Cancer*. 2020;136:132–9.
72. de Joode K, Tol J, Hamberg P, Cloos M, Kastelijn EA, Borgers JSW, et al. Life-prolonging treatment restrictions and outcomes in patients with cancer and COVID-19: an update from the Dutch Oncology COVID-19 Consortium. *Eur J Cancer*. 2022;160:261–72.
73. Maringe C, Spicer J, Morris M, Purushotham A, Nolte E, Sullivan R, et al. The impact of the COVID-19 pandemic on cancer deaths due to delays in diagnosis in England, UK: a national, population-based, modelling study. *Lancet Oncol*. 2020;21:1023–34.
74. Liang W, Guan W, Chen R, Wang W, Li J, Xu K, et al. Cancer patients in SARS-CoV-2 infection: a nationwide analysis in China. *Lancet Oncol*. 2020;21:335–7.
75. Zhang L, Zhu F, Xie L, Wang C, Wang J, Chen R, et al. Clinical characteristics of COVID-19-infected cancer patients: a retrospective case study in three hospitals within Wuhan, China. *Ann Oncol*. 2020;31:894–901.
76. Park R, Lee SA, Kim SY, de Melo AC, Kasi A. Association of active oncologic treatment and risk of death in cancer patients with COVID-19: a systematic review and meta-analysis of patient data. *Acta Oncol*. 2021;60:13–9.
77. Russano M, Citarella F, Vincenzi B, Tonini G, Santini D. Coronavirus disease 2019 or lung cancer: what should we treat? *J Thorac Oncol*. 2020;15:e105–6.
78. Banna G, Curioni-Fontecedro A, Friedlaender A, Addeo A. How we treat patients with lung cancer during the SARS-CoV-2 pandemic: primum non nocere. *ESMO Open*. 2020;5. e000765–e000765.
79. Sanz-Santos J, Rami-Porta R, Call S. Lessons already learnt from the coronavirus disease 2019 pandemic. *J Thorac Oncol*. 2020;15:e107–8.
80. Ouyang W, Hu J, Zhang H, Xie C. The management of patients with lung cancer during the outbreak of coronavirus disease 2019. *J Thorac Oncol*. 2020;15:e106–7.
81. COVIDSurg, Collaborative. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. *Lancet*. 2020;396:27–38. [http://dx.doi.org/10.1016/S0140-6736\(20\)31182-X](http://dx.doi.org/10.1016/S0140-6736(20)31182-X).
82. COVIDSurg Collaborative; GlobalSurg Collaborative. Timing of surgery following SARS-CoV-2 infection: an international prospective cohort study. *Anaesthesia*. 2021;76:748–58. doi:10.1111/anae.15458.
83. Aran V, De Marchi P, Zamboni M, Ferreira CG. Dealing with lung cancer in the COVID-19 scenario (a review). *Mol Clin Oncol*. 2021;14. 27–27.
84. Thoracic Surgery Outcomes Research Network I, Antonoff M, Backhus L, Boffa DJ, Broderick SR, Brown LM, et al. COVID-19 guidance for triage of operations for thoracic malignancies: A consensus statement from Thoracic Surgery Outcomes Research Network. *J Thorac Cardiovasc Surg*. 2020;160:601–5.
85. Moazzami B, Razavi-Khorasani N, Dooghaie Moghadam A, Farokhi E, Rezaei N. COVID-19 and telemedicine: immediate action required for maintaining healthcare providers well-being. *J Clin Virol*. 2020;126:104345.
86. Calton BA, Bischoff K, Pantilat SZ. "I just need to hold his hand": telemedicine is powerful. But Not Perfect *J Palliat Med*. 2021;24:166–7.
87. Zhao W, Zhong Z, Xie X, Yu Q, Liu J. Relation between chest CT findings and clinical conditions of coronavirus disease (COVID-19) pneumonia: a multicenter study. *Am J Roentgenol*. 2020;214:1072–7.
88. Devie A, Kanagaratnam L, Perotin JM, Jolly D, Ravey JN, Djelouah M, et al. COVID-19: a qualitative chest CT model to identify severe form of the disease. *Diagn Interv Imaging*. 2021;102:77–84.
89. Peng P, Wang F, Tang ZR, Liu X, Zhang ZH, Song H, et al. Bronchiectasis is one of the indicators of severe coronavirus disease 2019 pneumonia. *Chin Med J (Engl)*. 2021;134:2486–8.
90. Wang Y, Mao K, Li Z, Xu W, Shao H, Zhang R. Clinical study of pulmonary CT lesions and associated bronchiectasis in 115 convalescent patients with novel coronavirus pneumonia (COVID-19) in China. *Can J Physiol Pharmacol*. 2021;99:328–31.

91. Han X, Fan Y, Alwaid O, Li N, Xia X, Yuan M, et al. Six-month follow-up chest CT findings after severe COVID-19 pneumonia. *Radiology*. 2021;299:E177–86.
92. José RJ, Manuel A, Gibson-Bailey K, Lee L. Post COVID-19 bronchiectasis: a potential epidemic within a pandemic. *Expert Rev Respir Med*. 2020;14:1183–4.
93. Alqahtani JS, Oyelade T, Aldhahir AM, Mendes RG, Alghamdi SM, Miravittles M, et al. Reduction in hospitalised COPD exacerbations during COVID-19: a systematic review and meta-analysis. *PLOS ONE*. 2021;16, e0255659.
94. Metersky ML. Fewer bronchiectasis exacerbations during the “lockdown” for COVID-19: can we convert knowledge into action? *Am J Respir Crit Care Med*. 2021;204:759–60.
95. Choi H, Lee H, Lee SK, Yang B, Chung SJ, Yeo Y, et al. Impact of bronchiectasis on susceptibility to and severity of COVID-19: a nationwide cohort study. *Ther Adv Respir Dis*. 2021;15, 1753466621995043.
96. Guan WJ, Liang WH, Shi Y, Gan LX, Wang HB, He JX, et al. Chronic respiratory diseases and the outcomes of COVID-19: a nationwide retrospective cohort study of 39,420 cases. *J Allergy Clin Immunol Pract*. 2021;9:2645–55, e14.
97. Aveyard P, Gao M, Lindson N, Hartmann-Boyce J, Watkinson P, Young D, et al. Association between pre-existing respiratory disease and its treatment, and severe COVID-19: a population cohort study. *Lancet Respir Med*. 2021;9:909–23.
98. Crichton ML, Shoemark A, Chalmers JD. The impact of the COVID-19 pandemic on exacerbations and symptoms in bronchiectasis: a prospective study. *Am J Respir Crit Care Med*. 2021;204:857–9.
99. de la Rosa Carrillo D, López-Campos JL, Alcázar Navarrete B, Calle Rubio M, Cantón Moreno R, et al. Consensus document on the diagnosis and treatment of chronic bronchial infection in chronic obstructive pulmonary disease. *Arch Bronconeumol*. 2020;56:651–64, <http://dx.doi.org/10.1016/j.arbres.2020.04.023>.
100. Martínez-García MA, Villa C, Dobarganes Y, Girón R, Maíz L, García-Clemente M, et al. RIBRON: the Spanish online bronchiectasis registry. characterization of the first 1912 patients. *Arch Bronconeumol*. 2021;57:28–35, <http://dx.doi.org/10.1016/j.arbres.2019.12.021>.
101. Williamson L. Living with bronchiectasis during the COVID-19 pandemic. *Lancet Respir Med*. 2021;9:343–4.
102. Milito C, Soccodato V, Auria S, Pulvirenti F, Quinti I. COVID-19 in complex common variable immunodeficiency patients affected by lung diseases. *Curr Opin Allergy Clin Immunol*. 2021;21:535–44.
103. Pedersen ESL, Goutaki M, Harris AL, Dixon L, Manion M, Rindlisbacher B, et al. SARS-CoV-2 infections in people with primary ciliary dyskinesia: neither frequent, nor particularly severe. *Eur Respir J*. 2021;58, 2004548.
104. Sabadosa KA, Faro A, Nelson EC, Marshall BC. Impact of the COVID-19 pandemic: how our response is shaping the future of cystic fibrosis care. *J Cyst Fibros*. 2021;20 Suppl. 3:1–2, <http://dx.doi.org/10.1016/j.jcf.2021.09.002>.
105. Sanders DB, Wu R, O’Neil T, Elbert A, Petren K, Jain R, et al. Changes in care during the COVID-19 pandemic for people with cystic fibrosis. *Ann Am Thorac Soc*. 2022, <http://dx.doi.org/10.1513/AnnalsATS.202105-5320C>.
106. Colombo C, Burgel PR, Gartner S, van Koningsbruggen-Rietschel S, Naehrlich L, Sermet-Gaudelus I, et al. Impact of COVID-19 on people with cystic fibrosis. *Lancet Respir Med*. 2020;8:e35–6, [http://dx.doi.org/10.1016/S2213-2600\(20\)30177-6](http://dx.doi.org/10.1016/S2213-2600(20)30177-6).
107. Bucher J, Boelle PY, Hubert D, Lebourgeois M, Stremler N, Durieu I, et al. Lessons from a French collaborative case-control study in cystic fibrosis patients during the 2009 A/H1N1 influenza pandemic. *BMC Infect Dis*. 2016;16:55, <http://dx.doi.org/10.1186/s12879-016-1352-2>.
108. Burgel PR, Goss C. COVID-19 outcomes in people with cystic fibrosis. *Curr Opin Pulm Med*. 2021;27:538–43, <http://dx.doi.org/10.1097/MCP.0000000000000823>.
109. McClenaghan E, Cosgriff R, Brownlee K, Ahern S, Burgel PR, Byrnes CA, et al. The global impact of SARS-CoV-2 in 181 people with cystic fibrosis. *J Cyst Fibros*. 2020;19:868–71, <http://dx.doi.org/10.1016/j.jcf.2020.10.003>.
110. Naehrlich L, Orenti A, Dunlevy F, Kasmi I, Harutyunyan S, Pfeleger A, et al. Incidence of SARS-CoV-2 in people with cystic fibrosis in Europe between February and June 2020. *J Cyst Fibros*. 2021;20:566–77, <http://dx.doi.org/10.1016/j.jcf.2021.03.017>.
111. Mondejar-Lopez P, Quintana-Gallego E, Giron-Moreno RM, Cortell-Aznar I, Ruiz de Valbuena-Maiz M, Diab-Caceres L, et al. Impact of SARS-CoV-2 infection in patients with cystic fibrosis in Spain: incidence and results of the national CF-COVID19-Spain survey. *Respir Med*. 2020;170, <http://dx.doi.org/10.1016/j.rmed.2020.106062>, 106062.
112. Jung A, Orenti A, Dunlevy F, Alekseejeva E, Bakkeheim E, Bobrovnichy V, et al. Factors for severe outcomes following SARS-CoV-2 infection in people with cystic fibrosis in Europe. *ERJ Open Res*. 2021;7, <http://dx.doi.org/10.1183/23120541.00411-2021>, 00411–2021.
113. Patel S, Thompson MD, Slaven JE, Sanders DB, Ren CL. Reduction of pulmonary exacerbations in young children with cystic fibrosis during the COVID-19 pandemic. *Pediatr Pulmonol*. 2021;56:1271–3, <http://dx.doi.org/10.1002/ppul.25250>.
114. Davies J. The coronavirus pandemic has forced rapid changes in care protocols for cystic fibrosis. *Nature*. 2020;583:S15, <http://dx.doi.org/10.1038/d41586-020-02112-y>.
115. Radtke T, Haile SR, Dressel H, Benden C. Recommended shielding against COVID-19 impacts physical activity levels in adults with cystic fibrosis. *J Cyst Fibros*. 2020;19:875–9, <http://dx.doi.org/10.1016/j.jcf.2020.08.013>.
116. Fernandez-Del-Valle M, Donadio MVF, Pérez-Ruiz M. Physical exercise as a tool to minimize the consequences of the Covid-19 quarantine: an overview for cystic fibrosis. *Pediatr Pulmonol*. 2020;55:2877–82, <http://dx.doi.org/10.1002/ppul.25041>.
117. Havermans T, Houben J, Vermeulen F, Boon M, Proesmans M, Lorent N, et al. The impact of the COVID-19 pandemic on the emotional well-being and home treatment of Belgian patients with cystic fibrosis, including transplanted patients and paediatric patients. *J Cyst Fibros*. 2020;19:880–7, <http://dx.doi.org/10.1016/j.jcf.2020.07.022>.
118. Westcott KA, Wilkins F, Chancellor A, Anderson A, Doe S, Echevarria C, et al. The impact of COVID-19 shielding on the wellbeing, mental health and treatment adherence of adults with cystic fibrosis. *Future Healthc J*. 2021;8:e47–9, <http://dx.doi.org/10.7861/fhj.2020-0205>.
119. Smith BA, Georgiopoulos AM, Mueller A, Abbott J, Lomas P, Aliaj E, et al. Impact of COVID-19 on mental health: effects on screening, care delivery, and people with cystic fibrosis. *J Cyst Fibros*. 2021;20 Suppl. 3:31–8, <http://dx.doi.org/10.1016/j.jcf.2021.08.027>.
120. Gifford AH, Ong T, Dowd C, Van Citters AD, Scalia P, Sabadosa KA, et al. Evaluating barriers to and promoters of telehealth during the COVID-19 pandemic at U.S. cystic fibrosis programs. *J Cyst Fibros*. 2021;20 Suppl. 3:9–13, <http://dx.doi.org/10.1016/j.jcf.2021.08.034>.
121. Albon D, Van Citters AD, Ong T, Dieni O, Dowd C, Willis A, et al. Telehealth use in cystic fibrosis during COVID-19: association with race, ethnicity, and socioeconomic factors. *J Cyst Fibros*. 2021;20 Suppl. 3:49–54, <http://dx.doi.org/10.1016/j.jcf.2021.09.006>.
122. Jaclyn D, Andrew N, Ryan P, Julianna B, Christopher S, Nauman C, et al. Patient and family perceptions of telehealth as part of the cystic fibrosis care model during COVID-19. *J Cyst Fibros*. 2021;20:e23–8, <http://dx.doi.org/10.1016/j.jcf.2021.03.009>.
123. Flume PA, Saiman L, Marshall B. The impact of COVID-19 in cystic fibrosis. *Arch Bronconeumol*. 2021, <http://dx.doi.org/10.1016/j.arbres.2021.12.003>.
124. Lenhart-Pendergrass PM, Anthony M, Sariyska S, Andrews A, Scavezze H, Towler E, et al. Detection of bacterial pathogens using home oropharyngeal swab collection in children with cystic fibrosis. *Pediatr Pulmonol*. 2021;56:2043–7, <http://dx.doi.org/10.1002/ppul.25421>.
125. Loupy A, Aubert O, Reese PP, Bastien O, Bayer F, Jacquelinet C. Organ procurement and transplantation during the COVID-19 pandemic. *Lancet*. 2020;395:e95–6, [http://dx.doi.org/10.1016/S0140-6736\(20\)31040-0](http://dx.doi.org/10.1016/S0140-6736(20)31040-0).
126. Picard C, Le Pavec J, Tissot A. Groupe Transplantation Pulmonaire de la Société de Pneumologie de Langue Française SPLF. Impact of the Covid-19 pandemic and lung transplantation program in France. *Respir Med Res*. 2020;78:100758, <http://dx.doi.org/10.1016/j.resmer.2020.100758>.
127. Burgel PR, Durieu I, Chiron R, Ramel S, Danner-Boucher I, Prevotat A, et al. Rapid improvement after starting elexacaftor-tezacaftor-ivacaftor in patients with cystic fibrosis and advanced pulmonary disease. *Am J Respir Crit Care Med*. 2021;204:64–73, <http://dx.doi.org/10.1164/rccm.202011-41530C>.
128. Pearson K, Mayer-Hamblett N, Goss CH, Retsch-Bogart GZ, VanDalfsen JM, Burks P, et al. The impact of SARS-CoV-2 on the cystic fibrosis foundation therapeutics development network. *J Cyst Fibros*. 2021;20:195–7, <http://dx.doi.org/10.1016/j.jcf.2020.12.007>.
129. Narasimhan M, Mahimainathan L, Clark AE, Usmani A, Cao J, Araj E, et al. Serological response in lung transplant recipients after two doses of SARS-CoV-2 mRNA vaccines. *Vaccines (Basel)*. 2021;9:708, <http://dx.doi.org/10.3390/vaccines9070708>.
130. Guan W-J, Liang W-H, Zhao Y, et al. Comorbidity and its impact on 1590 patients with COVID-19 in China: a nationwide analysis. *Eur Respir J*. 2020;14, <http://dx.doi.org/10.1183/13993003.00547-2020>, 2000547.
131. Alqahtani JS, Oyelade T, Aldhahir AM, Alghamdi SM, Almeahmadi M, Alqahtani AS, et al. Prevalence, severity and mortality associated with COPD and smoking in patients with COVID-19: a rapid systematic review and meta-analysis. *PLOS ONE*. 2020;15, <http://dx.doi.org/10.1371/journal.pone.0233147>, e0233147.
132. Lippi G, Henry BM. Chronic obstructive pulmonary disease is associated with severe coronavirus disease 2019 (COVID-19). *Respir Med*. 2020;167:105941, <http://dx.doi.org/10.1016/j.rmed.2020.105941>.
133. Graziani D, Soriano JB, Del Rio-Bermudez C, Morena D, Díaz T, Castillo M, et al. Characteristics and prognosis of COVID-19 in patients with COPD. *J Clin Med*. 2020;9:E3259, <http://dx.doi.org/10.3390/jcm9103259>.
134. Halpin DMG, Vogelmeier CF, Agusti A. COPD and COVID-19. *Arch Bronconeumol*. 2021;57:162–4, <http://dx.doi.org/10.1016/j.arbr.2021.01.004>.
135. García-Pachón E, Zamora-Molina L, Soler-Sempere MJ, Baeza-Martínez C, Grau-Delgado J, Padilla-Navas I, et al. Asthma and COPD in hospitalized COVID-19 patients. *Arch Bronconeumol*. 2020 Sep;56:604–6, <http://dx.doi.org/10.1016/j.arbres.2020.05.007>.
136. Tiotiu A. Impact of COVID-19 on the most frequent middle and lower obstructive airway diseases/syndromes in adult population. *Arch Bronconeumol*. 2021;57:7–8, <http://dx.doi.org/10.1016/j.arbres.2021.02.006>.
137. Schultze A, Walker AJ, MacKenna B, Morton CE, Bhaskaran K, Brown JP, et al. Risk of COVID-19-related death among patients with chronic obstructive pulmonary disease or asthma prescribed inhaled corticosteroids: an observational cohort study using the OpenSAFELY platform. *Lancet Respir Med*. 2020;8:1106–20, [http://dx.doi.org/10.1016/S2213-2600\(20\)30415-X](http://dx.doi.org/10.1016/S2213-2600(20)30415-X).
138. Tashkin DP, Barjaktarevic IZ. Nebulized treatments and the possible risk of coronavirus transmission: where is the evidence? *Chronic Obstr Pulm Dis*. 2020;7:136–8, <http://dx.doi.org/10.15326/jcopdf.7.3.2020.0161>.
139. Long Y, Hu T, Liu L, Chen R, Guo Q, Yang L, et al. Effectiveness of N95 respirators versus surgical masks against influenza: a systematic review and meta-analysis. *J Evid Based Med*. 2020;13:93–101, <http://dx.doi.org/10.1111/jebm.12381>.

140. Wichmann D, Sperhake J-P, Lütgehetmann M, Steurer S, Edler C, Heinemann A, et al. Autopsy findings and venous thromboembolism in patients with COVID-19: a prospective cohort study. *Ann Intern Med.* 2020;173:268–77.
141. Klok FA, Kruij M, Van der Meer NJM, Arbous MS, Gommers D, Kant KM, et al. Incidence of thrombotic complications in critically ill ICU patients with COVID-19. *Thromb Res.* 2020;191:145–7.
142. Helms J, Tacquard C, Severac F, Leonard-Lorant I, Ohana M, Delabranche X, et al. High risk of thrombosis in patients with severe SARS-CoV-2 infection: a multicenter prospective cohort study. *Intensive Care Med.* 2020;46:1089–98.
143. Malas MB, Naazie IN, Elsayed N, Mathlouthi A, Marmor R, Clary B. Thromboembolism risk of COVID-19 is high and associated with a higher risk of mortality: a systematic review and meta-analysis. *EclinicalMedicine.* 2020;29:100639, <http://dx.doi.org/10.1016/j.eclinm.2020.100639> [accessed 19.3.22].
144. Lu Y, Pan L, Zhang W-W, Cheng F, Hu S-S, Zhang X, et al. A meta-analysis of the incidence of venous thromboembolic events and impact of anticoagulation on mortality in patients with COVID-19. *Int J Infect Dis.* 2020;100:34–41.
145. López-Reyes R, Oscullo G, Jiménez D, Cano I, García-Ortega A. Thrombotic risk and Covid-19: review of current evidence for a better diagnostic and therapeutic approach. *Arch Bronconeumol.* 2021;57:55–64, <http://dx.doi.org/10.1016/j.arbres.2020.07.033>.
146. Rodríguez-Sevilla JJ, Rodó-Pin A, Espallargas I, Villar-García J, Molina L, Pérez Terán P, et al. Pulmonary embolism in patients with Covid-19 pneumonia: the utility of D-dimer. *Arch Bronconeumol.* 2020;56:758–9, <http://dx.doi.org/10.1016/j.arbr.2020.10.008>.
147. Mosquera MG, Fernández-Ruiz M, Rodríguez ES, Martínez AM, Sanz LI, Martín DM, et al. Predicción del desarrollo de tromboembolia pulmonar en pacientes con infección por SARS-CoV-2. *Med Clin (Barc).* 2021;158:206–10, <http://dx.doi.org/10.1016/j.medcli.2021.03.028>.
148. Bikkeli B, Madhavan MV, Jimenez D, Chuich T, Dreyfus I, Driggin E, et al. COVID-19 and thrombotic or thromboembolic disease: implications for prevention, antithrombotic therapy, and follow-up: JACC state-of-the-art review. *J Am Coll Cardiol.* 2020;75:2950–73.
149. Ortega-Paz L, Galli M, Capodanno D, Franchi F, Rollini F, Bikkeli B, et al. Safety and efficacy of different prophylactic anticoagulation dosing regimens in critically and non-critically ill patients with COVID-19: a systematic review and meta-analysis of randomized controlled trials. *Eur Heart J Cardiovasc Pharmacother.* 2021, <http://dx.doi.org/10.1093/ehjcvp/pvab070>, pvab070.
150. The National Institute for Health and Care Excellence (NICE) – NICE COVID-19 rapid guideline: Managing COVID-19 v2.0-10/3/22 [Internet]. Available from: <https://app.magicapp.org/#/guideline/6143/section/98163> [accessed 19.3.22].
151. Aktaa S, Wu J, Nadarajah R, Rashid M, de Belder M, Deanfield J, et al. Incidence and mortality due to thromboembolic events during the COVID-19 pandemic: multi-sourced population-based health records cohort study. *Thromb Res.* 2021;202:17–23, <http://dx.doi.org/10.1016/j.thromres.2021.03.006>.
152. Remy-Jardin M, Duthoit L, Perez T, Felloni P, Favier JB, Fry S, et al. Assessment of pulmonary arterial circulation 3 months after hospitalization for SARS-CoV-2 pneumonia: dual-energy CT (DECT) angiographic study in 55 patients. *EclinicalMedicine.* 2021;34, <http://dx.doi.org/10.1016/j.eclinm.2021.100778> [accessed 19.3.22].
153. Adeloye D, Elneima O, Daines L, Poinasamy K, Quint JK, Walker S, et al. The long-term sequelae of COVID-19: an international consensus on research priorities for patients with pre-existing and new-onset airways disease. *Lancet Respir Med.* 2021;9:1467–78, [http://dx.doi.org/10.1016/S2213-2600\(21\)00286-1](http://dx.doi.org/10.1016/S2213-2600(21)00286-1).
154. Boukhris M, Hillani A, Moroni F, Annabi MS, Addad F, Ribeiro MH, et al. Cardiovascular implications of the COVID-19 pandemic: a global perspective. *Can J Cardiol.* 2020;36:1068–80, <http://dx.doi.org/10.1016/j.cjca.2020.05.018>.
155. Bartzak K, Milkowska-dymanowska J. The Utility of Telemedicine In Managing Patients After COVID 19. *Res Square.* 2022;1-11. Available from: https://www.researchsquare.com/article/rs1293204/v1?utm_source=researcher_app&utm_medium=referral&utm_campaign=RESR_MRKT-Researcher_inbound [accessed 19.3.22].
156. Saheb Sharif-Askari F, Goel S, Saheb Sharif-Askari N, Hafezi S, Al Heialy S, Hachim MY, et al. Asthma associated cytokines regulate the expression of SARS-CoV-2 receptor ACE2 in the lung tissue of asthmatic patients. *Front Immunol.* 2022;12, <http://dx.doi.org/10.3389/fimmu.2021.796094>, 796094.
157. Williamson EJ, Walker AJ, Bhaskaran K, Bacon S, Bates C, Morton CE, et al. Factors associated with COVID-19-related death using OpenSAFELY. *Nature.* 2020;584:430–6, <http://dx.doi.org/10.1038/s41586-020-2521-4>.
158. Bloom CI, Drake TM, Docherty AB, Lipworth BJ, Johnston SL, Nguyen-Van-Tam JS, et al. Risk of adverse outcomes in patients with underlying respiratory conditions admitted to hospital with COVID-19: a national, multicentre prospective cohort study using the ISARIC WHO Clinical Characterisation Protocol UK. *Lancet Respir Med.* 2021;9:699–711, [http://dx.doi.org/10.1016/S2213-2600\(21\)00013-8](http://dx.doi.org/10.1016/S2213-2600(21)00013-8).
159. Lee SC, Son KJ, Han CH, Jung JY, Park SC. Impact of comorbid asthma on severity of coronavirus disease (COVID-19). *Sci Rep.* 2020;10:21805.
160. Bloom CI, Cullinan P, Wedzicha JA. Asthma phenotypes and COVID-19 risk: a population-based observational study. *Am J Respir Crit Care Med.* 2021 Oct 20, <http://dx.doi.org/10.1164/rccm.202107-1704OC>.
161. Liu S, Cao Y, Du T, Zhi Y. Prevalence of comorbid asthma and related outcomes in COVID-19: a systematic review and metaanalysis. *J Allergy Clin Immunol Pract.* 2021;9:693–701.
162. Adir Y, Saliba W, Beurnier A, Humbert M. Asthma and COVID-19: an update. *Eur Respir Rev.* 2021;30:210152, <http://dx.doi.org/10.1183/16000617.0152-2021>.
163. Shi T, Pan J, Vasileiou E, Sheikh A. Risk of serious COVID-19 outcomes among adults with asthma in Scotland: a national incident cohort study. *Lancet Respir Med.* 2022, [http://dx.doi.org/10.1016/S2213-2600\(21\)00543-9](http://dx.doi.org/10.1016/S2213-2600(21)00543-9), S2213-2600(21)00543-9.
164. Mongkongsritagoon W, Preeksapraopong C, Kewcharoen J, Tokavanich N, Prasitlumkum N, Huang J, et al. Prevalence and risk associated with asthma in children hospitalized with SARS-CoV-2: a meta-analysis and systematic review. *J Allergy Clin Immunol Pract.* 2022, <http://dx.doi.org/10.1016/j.jaip.2021.12.044>, S2213-2198(22)00083-6.
165. Stout S, Murphy H, Pandya A, Yeh HW, Portnoy J. The effect of coronavirus disease 2019 on asthma visits. *Ann Allergy Asthma Immunol.* 2022, <http://dx.doi.org/10.1016/j.anaai.2022.01.027>, S1081-1206(22)00048-5.
166. Peters MC, Sajuthi S, Deford P, Christenson S, Rios CL, Montgomery MT, et al. COVID-19 related genes in sputum cells in asthma: relationship to demographic features and corticosteroids. *Am J Respir Crit Care Med.* 2020;202:83–90, <http://dx.doi.org/10.1164/rccm.202003-0821OC>.
167. Yamaya M, Nishimura H, Deng X. Inhibitory effects of glycopyrronium, formoterol, and budesonide on coronavirus HCoV-229E replication and cytokine production by primary cultures of human nasal and tracheal epithelial cells. *Respir Investig.* 2020;58:155–68.
168. Suda K, Tsuruta M, Eom J. Acute lung injury induces cardiovascular dysfunction: effects of IL-6 and budesonide/formoterol. *Am J Respir Cell Mol Biol.* 2011;45:510–6.
169. Ramakrishnan S, Nicolau DV, Langford B, Mahdi M, Jeffers H, Mwasuku C, et al. Inhaled budesonide in the treatment of early COVID-19 (STOIC): a phase 2, open-label, randomised controlled trial. *Lancet Respir Med.* 2021;9:763–72, [http://dx.doi.org/10.1016/S2213-2600\(21\)00160-0](http://dx.doi.org/10.1016/S2213-2600(21)00160-0).
170. Yu L-M, Bafadhel M, Dorward J, Hayward G, Saville BR, Gbinigie O, et al. Inhaled budesonide for COVID-19 in people at high risk of complications in the community in the UK (PRINCIPLE): a randomised, controlled, open-label, adaptive platform trial. *Lancet.* 2021;398:843–55, [http://dx.doi.org/10.1016/S0140-6736\(21\)01744-X](http://dx.doi.org/10.1016/S0140-6736(21)01744-X).
171. Ezer N, Belga S, Daneman N, Chan A, Smith BM, Daniels SA, et al. Inhaled and intranasal ciclesonide for the treatment of covid-19 in adult outpatients: CONTAIN phase II randomised controlled trial. *BMJ.* 2021;375, <http://dx.doi.org/10.1136/bmj.2021-068060>, e068060.
172. Clemency BM, Varughese R, Gonzalez-Rojas Y, Morse CG, Phipatanakul W, Koster DJ, et al. Efficacy of inhaled ciclesonide for outpatient treatment of adolescents and adults with symptomatic COVID-19: a randomized clinical trial. *JAMA Intern Med.* 2022;182:42–9, <http://dx.doi.org/10.1001/jamainternmed.2021.6759>.
173. Agustí A, De Stefano G, Levi A, Muñoz X, Romero-Mesones C, Sibila O, et al. Add-on inhaled budesonide in the treatment of hospitalised patients with COVID-19: a randomised clinical trial. *Eur Respir J.* 2022, <http://dx.doi.org/10.1183/13993003.03036-2021>, 2103036.
174. Lee TC, Bortolussi-Courval É, Belga S, Daneman N, Chan AK, Hanula R, et al. Inhaled corticosteroids for outpatients with Covid-19: a meta-analysis. *Eur Respir J.* 2022, <http://dx.doi.org/10.1183/13993003.02921-2021>, 2102921.
175. Chu VT, Fröhlich A, Steinhauser G, Scheel T, Roch T, Fillatreau S, et al. Eosinophils are required for the maintenance of plasma cells in the bone marrow. *Nat Immunol.* 2011;12:151–9, <http://dx.doi.org/10.1038/ni.1981>.
176. Runnstrom MC, Morrison-Porter A, Ravindran M, Quehl H, Ramonell RP, Woodruff M, et al. Reduced COVID-19 vaccine response in patients treated with biologic therapies for asthma. *Am J Respir Crit Care Med.* 2022, <http://dx.doi.org/10.1164/rccm.202111-2496LE>.
177. Esquivel A, Busse WW, Calatroni A, Toghias AG, Grindle KG, Bochkov YA, et al. Effects of omalizumab on rhinovirus infections, illnesses, and exacerbations of asthma. *Am J Respir Crit Care Med.* 2017;196:985–92, <http://dx.doi.org/10.1164/rccm.201701-01200C>.
178. Izquierdo JL, Almonacid C, González Y, Del Río-Bermudez C, Ancochea J, Cárdenas R, et al. The impact of COVID-19 on patients with asthma. *Eur Respir J.* 2021;57, <http://dx.doi.org/10.1183/13993003.03142-2020>, 2003142.
179. Rial MJ, Valverde M, Del Pozo V, González-Barcala FJ, Martínez-Rivera C, Muñoz X, et al. Clinical characteristics in 545 patients with severe asthma on biological treatment during the COVID-19 outbreak. *J Allergy Clin Immunol Pract.* 2021;9:487–9, <http://dx.doi.org/10.1016/j.jaip.2020.09.050>.
180. Matucci A, Caminati M, Vivarelli E, Vianello A, Micheletto C, Menzella F, et al. COVID-19 in severe asthmatic patients during ongoing treatment with biologics targeting type 2 inflammation: results from a multicenter Italian survey. *Allergy.* 2021;76:871–4, <http://dx.doi.org/10.1111/all.14516>.
181. Lohia P, Sreeram K, Nguyen P, Choudhary A, Khicher S, Yarandi H, et al. Preexisting respiratory diseases and clinical outcomes in COVID-19: a multihospital cohort study on predominantly African American population. *Respir Res.* 2021;22:1–9.
182. Signes-Costa J, Núñez-Gil JJ, Soriano JB, Arroyo-Espliguero R, Eid CM, Romero R, et al. Prevalence and 30-day mortality in hospitalized patients with covid-19 and prior lung diseases. *Arch Bronconeumol.* 2021;57:13–20, <http://dx.doi.org/10.1016/j.arbres.2020.11.012>.
183. Esposito AJ, Menon AA, Ghosh AJ, Putman RK, Fredenburgh LE, El-Chemaly SY, et al. Increased odds of death for patients with interstitial lung disease and COVID-19: a case-control study. *Am J Respir Crit Care Med.* 2020;202:1710–3.
184. Lee H, Choi H, Yang B, Lee SK, Park TS, Park DW, et al. Interstitial lung disease increases susceptibility to and severity of COVID-19. *Eur Respir J.* 2021;58, <http://dx.doi.org/10.1183/13993003.04125-2020>, 2004125.
185. Galloway L, Uzunhan Y, Borie R, Lazor R, Rigaud P, Marchand-Adam S, et al. Risk factors for mortality after COVID-19 in patients with preexisting interstitial lung disease. *Am J Respir Crit Care Med.* 2021;203:245–9, <http://dx.doi.org/10.1164/rccm.202007-2638LE>.

186. Drake TM, Docherty AB, Harrison EM, Quint JK, Adamali H, Agnew S, et al. Outcome of hospitalization for COVID-19 in patients with interstitial lung disease: an international multicenter study. *Am J Respir Crit Care Med.* 2020;202:1656–65, <http://dx.doi.org/10.1164/rccm.202007-2794OC>.
187. Ambardar SR, Hightower SL, Huprikar NA, Chung KK, Singhal A, Collen JF. Post-COVID-19 pulmonary fibrosis: novel sequelae of the current pandemic. *J Clin Med.* 2021;10:2452, <http://dx.doi.org/10.3390/jcm10112452>.
188. Michalski JE, Kurcha JS, Schwartz DA. From ARDS to pulmonary fibrosis: the next phase of the COVID-19 pandemic? *Transl Res.* 2022;241:13–24, <http://dx.doi.org/10.1016/j.trsl.2021.09.001>.
189. Goto Y, Sakamoto K, Fukihara J, Suzuki A, Omote N, Ando A, et al. COVID-19-triggered acute exacerbation of IPF, an underdiagnosed clinical entity with two-peaked respiratory failure: a case report and literature review. *Front Med.* 2022;9:1–6.
190. George PM, Wells AU, Jenkins RG. Personal View Pulmonary fibrosis and COVID-19: the potential role for antifibrotic therapy. *Lancet Respir Med.* 2020;2600:1–9.
191. Bando T, Takei R, Mutoh Y, Sasano H, Yamano Y, Yokoyama T, et al. Acute exacerbation of idiopathic pulmonary fibrosis after SARS-CoV-2 vaccination. *Eur Respir J.* 2022;59, http://dx.doi.org/10.1183/13993003.02806-2021_2102806.
192. Amiya S, Fujimoto J, Matsumoto K, Yamamoto M, Yamamoto Y, Yoneda M, et al. Case report: Acute exacerbation of interstitial pneumonia related to messenger RNA COVID-19 vaccination. *Int J Infect Dis.* 2022;116:255–7, <http://dx.doi.org/10.1016/j.ijid.2022.01.031>.
193. Ghincea A, Ryu C, Herzog EL. An acute exacerbation of idiopathic pulmonary fibrosis after BNT162b2 mRNA COVID-19 vaccination: a case report. *Chest.* 2022;161:e71–3.
194. Wong AW, Fidler L, Marcoux V, Johannson KA, Assayag D, Fisher JH, et al. Practical considerations for the diagnosis and treatment of fibrotic interstitial lung disease during the coronavirus disease 2019 pandemic. *Chest.* 2020;158:1069–78, <http://dx.doi.org/10.1016/j.chest.2020.04.019>.
195. Cardeñosa SC, Palomo M, Francesqui J, Alsina X, Hernández C, Albacar N, et al. Home oxygen monitoring in patients with interstitial lung disease. *Ann Am Thorac Soc.* 2022;19:493–7, <http://dx.doi.org/10.1513/AnnalsATS.202103-319RL>.
196. Moor CC, Mostard RLM, Grutters JC, Bresser P, Aerts JGJV, Chavannes NH, et al. Home monitoring in patients with idiopathic pulmonary fibrosis: a randomized controlled trial. *Am J Respir Crit Care Med.* 2020;202:393–401.
197. Farsalinos K, Barbouni A, Poulas K, Polosa R, Caponnetto P, Niaura R. Current smoking, former smoking, and adverse outcome among hospitalized COVID-19 patients: a systematic review and meta-analysis. *Ther Adv Chronic Dis.* 2020;11, <http://dx.doi.org/10.1177/2040622320935765>, 2040622320935765.
198. Takagi H. Systematic review of the prevalence of current smoking among hospitalized COVID-19 patients in China: could nicotine be a therapeutic option? *Intern Emerg Med.* 2020;15:1601–2163, <http://dx.doi.org/10.1007/s11739-020-02473-2>.
199. Jiménez-Ruiz CA, López-Padilla D, Alonso-Arroyo A, Aleixandre-Benavent R, Solano-Reina S, de Granda-Orive JI. COVID-19 and smoking: a systematic review and meta-analysis of the evidence. *Arch Bronconeumol.* 2021;57:21–34, <http://dx.doi.org/10.1016/j.arbres.2020.06.024>.
200. Jiménez-Ruiz CA, López-Padilla D, Alonso-Arroyo A, Aleixandre-Benavent R, Solano-Reina S, de Granda-Orive JI. Reply to "smoker, former smoker and COVID-19". *Arch Bronconeumol.* 2021;57:67–8, <http://dx.doi.org/10.1016/j.arbres.2021.01.005>.
201. Zhang H, Ma S, Han T, Qu G, Cheng C, Uy JP, et al. Association of smoking history with severe and critical outcomes in COVID-19 patients: a systemic review and meta-analysis. *Eur J Integr Med.* 2021;43:101313, <http://dx.doi.org/10.1016/j.eujim.2021.101313>.
202. Patanavanich R, Glantz SA. Smoking is associated with worse outcomes of COVID-19 particularly among younger adults: a systematic review and meta-analysis. *BMC Public Health.* 2021;21:1554, <http://dx.doi.org/10.1186/s12889-021-11579-x>.
203. Hopkinson NS, Rossi N, El-Sayed Moustafa J, Laverty AA, Quint JK, Freidin M, et al. Current smoking and COVID-19 risk: results from a population symptom app in over 2.4 million people. *Thorax.* 2021;76:714–22, <http://dx.doi.org/10.1136/thoraxjnl-2020-216422>.
204. McFadden DD, Bornstein SL, Vassallo R, Salonen BR, Bhuiyan MN, Schroeder DR, et al. Symptoms COVID 19 positive vapers compared to COVID 19 positive non-vapers. *J Prim Care Community Health.* 2022;13, <http://dx.doi.org/10.1177/21501319211062672>, 21501319211062672.
205. Kale D, Perski O, Herbec A, Beard E, Shahab L. Changes in cigarette smoking and vaping in response to the COVID-19 pandemic in the UK: findings from baseline and 12-month follow up of HEBECO study. *Int J Environ Res Public Health.* 2022;19:630, <http://dx.doi.org/10.3390/ijerph19020630>.
206. Pastor Esplá E, Castelló Faus C, Jordá Baldó A, Boira Enrique I, Chiner Vives E. COVID-19 and smoking: an opportunity to quit. *Arch Bronconeumol.* 2021;57:784–5, <http://dx.doi.org/10.1016/j.arbres.2021.03.011>.
207. Siddiqi K, Siddiqi F, Khan A, Ansaari S, Kanaan M, Khokhar M, et al. The impact of COVID-19 on smoking patterns in pakistan: findings from a longitudinal survey of smokers. *Nicotine Tob Res.* 2021;23:765–9, <http://dx.doi.org/10.1093/ntr/ntaa207>.
208. Al-Tammemi AB, Barakat M, Al Tamimi D, Alhallaq SA, Al Hasan DM, Khasawneh GM, et al. Beliefs toward smoking and COVID-19, and the pandemic impact on smoking behavior and quit intention: findings from a community-based cross-sectional study in Jordan. *Tob Use Insights.* 2021;14, <http://dx.doi.org/10.1177/1179173X211053022>, 1179173X211053022.
209. Yang H, Ma J. How the COVID-19 pandemic impacts tobacco addiction: changes in smoking behavior and associations with well-being. *Addict Behav.* 2021;119:106917, <http://dx.doi.org/10.1016/j.addbeh.2021.106917>.
210. Gupte HA, Mandal G, Jagiasi D. How has the COVID-19 pandemic affected tobacco users in India: lessons from an ongoing tobacco cessation program. *Tob Prev Cessat.* 2020;6:53, <http://dx.doi.org/10.18332/tpc/127122>.
211. Clancy L. Tobacco, tobacco control and Covid-19: understanding their associations. *Arch Bronconeumol.* 2022;58:113–4, <http://dx.doi.org/10.1016/j.arbres.2021.07.004>.
212. Maloney SF, Combs M, Scholtes RL, Underwood M, Kilgalen B, Soule EK, et al. Impacts of COVID-19 on cigarette use, smoking behaviors, and tobacco purchasing behaviors. *Drug Alcohol Depend.* 2021;229 Pt B, <http://dx.doi.org/10.1016/j.drugalcdep.2021.109144>, 109144.
213. Hoepfner SS, Carlon HA, Kahler CW, Park ER, Darville A, Rohsenow DJ, et al. COVID-19 Impact on smokers participating in smoking cessation trials: the experience of nondaily smokers participating in a smartphone app study. *Telemed Rep.* 2020;2, 1, <http://online.liebertpub.com/doi/10.1089/tmr.2021.0008>.
214. Rábade Castedo C, Signes-Costa J, Jiménez-Ruiz CA. COVID-19 and tobacco. *Arch Bronconeumol.* 2021;57:5–6, <http://dx.doi.org/10.1016/j.arbres.2020.07.014>.