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Review

Turkish Thoracic Society Early Career Members Task Force Group's Virtual Congress Notes: European Respiratory Society International Congress 2020

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Abstract

In this article, Early Career Task Force Group members of the Turkish Thoracic Society summarize the European Respiratory Society 2020 virtual congress. Current developments in the field of respiratory diseases were compiled with the addition of sessions specific to coronavirus disease 2019 this year. Almost all of the congress sessions were examined, and the important and striking results of the congress were highlighted. Congress sessions were attended by expert researchers, and the prominent messages of each session were highlighted in short summaries. They were then grouped under relevant titles and ranked in order of meaning and relation. It was finalized by a team of researchers.

KEYWORDS: Respiratory diseases, Lung health, European Respiratory Society, congress highlights
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INTRODUCTION

The European Respiratory Society (ERS) International Congress was held virtually in 2020 due to the coronavirus disease 2019 (COVID-19) pandemic that seriously affected the world. The congress brought together respiratory researchers with exciting, leading, and current issues although it could not be held with individual participation. Current research and developments on respiratory system diseases and also special sessions for COVID-19 were conveyed in the congress.

Congress sessions were closely followed by the members of the Turkish Thoracic Society (TTS). Turkish Thoracic Society Early Career Members Task Force Group (TTS-ECMTG) members also attended most of the congress sessions while struggling with the pandemic in their institutions. As a product, an electronic booklet containing ERS session summaries was published after the congress.[1] In this way, researchers and physicians who could not attend the congress due to the pandemic were able to access up-to-date information more easily.

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A collective and systematic path was followed in the preparation of this article. Fifty-three sessions that stood out at the ERS 2020 congress were carefully selected. The sessions were apportioned and attended by the authors mentioned in the article, and highlights of each session were compiled. The notes of the sessions were combined under headings according to the subjects and turned into an article.

There are the efforts and perspectives of the real heroes fighting the pandemic in this article which compiles the current data provided by the ERS International Congress 2020 with the perspective of the TTS-ECMTG. This article is planned in order to present up-to-date data in aggregate, highlight important messages, and also to guide scientific meetings and research to be conducted in the upcoming years.

CORONAVIRUS DISEASE 2019

In the presentations about the recapitulation of COVID-19, it was pointed out that it is a pandemic with over 84 million cases worldwide, causing over 1 million deaths.[2] Although severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) was first seen in Wuhan, China's Hubei province in early December 2019, the disease is thought to have emerged around October 2019.[3]

Basic science point of view revealed that SARS-CoV-2 is one of the sub-types of viruses belonging to the β-coronavirus genus. Judging by the structure of the virus, it contains a single-stranded RNA genome and is protected by the nucleocapsid protein. In addition to being surrounded by lipid membrane and envelope proteins, it contains spike proteins (formed in the S1 and S2 domains) on its surface. The virus binds to the angiotensin-converting enzyme 2 (ACE2) receptor of the host cell with the S1 domains located on the upper part of the spike proteins.[4,5] It was also reported that peripheral blood mononuclear cell analysis is important for the characteristic of the disease. As a result of the studies, it was reported that the neutrophil/T-cell ratio is a better predictor than the neutrophil/lymphocyte ratio. Spike protein can enter broncho-epithelial cells without the ACE2 receptor. It is thought that this receptor may also be an integrin.[6]

According to World Health Organization (WHO), most of the cases are men. The common age group is between 25 and 64 years, and most of the deaths occur between 65 and 84 years. In the light of the International Severe Acute Respiratory and Emerging Infection Consortium, the female sex is protective, and old age, chronic heart/lung/kidney disease, diabetes, obesity, chronic neurological disorder, malignancy, and moderate-severe liver disease are risk factors for mortality.[7-10] Lymphopenia, leukopenia, and thrombocytopenia are associated with poor prognosis. Neutrophil/lymphocyte and neutrophil/CD8+ T-cell ratio can be used in terms of the severity of the inflammatory response. The depth of lymphopenia correlates with the severity of the disease. Interleukin-6 (IL-6) and D-dimer are used together to predict hospitalization and out-of-hospital mortality (96.4%).[11]

It was shown that neutralizing antibodies against SARS-CoV-2 began to form in the first week and plateaued in the second week in 175 patients with COVID-19 who recovered.[12] In another study, virus-specific immunoglobulin G was found to be low (P = .005) in the acute phase and decreased neutralizing antibody levels in 81.1% of asymptomatic cases compared to 62.2% of symptomatic cases during the recovery phase.[13] Natural infection initiates B- and T-cell immunity; however, the durability of immune protection is uncertain.

In medical wards, patients with an oxygen saturation of equal or lower than 92% are suggested to initiate oxygen treatment via face mask or low-dose oxygen treatment with up to 60% of FiO_2 via venturi mask. Nasal cannula is not recommended. If oxygen saturation is equal or lower than 92% and/or dyspnea persists, intensive care unit (ICU) transfer is required. In a multi-center study from Italy, the results of non-invasive ventilation (NIV) implementation in 679 patients with COVID-19 were presented. Intubation rates in high-flow nasal cannula, continuous positive airway pressure (CPAP), and NIV patients were 29%, 25%, and 28%, and mortality rates were 16%, 30%, and 30%, respectively.[14] In ICU, prone position is suggested if PaO_2/FiO_2 ratio is lower than 150 despite FiO_2 higher than 60%.

Regarding the antiviral treatment, there is not enough evidence of remdesivir to decrease mortality.[15,16] Hydroxychloroquine was shown to prolong hospital stay and to have no effect on 28-day mortality. Moreover, higher invasive mechanic ventilation requirement and death rates were reported in patients treated with hydroxychloroquine.[17] No prognostic advantage was shown with lopinavir–ritonavir treatment compared to standard treatment.[18] The WHO recommended not to use hydroxychloroquine and lopinavir–ritonavir in light of these reports. When it comes to anti-inflammatory drugs, systemic corticosteroids are the only treatment options proven to decrease mortality.[19] Convalescent plasma therapy may be recommended only in critical patients. Anticoagulants are recommended at least in prophylactic dose in all hospitalized patients and in treatment dose in the ICU.[20] There is no evidence of the efficacy of systemic antibiotics in patients with COVID-19.

The effects of COVID-19 on children and adults with chronic respiratory diseases were discussed in the "COVID-19 with Premorbid Respiratory Disease Session." Around 5.5% of the children with cystic fibrosis (CF) required intensive care, and the mortality was 2.1%.[21] Disease effects are similar in children with asthma and adults with asthma who do not require systemic steroids compared to the healthy population of the same age. In chronic obstructive pulmonary disease (COPD) patients with COVID-19, the risk of septic shock, acute respiratory distress syndrome (ARDS), and bacterial co-infection is significantly increased.[22] Interstitial lung diseases (ILDs) increase the

MAIN POINTS

- Novel messages of the European Respiratory Society 2020 are summarized in this article.
- Coronavirus disease 2019 was a major topic of this year's congress.
- Artificial intelligence-based research is progressing in the field of thoracic oncology.
- Interstitial lung diseases and gene-based studies attract attention.

risk due to lung damage, respiratory dysfunction, and immunosuppressive treatments. Coronavirus disease 2019 has a more severe course, especially in lung cancer patients and other cancers that have metastasized to the lung.[23]

The "Post-COVID Session" focused on follow-up and rehabilitation processes after hospitalization, palliative care, and long-term effects of COVID-19. Comorbidities are very common in people with severe COVID-19 infection. These patients should be evaluated for palliative care as long as their symptoms persist. Continuous oxygen therapy is recommended for patients whose oxygen saturation falls below 90%. Opioid therapy is recommended for patients whose dyspnea does not regress despite optimal treatment.[24] New lesions on lung imaging, diffusion disorder, and loss of total lung capacity may develop even 3-4 weeks after the treatment.[25] Hospitalized patients should be comprehensively evaluated after 6-8 weeks and personal pulmonary rehabilitation plans should be structured.[26]

In smokers compared to non-smokers, hospitalization, severe disease course, and mortality rates due to COVID-19 are higher.[27] It is suggested that smoking can increase the cellular uptake mechanisms of SARS-CoV-2 through α7-nAChR signaling. A possible α7-nAChR downstream mechanism could be the induction of phospho-Akt and phospho-p44/42 MAPK. Smoking can affect the pathophysiology and clinical outcome of COVID-19 in various organ systems, including the brain.[28]

PEDIATRIC RESPIRATORY DISEASES

Congenital thoracic malformations can occur by various mechanisms and can affect different tissues in the lung. Patients with congenital thoracic malformation should be followed up for infection, pulmonary hypertension, pulmonary functions, and malignancy (especially congenital pulmonary airway malformation).[29] The frequency of post-infectious bronchiolitis obliterans (PIBO) is gradually increasing. Especially, adenovirus infection and history of previous severe infection are important clues in diagnosis. Although there are different approaches in PIBO treatment, the exact and effective treatment is not known.[30] Low respiratory functions early in life pose a risk for respiratory problems throughout life.[31] Regular follow-up of children with positive airway pressure therapy and sleep-disordered breathing is important for increasing patient compliance, learning device features, and determining the process of leaving the device.[32]

There are different guidelines in asthma management in children. Although Global Initiative for Asthma (GINA) is the most renewed guideline, none of these guides offers the most appropriate approach. Treatment responses may also vary among asthma patients. It is recommended to examine and treat comorbid conditions such as obstructive sleep apnea, gastroesophageal reflux disease, and obesity that may accompany asthma.[33] The primary goal of asthma treatment is to control asthma symptoms and prevent attacks.[34]

Updates on the management of lung infections, pancreatic and liver diseases, new treatments of CF and challenges in treatment adherence, and social and emotional well-being of CF patients are discussed in the session of updates in CF. With current studies, there is a trend toward creating CF transmembrane conductance regulator (CFTR) modulator therapies, while reducing the effects of CFTR protein dysfunction is aimed in traditional treatment of CF. As a result of studies conducted with the use of CFTR modulator, a decrease in hepatobiliary complications, reductions in liver steatosis, decreases in the frequency and severity of acute pancreatitis, and increase in exocrine pancreatic functions is observed.[35-38] Additionally, they have shown that it increases the levels of forced expiratory volume in 1 second (FEV1), decreases the number of attacks, and decreases sweat chlorine levels.[39-43]

RESPIRATORY INFECTIONS

Factors associated with antibiotic resistance and factors related to the use of innate immunity to increase antibiotic efficacy, ways to determine the optimal treatment dose to eliminate infections and prevent the development of antibiotic resistance, and treatment methods of the biofilms were discussed. The highlights are listed subsequently. Having C-reactive protein above 50 mg/dL is significant in deciding to start the antibiotics. Azithromycin reduces the number of bacterial colonies (cfu/min) of infections caused by klebsiella and acinetobacter, which have multiple drug resistance. P2Y12 inhibitor ticagrelor is protective against *Staphylococcus aureus* bacteremia and decreases mortality rates. The use of oseltamivir in methicillin-resistant *S. aureus* bacteremia decreases the mortality. Hyperbaric oxygen therapy allows bacterial proliferation which can increase the sensitivity to the antibiotics.[44-47] In patients with CF, inflammation develops early before infections. The early onset of mucoobstructive inflammation in CF patients is closely related to lung injury.[48] As the life span increases, the frequency of both the complications related to the disease and the complications expected with aging increases.[49]

The WHO's emergencies on tuberculosis (TB) were also discussed. Considering cases with multi-drug-resistant TB in Europe and human immunodeficiency virus/antiretroviral treatments in sub-Saharan Africa, simplifying TB would be very risky. Today, COVID-19 is the most important health issue threatening the world; however, this pandemic is estimated to make a 5-year regression in trials on TB.

Management, new guideline recommendations, and important developments of community-acquired pneumonia (CAP) were discussed in 1 session. The most important factor in the selection of antibiotics for CAP is local epidemiological data of microorganisms and their resistance profiles.[50] It is necessary to consider the alternative diagnosis in unresolved CAP, and if necessary, bronchoscopy, bronchoalveolar lavage (BAL), and histopathological examinations can be applied. The faster detection of causative pathogens using molecular methods results in appropriate antibiotic selection.[51] An immunosuppressive disease should be considered in patients with a history of hospitalization for CAP 2-3 times a year. Around 20-30% of immunosuppressive patients are hospitalized with the diagnosis of CAP, and most of these patients are followed up in ICUs.[52]

Thoracic Oncology

In the article titled "ESR/ERS Statement paper on lung cancer screening," in which 26 authors from 15 European countries

evaluated the current approach and important points in lung cancer screening, the latest developments were summarized in line with the algorithms.[53] Adequate diagnostic quality, volumetric evaluation of nodules, and computed tomography (CT) protocols with as low radiation dose as possible are recommended.[54] It is possible to evaluate nodules with as little radiation as possible by using Artificial Intelligence (AI) to detect nodules in computer-aided diagnostic evaluation and malignancy identification.[55] While solid nodules can be evaluated well in ultra-low-dose CT imaging, nodules with ground-glass density may not be sufficiently differentiated.

Nodules detected by imaging do not show signs or symptoms; they are detected as solid nodules between 5 mm and 30 mm and 23-36%. Imaging-guided biopsy should be considered in solid nodules larger than 8 mm or semi-solid nodules with a doubling time of less than 600 days and a malignancy risk above 10%.[56] Transbronchial technology has evolved from fluoroscopic bronchoscopy to radial Endobronchial ultrasound, electromagnetic navigation bronchoscopy, three-dimensional (3D) imaging with cone-beam computed tomography, and robotic procedures. Biofluids-based candidate biomarkers are circulating tumor cells, circulating tumor DNA, cell-free DNA, messenger RNA, micro RNA, proteins/peptide fragments, metabolic products, volatile organic compounds. Tumor-educated platelets are one of the new biomarkers in liquid biopsies. Radiomics is a stepwise process depending on AI. They both are highly promising. Artificial intelligence-based applications make a difference in lung cancer screening. Key applications are computer-aided detection, radiomics, and radiogenomics.[57] Computer-aided detection systems can detect lung cancer at an early stage but can be useful as a second reader.

The follow-up and treatment plan of ground-glass opacities that can be viewed as pure ground-glass and semi-solid ground-glass nodules should be made according to the morphology of the nodule. A minimum of 5 years of follow-up should be done at intervals of 6-12 months for pure ground-glass nodules and 3-6 months for semi-solid ground-glass opacities. Biopsy should be considered if there is an increase in size and/or density (solid component) of more than 2 mm.

The relationship between the lung cancer microenvironment and the lung microbiome, the role of immunotherapy in small cell lung cancer, and the management of dyspnea and pain in thoracic malignancies were discussed. The microbiota change (the presence of *Ruminococcaceae*- and *Agathobacter*-enriched flora) before and after immune checkpoint inhibitors in advanced stage Non-small cell lung cancer patients is associated with overall survival.[58] It was mentioned that first-line durvalumab plus etoposide with either cisplatin or carboplatin (platinum-etoposide) showed a significant improvement in overall survival versus platinum-etoposide alone in patients with extensive-stage small cell lung cancer (ES-SCLC) in the Durvalumab ± Tremelimumab in Combination With Platinum Based Chemotherapy in Untreated Extensive-Stage Small Cell Lung Cancer Trial study.[59] Updated results of the same study support the use of durvalumab plus platinum-etoposide as a new standard of care for the first-line treatment of ES-SCLC.[60,61]

Screening lung cancer has been shown to reduce lung cancer-related deaths. However, it is necessary to plan capacity needs for the workforce, technological equipment, and facilities.[62] Surgical treatment is safe after neoadjuvant immunotherapy in oligometastatic non-small cell lung cancer in early or locally advanced stage, with promising results. Combined immuno-chemotherapy studies are ongoing.[63,64] In patients with small cell lung cancer with good performance, an increase in survival has been shown with twice-daily radiotherapy, concurrent chemotherapy, and prophylactic cranial radiotherapy.[65] The successful results of integrating oncology and palliative care have been demonstrated. Not only improved quality of life but also longer survival and less aggressive end-of-life care were seen.[66] Thoracic malignancy patients with COVID-19 have higher mortality compared to the other population. In the COVID-19 in patients with thoracic malignancies Trial study, better survival was demonstrated in patients who received steroids or anticoagulants before diagnosis.[67]

Interstitial Lung Diseases

Severe pulmonary sarcoidosis was discussed in a single session. Pulmonary fibrosis is the most powerful indicator of mortality on sarcoidosis. Pulmonary function tests (PFT) can show the effect of fibrosis by low pulmonary functions. On the other hand, fibrosis may appear instead of normal PFTs. Disease severity not only depends on staging but also involved organ numbers, especially cardiac involvement is important.[57] Black race, Human leukocyte antigen-DR3 negativity, lupus pernio, chronic uveitis, age at onset >40 years, splenomegaly, cystic bone lesions, myocardial involvement, and central nervous system involvement are poor prognostic markers. In a study, risk identification has been made by composite physiological index (CPI) which is a clinicoradiological staging system predicting the strongest mortality. An optimal CPI threshold of 40 units was identified. The CPI40, main pulmonary artery diameter to ascending aorta diameter ratio (MPAD/AAD), and an extent of fibrosis threshold of 20% were combined to form a staging algorithm. If CPI >40 or CPI ≤40 with MPAD/AAD >1 or extent of fibrosis on High-resolution computed tomography >20%, it means high risk or poor prognosis. If CPI ≤40, MPAD/AAD <1, and extent of fibrosis on High-resolution computed tomography <20%, it means low risk or good prognosis.[68] Prognosis may be worse if the patient needs treatment at the time of the diagnosis. Preventing silence myocardial damage, treating myocardial inflammation, and sustaining long-term treatment effect should be targeted.[69]

The effects of genetic disposition, particle size, environmental factors in idiopathic pulmonary fibrosis (IPF) and microbiome effects on immunity were discussed in the "air pollution with ILD: a call to arms" session. Genetic predisposition and environmental pollution increase the risk of developing pulmonary fibrosis.[70] Particles smaller than 2.5 microns in diameter reach the alveoli and cause ILDs. In IPF, alveolar epithelial cell damage, apoptosis, and epithelial–mesenchymal transformation can occur.[71] In IPF, air pollution is directly related to low Forced vital capacity, rapid decrease in Forced vital capacity values, and IPF acute attack.[70] There are many factors such as "air pollution" that affect lung microbiome, and they cause acute and chronic diseases.[72]

"Human ex vivo models of ILD" symposium was discussed to present models of early events of IPF ex vivo and the use of these models in evaluating pathogenesis. Human 3D ex vivo lung tissue cultures (generated from precision-cut lung slices) are exposed to a fibrotic cocktail of growth factors and cytokines to replicate IPF. The model represents a valuable tool to assess anti-fibrotic mechanisms of potential drugs for the treatment of IPF patients.[73] Induced pluripotent stem cell models have heterogeneity. To counteract this, the group has used a computation-based approach to single-cell RNA sequencing and Wnt modulation. This emerging technology allows for indefinite expansion of induced type II alveolar epithelial cells (ATII) in culture and provides a guide for improving directed differentiation to ATII which can be used to model ILD and other lung diseases and screen for novel drug therapies.[74] Immortal cell lines answer to generic biological questions such as how the expression of a mutant surfactant protein C results in mistrafficking and causes ATII dysfunction. Lung-on-chip models are a promising tool that may provide insights into new therapeutic targets and enable animal-free preclinical drug testing.[75]

There are some commonalities in the genetics of ILDs. Genetic mutations, telomere shortness, and surfactant protein mutations provide information in the investigation of lung transplantation and mortality.[76,77] In terms of MUC5B, chronic hypersensitivity pneumonia profile is very similar to IPF. When the honeycomb appearance was examined, it was observed that hypersensitivity pneumonitis (HP) results had the same poor outcome as those of IPF patients.[78] When integrative diagnosis of ILDs with clinical and radiological data is insufficient, lung biopsy methods remain an important diagnostic step.[79,80]

Pulmonary Vascular Diseases

Pulmonary hypertension in early life was discussed in 1 session. Female sex is the strongest risk factor for pulmonary arterial hypertension (PAH).[81,82] However, the prognosis in men is worse than in women.[83,84] There are differences in gender-related response to PAH treatment.[85] Loss of signaling in the BMP9/BMPR2/ALK1 pathway plays a central role in the pathobiology of PAH.[86] Patients with idiopathic, sporadic, or hereditary PAH are likely to carry genetic mutations in BMPR (29%) and/or similar genes.[87] The incidence of developing PAH in BMPR2 gene mutation carriers is 2.25% (3.4% in women and 1% in men).[88] Bronchopulmonary dysplasia (BPD) is also a risk factor for PAH and infants with moderate-severe BPD should be screened for PAH because of the unfavorable effects on prognosis.[89,90]

Airway Diseases

There are many causes and diseases that cause or may be associated with chronic cough (CC). In the presence of unexplained or refractory CC, the diagnosis of "cough reflex hypersensitivity syndrome" should be kept in mind. Traditional treatments such as morphine, gabapentin, and pregabalin can be hardly tolerated due to their side effects. With gefapixant, a P2X3 blocker, positive results are obtained especially in the treatment of idiopathic CC. It has been shown to be effective in low doses, and its side effect of taste disturbance is more tolerable.[91] Speech and language therapies are also beneficial in patients with speech impairment due to cough.[92]

Mild and severe asthma treatment and neutrophilic asthma phenotype were discussed in a symposium. Short-acting beta-2 agonist (SABA) should not be given alone to asthmatic patients over the age of 12 years; inhaled corticosteroids (ICS) treatment should be given regularly or in the presence of symptoms.[93] Severe asthma could be divided into 2 phenotypes as T-helper 2 (Th2) and non-Th2 asthma.[94] Biological therapies primarily target Th2 asthma and are indicated in patients with exacerbations or regular Oral corticosteroids use. Today, anti-IgE (omalizumab), anti-IL-5 (mepolizumab, reslizumab), anti-IL5 R (benralizumab) Ant, and IL4/13 (dupilumab) are used in the treatment of severe Th2 asthma. Their predictors have been defined and should be included in pretreatment evaluation.[95]

Use of low-dose ICS has been reported to reduce mortality in asthma.[96] High short-actingSABA use is an important risk factor in asthma exacerbation. In the study called An Overview of Short-Acting β2-Agonist Use in Asthma in European Countries, it has been shown that increased use of SABA is associated with death and exacerbations in asthma.[97] Repeated oral corticosteroid use in uncontrolled severe asthma causes comorbidities such as obesity, diabetes mellitus, obstructive sleep apnea syndrome (OSA), and hypertension. Instead of using chronic oral corticosteroids in patients with severe asthma, treatments such as mepolizumab, benralizumab, and dupilumab should be kept in mind according to the phenotypic evaluation recommended in the last step in the GINA guideline.[98] Long-term use of treatment options, including ICS, increases the risk of pneumonia. According to the Single Inhaler Triple Therapy vs dual therapies Trial study, a higher incidence of pneumonia is seen in treatment groups containing ICS than in the long-acting muscarinic antagonist /long-acting beta-2 agonist group.[99] If the eosinophil count in the blood is >300 in patients with COPD, it is stated as a strong recommendation to continue using ICS. Conditional discontinuation of ICS is recommended in patients with eosinophil count <300 in the blood and less than 2 exacerbations per year. There was limited evidence if the patient had a blood eosinophil count of <300 and more than 2 episodes per year or had 1 hospitalization. In this case, the individual patient's risks and benefits should be discussed and decided.[100]

The future of bronchiectasis management was discussed too. Considering new meta-analysis proving benefit in terms of exacerbation and time to first exacerbation, long-term macrolide antibiotics for the treatment of bronchiectasis in adults is recommended even in patients with colonization of *Pseudomonas aeruginosa*.[101] Inhaled antibiotics are also recommended in adult brochiectasis patients in order to control frequency of exacerbations, especially with high bacterial load and frequent exacerbations.[102] Mucus concentration is shown to be associated with bronchiectasis extend, bacterial load, and inflammation, while MUC5AC/MUC5B ratio is associated with disease severity in bronchiectasis patients.[103] Classification of bronchiectasis patients according to endotype and inflammatory patterns are important due to different potential treatment modalities. Neutrophil elastase

airway test is a newly defined test to assess severity and exacerbation risk in bronchiectasis patients.[104]

Respiratory Critical Care

Diagnosis and treatment strategies and algorithms for ILD in the intensive care were discussed in the "ILD Patients in the ICU Session." Extracorporeal membrane oxygenation is a life-saving option for patients with ILD and acute respiratory failure (ARF), provided they are candidates for lung transplantation.[105] Computed tomography signs of fibrosis predict poor survival in all patterns of ILD-ARF.[106] Bronchoalveolar lavage in the clinical assessment of ARF-ILD is often performed with only a 13% yield.[107] Open lung biopsy in ARDS provided a specific diagnosis in 84% of patients and altered management in 73%.[108] The evaluation of likely reversibility is the cornerstone in the management of ILD patients in ICU.

As the pandemic progressed, intensive care mortality rates have decreased and several risk factors for mortality were identified.[109] Contrary to popular belief, non-invasive mechanical ventilation and high-flow nasal oxygen systems were shown to be safe in terms of viral transmission.[14] In resource-limited settings, even basic supportive treatment options like oxygen therapy were problematic.[110]

Diagnostic strategies in the ICU were discussed in the "Respiratory Critical Care Session.'' Currently, imaging methods, bronchoscopy, and microbiological culture are used for diagnostic purposes. New diagnostic tests that have been developed to be available in the near future are divided into 2 methods, namely imaging methods and biological technology. Imaging methods are quantitative/dynamic ultrasound and confocal lung endoscopy. Biological methods are breath analysis and omic technology in BAL. Confocal lung endoscopy provides information about in vivo pathology. Breath air analysis is quick and reproducible. It has been shown that metabolites in exhaled air can be used in the diagnosis of ARDS.[111] Comprehensive omic analysis is more diagnostic, providing insight into the snapshot of the disease.[112] Although it is not known whether the lung microbiome is a new therapeutic target for the prevention and treatment of ARF, it is one of the important topics that need to be investigated.

Sleep and Breathing Disorders

Obstructive sleep apnea syndrome is a common, multifactorial disease with significant mortality and morbidity but is still underdiagnosed and under-treated. With personalized treatment in OSA, causal treatments for pathophysiology, symptomatic treatment for symptoms such as excessive daytime sleepiness, insomnia, and result-oriented treatments for comorbidities can be planned. In personalized treatment, the patient's upper airway morphology, arousal threshold, loop gain, and muscle response are important.[113] Intermittent hypoxia triggers hypertension, inflammation, endothelial dysfunction, hyper-coagulation, and atherosclerosis.[114] It has been reported that CPAP therapy can significantly reduce the risk of adverse cardiovascular events and stroke among patients using CPAP for more than 4 h/night.[115] If drivers with a diagnosis of OSA have regular use of CPAP for ≥4 h/night and 70% of all nights and there is no excessive sleepiness during the day, it is appropriate to issue or renew their driving license.[116,117]

Sleep and exercise have a bidirectional interaction with each other with a variety of consequences through complicated inflammatory, endocrinological, and neurological mechanisms in acute and chronic stages. Sleep loss results in decrease in physical performance and recovery and increase in exercise-induced diseases. Meanwhile, moderate-intensity aerobic physical activity increases sleep time and slow-wave sleep.[118] The decreased VO_2 max and the impaired heart rate response point an impairment in cardiopulmonary exercise test capacity, which is an important indicator of cardiopulmonary functional capacity and mortality.[119] Comorbid factors such as obesity and cardiac diseases also have potential influences on these associations.[120] In patients with OSA, abnormal blood pressure response is reported and is influenced by obesity.[121] Physical activity has an important role in preventing both OSA and hypertension but requires objective measurement. Aerobic exercise combined with non-invasive mechanical ventilation treatment in OSA patients improves daytime blood pressure.[122] Since physical activity prevents cardiovascular and metabolic diseases in OSA patients, it should be regarded as a part of multicomponent individualized treatment in patients with sleep disorders.[123]

Lung Health

As people age, a decrease in lung capacity, antioxidant activity, anti-aging molecules, and the innate immune system is observed. On the other hand, an increase in autoantibodies, neutrophil and macrophage activities, and inflammatory mediators are observed. Lung capacity increases every year until the age of 25 and reaches maximum capacity at the age of 25, and after that, lung capacity is lost every year. Oxidative stress and smoking increase the rate of lung capacity loss.[124] Lung diseases arise as a result of genome instability, cellular aging, and mitochondrial dysfunction due to telomere wear.[125] Cellular aging contributes to the deterioration of progenitor cell function. Fibrotic mediators affect cellular aging. It is necessary to define specific senotherapeutics and aging biomarkers for chronic lung diseases.

Occupational burden of nonmalignant respiratory diseases was discussed in light of the recent American Thoracic Society/ERS statement.[126] Respiratory conditions of concern were COPD, chronic bronchitis, asthma, IPF, pulmonary alveolar proteinosis, TB, CAP, and granulomatous lung diseases, including sarcoidosis and HP. Weighted summary estimates were calculated from population attributable fraction (PAF) and occupationally attributable burden values and were presented with their 95% CI. The results demonstrated the substantial role of workplace environment in the burden of several lung diseases and were as follows: asthma (PAF, 16%); COPD (PAF, 14%); chronic bronchitis (PAF, 13%); IPF (PAF, 26%); HP (occupational burden, 19%); other granulomatous diseases, including sarcoidosis (occupational burden, 30%); pulmonary alveolar proteinosis (occupational burden, 29%); TB (occupational burden, 2.3% in silica-exposed workers and 1% in healthcare workers); and CAP in working-age adults (PAF, 10%). Among occupational exposures organic (i.e., cotton, grain) and inorganic dust (i.e., coal, silica), cadmium and ambient air pollutants (i.e., Vapors, Gases, Dusts, or Fumes [VGDF]) were the most established causes of COPD. Avoidance from exposure is essential in the management of

patients with work-related conditions. The physician should also consider the socioeconomic aspects.

Normal lung development is necessary to achieve maximum lung health in adulthood.[127] Prenatal factors, genetic factors, and factors in early childhood affect lung development.[128] Maternal asthma, paternal asthma, childhood asthma, maternal smoking, and childhood respiratory infections were significantly associated with lower FEV1 and defined as "childhood disadvantage factors."[129] People who are disadvantaged at an early age have permanently lower lung function. The impact of childhood disadvantage is as great as the impact of heavy smoking.[129] Decreased respiratory function expiratory flow is expected when parents smoke in infancy.[130,131] Like any other organ, the lungs also age.[132] Physiological lung aging is associated with anatomic and functional changes that result in a progressive decrease in expiratory flow rates with age in otherwise healthy people.[132] The incidence of COPD and IPF (2 common chronic respiratory diseases) increases with advanced age. It is plausible, therefore, that abnormal regulation of the mechanisms of normal aging may contribute to the pathobiology of both COPD and IPF.[132]

Managing frailty in patients with acute or chronic lung disorders is mentioned. Frailty can be defined as a highly heterogeneous medical syndrome that defines a state of reduced endurance characterized by decreased physiological functions, which increases the risk of physical dependence and/or death of an individual for various reasons.[133] Components of frailty defined by Fried et al[134] include unintentional weight loss, self-reported exhaustion, weakness, slow walking speed, and low physical activity. Frailty is common in patients with COPD (10.2 %).[135] Muscle satellite cell function is lower in COPD patients compared with age-matched controls, type 1 and type 2 muscle fiber capillarization is decreased, and the distance between the muscle satellite cell and the closest capillaries is increased.[136,137] Frailty can be prevented or reversed through rehabilitation.[138]

The symposium titled "successful stories on improving the delivery of tobacco-use treatment" was chaired by Jorden Vestbo and Sofia Bela Ravara. One of the highlights of the session was Ottawa Model for Smoking Cessation (OMSC) in primary setting.[139] The model aims to give smoking cessation interventions to hospitalized patients in primary settings. The followed methods of the project includes: (1) identification of all smoker patients at hospitalization, (2) documentation of their smoking status, (3) initiation of smoking cessation pharmacotherapy for bedside within hours of application, and the ideal was stated to be starting immediately, and (4) performing face-to-face follow-ups during hospitalization and after discharge by phone for 2-6 months. The studies have shown the effectiveness of the model and that the model is currently being followed by most of the hospitals in Canada.[140] In conclusion, considering the disrupted smoking cessation delivery to outpatient clinics in our country due to the pandemic, the successful example of OMSC looks clinically relevant and applicable.

CONCLUSIONS

This article was created by the detailed analysis of the ERS International Congress sessions and the compilation of their key points. Scientific meetings for 2020 were disrupted due to the pandemic. It was important that pioneering congresses were held virtually. Therefore, updated information on respiratory developments as well as on COVID-19 has been collectively presented in this study. It is important to provide up-to-date information collectively in today's world of rapid scientific developments. The studies in this direction will increase even more in the future.

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REFERENCES

1. Turkish Thoracic Society Early Career Members Taskforce Group. *European Respiratory Society Internationally Virtual Congress 2020*. 2021. Available at: https://www.toraks.org.tr/site/community/downloads/tS5bMgnfB14Yh_5n.
2. Johns Hopkins Coronavirus Resource Center. *COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU)*. 2021. Available at: https://coronavirus.jhu.edu/map.html.
3. Li Q, Guan X, Wu P, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N Engl J Med*. 2020;382(13):1199-1207. [CrossRef]
4. Forni D, Cagliani R, Clerici M, Sironi M. Molecular evolution of human coronavirus genomes. *Trends Microbiol*. 2017;25(1):35-48. [CrossRef]
5. Saini G, Porte J, Weinreb PH, et al. αvβ6 integrin may be a potential prognostic biomarker in interstitial lung disease. *Eur Respir J*. 2015;46(2):486-494. [CrossRef].
6. Mann ER, Menon M, Knight SB, et al. Longitudinal immune profiling reveals key myeloid signatures associated with COVID-19. *Sci Immunol*. 2020;5(51):eabd6197. [CrossRef]
7. Docherty AB, Harrison EM, Green CA, et al. Features of 20133 UK patients in hospital with COVID-19 using the ISARIC WHO Clinical Characterisation Protocol: prospective observational cohort study. *BMJ*. 2020;369:m1985. [CrossRef]
8. Harrison EM, Docherty AB, Barr B, et al. Ethnicity and outcomes from COVID-19: the ISARIC CCP-UK prospective observational cohort study of hospitalised patients. *SSRN Electron J*. 2020. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3618215.
9. Swann OV, Holden KA, Turtle L, et al. Clinical characteristics of children and young people admitted to hospital with

covid-19 in United Kingdom: prospective multicentre observational cohort study. *BMJ*. 2020;370. [CrossRef]
10. Knight SR, Ho A, Pius R, et al. Risk stratification of patients admitted to hospital with covid-19 using the ISARIC WHO Clinical Characterisation Protocol: development and validation of the 4C Mortality Score. *BMJ*. 2020;370:m3339. [CrossRef]
11. Liu J, Li S, Liu J, et al. Longitudinal characteristics of lymphocyte responses and cytokine profiles in the peripheral blood of SARS-CoV-2 infected patients. *EBiomedicine*. 2020;55. [CrossRef]
12. Wu F, Wang A, Liu M, et al. Neutralizing antibody responses to SARS-CoV-2 in a COVID-19 recovered patient cohort and their implications [Epub ahead of print]. *MedRxiv*. 2020. Available at: http://dx.doi.org/10.2139/ssrn.3566211.
13. Long QX, Tang XJ, Shi QL, et al. Clinical and immunological assessment of asymptomatic SARS-CoV-2 infections. *Nat Med*. 2020;26(8):1200-1204. [CrossRef]
14. Franco C, Facciolongo N, Tonelli R, et al. Feasibility and clinical impact of out-of-ICU noninvasive respiratory support in patients with COVID-19 related pneumonia. *Eur Respir J*. 2020;56(5). [CrossRef]
15. Beigel JH, Tomashek KM, Dodd LE. Remdesivir for the treatment of COVID-19 — preliminary report. *N Engl J Med*. 2020;383(10):994. [CrossRef]
16. Goldman JD, Lye DCB, Hui DS, et al. Remdesivir for 5 or 10 days in patients with severe COVID-19. *N Engl J Med*. 2020;383(19):1827-1837. [CrossRef]
17. Horby P, Mafham M, Linsell L, et al. Effect of hydroxychloroquine in Hospitalized Patients with COVID-19: preliminary results from a multi-centre, randomized, controlled trial [Epub ahead of print]. *MedRxiv*. 2020. [CrossRef]
18. Cao B, Wang Y, Wen D, et al. A trial of lopinavir–ritonavir in adults hospitalized with severe COVID-19. *N Engl J Med*. 2020;382(19):1787-1799. [CrossRef]
19. Rosas IO, Brau N, Wters M, et al. Tocilizumab in hospitalized patients with COVID-19 pneumonia [Epub ahead of print]. *MedRxiv*. 2020;27. [CrossRef]
20. Bompard F, Monnier H, Saab I, et al. Pulmonary embolism in patients with COVID-19 pneumonia. *Eur Respir J*. 2020;56(1). [CrossRef]
21. Jung A. *21. The European Cystic Fibrosis Society Patient Registry 2020*. Available from: https://www.ecfs.eu/projects/ecfs-patient-registry/articles.
22. Peters MC, Sajuthi S, Deford P, 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(1):83-90. [CrossRef]
23. Dai M, Liu D, Liu M, et al. Patients with cancer appear more vulnerable to SARS-CoV-2: a multicenter study during the COVID-19 outbreak. *Cancer Discov*. 2020;10(6):783-791. [CrossRef]
24. Janssen DJA, Ekström M, Currow DC, et al. COVID-19: guidance on Palliative care from a European Respiratory Society International Task Force. *Eur Respir J*. 2020;56(3). [CrossRef]
25. Mo X, Jian W, Su Z, et al. Abnormal pulmonary function in COVID-19 patients at time of hospital discharge. *Eur Respir J*. 2020;55(6). [CrossRef]
26. Spruit MA, Holland AE, Singh SJ, Tonia T, Wilson KC, Troosters T. COVID-19: Interim guidance on rehabilitation in the hospital and post-hospital phase from a European Respiratory Society and American Thoracic Society-Coordinated International Task Force. *Eur Respir J*. 2020;56. [CrossRef]
27. Simons D, Shahab L, Brown J, Perski O. The association of smoking status with SARS-CoV-2 infection, hospitalization and mortality from COVID-19: a living rapid evidence review with Bayesian meta-analyses (version 7). *Addiction*. 2021;116(6):1319-1368. [CrossRef]
28. Olds JL, Kabbani N. Is nicotine exposure linked to cardiopulmonary vulnerability to COVID-19 in the general population? *FEBS Journal*. 2020;287(17):3651-3655. [CrossRef]
29. Annunziata F, Bush A, Borgia F, et al. Congenital lung malformations: unresolved issues and unanswered questions. *Front Pediatr*. 2019;7:239. [CrossRef]
30. Jerkic SP, Brinkmann F, Calder A, et al. Postinfectious bronchiolitis obliterans in children: diagnostic workup and therapeutic options: a workshop report. *Can Respir J*. 2020;2020:5852827. [CrossRef]
31. Sly PD, Bush A. From the cradle to the grave: the early-life origins of chronic obstructive pulmonary disease. *Am J Respir Crit Care Med*. 2016;193(1):1-2. [CrossRef]
32. Kaditis AG, Alonso Alvarez ML, Boudewyns A, et al. Obstructive sleep disordered breathing in 2- to 18-year-old children: diagnosis and management. *Eur Respir J*. 2016;47(1):69-94. [CrossRef]
33. Global Initiative for Asthma (GINA). *GINA 2020 Report*. 2020. Available at: https://ginasthma.org/reports/.
34. Peters U, Dixon AE, Forno E. Obesity and asthma. *J Allergy Clin Immunol*. 2018;141(4):1169-1179. [CrossRef]
35. Bessonova L, Volkova N, Higgins M, et al. Data from the US and UK cystic fibrosis registries support disease modification by CFTR modulation with ivacaftor. *Thorax*. 2018;73(8):731-740. [CrossRef]
36. Hayes D Jr, Warren PS, McCoy KS, Sheikh SI. Improvement of hepatic steatosis in cystic fibrosis with ivacaftor therapy.*J Pediatr Gastroenterol Nutr*. 2015;60(5):578-579. [CrossRef]
37. Kutney K, Donnola SB, Flask CA, et al. Lumacaftor/ivacaftor therapy is associated with reduced hepatic steatosis in cystic fibrosis patients. *World J Hepatol*. 2019;11(12):761-772. [CrossRef]
38. Safirstein J, Grant JJ, Clausen E, Savant D, Dezube R, Hong G. Biliary disease and cholecystectomy after initiation of elexacaftor/ivacaftor/tezacaftor in adults with cystic fibrosis. *J Cyst Fibros*. 2021;20(3):506-510. [CrossRef]
39. Ramsey BW, Davies J, McElvaney NG, et al. A CFTR potentiator in patients with cystic fibrosis and the G551D mutation. *Engl J Med*. 2011;365:1663-1672.
40. Sawicki GS, McKone EF, Pasta DJ, et al. Sustained benefit from ivacaftor demonstrated by combining clinical trial and cystic fibrosis patient registry data. *Am J Respir Crit Care Med*. 2015;192(7):836-842. [CrossRef]
41. Konstan MW, McKone EF, Moss RB, et al. Assessment of safety and efficacy of long-term treatment with combination lumacaftor and ivacaftor therapy in patients with cystic fibrosis homozygous for the F508del-CFTR mutation (Progress): a phase 3, extension study. *Lancet Respir Med*. 2017;5(2):107-118. [CrossRef]
42. Burgel PR, Munck A, Durieu I, et al. Real-life safety and effectiveness of Lumacaftor–Ivacaftor in patients with cystic fibrosis. *Am J Respir Crit Care Med*. 2020;201(2):188-197. [CrossRef]
43. Heltshe SL, West NE, VanDevanter DR, et al. Study design considerations for the Standardized Treatment of Pulmonary Exacerbations 2 (STOP2): a trial to compare intravenous antibiotic treatment durations in CF. *Contemp Clin Trials*. 2018;64:35-40. [CrossRef].
44. Tacconelli E, Peschel A, Autenrieth IB. Translational research strategy: an essential approach to fight the spread of antimicrobial resistance. *J Antimicrob Chemother*. 2014;69(11):2889-2891. [CrossRef]
45. Yardley L, Douglas E, Anthierens S, et al. Evaluation of a web-based intervention to reduce antibiotic prescribing for LRTI in six European countries: quantitative process analysis of the GRACE/INTRO randomised controlled trial. *Implement Sci*. 2013;8:134. [CrossRef]

46. Hamzeh-Cognasse H, Damien P, Chabert A, Pozzetto B, Cognasse F, Garraud O. Platelets and infections – complex interactions with bacteria. *Front Immunol*. 2015;6:82. [CrossRef]
47. Rybtke MT, Jensen PØ, Høiby N, Givskov M, Tolker-Nielsen T, Bjarnsholt T. The implication of Pseudomonas aeruginosa biofilms in infections. *Inflamm Allergy Drug Targets*. 2011;10(2):141-157. [CrossRef]
48. Montgomery ST, Mall MA, Kicic A, et al. Hypoxia and sterile inflammation in cystic fibrosis airways: mechanisms and potential therapies. *Eur Respir J*. 2017;49(1). [CrossRef]
49. Keogh RH, Tanner K, Simmonds NJ, Bilton D. The changing demography of the cystic fibrosis population: forecasting future numbers of adults in the UK. *Sci Rep*. 2020;10(1):10660. [CrossRef]
50. Olson G, Davis AM. Diagnosis and treatment of adults with community-acquired pneumonia. *JAMA*. 2020;323(9):885-886. [CrossRef]
51. Reinhart K, Bauer M, Riedemann NC, Hartog CS. New approaches to sepsis: molecular diagnostics and biomarkers. *Clin Microbiol Rev*. 2012;25(4):609-634. [CrossRef]
52. Ramirez JA, Musher DM, Evans SE, et al. Treatment of community-acquired pneumonia in immunocompromised adults: a consensus statement regarding initial strategies. *Chest*. 2020;158(5):1896-1911.[CrossRef]
53. Kauczor HU, Baird AM, Blum TG, et al. ESR/ERS statement paper on lung cancer screening. *Eur Radiol*. 2020;30(6):3277-3294. [CrossRef].
54. Messerli M, Kluckert T, Knitel M, et al. Ultralow dose CT for pulmonary nodule detection with chest x-ray equivalent dose – a prospective intra-individual comparative study. *Eur Radiol*. 2017;27(8):3290-3299. [CrossRef]
55. Zhang M, Qi W, Sun Y, Jiang Y, Liu X, Hong N. Screening for lung cancer using sub-millisievert chest CT with iterative reconstruction algorithm: image quality and nodule detectability. *Br J Radiol*. 2018;91(1090):20170658. [CrossRef]
56. Callister ME, Baldwin DR, Akram AR, et al. British Thoracic Society guidelines for the investigation and management of pulmonary nodules. *Thorax*. 2015;70(suppl 2):ii1-ii54. [CrossRef]
57. Liang M, Tang W, Xu DM, et al. Low-dose CT screening for lung cancer: computer-aided detection of missed lung cancers. *Radiology*. 2016;281(1):279-288. [CrossRef]
58. Hakozaki T, Richard C, Elkrief A, et al. The Gut Microbiome Associates with immune checkpoint inhibition outcomes in patients with advanced non-small cell lung cancer. *Cancer Immunol Res*. 2020;8(10):1243-1250. [CrossRef]
59. Paz-Ares L, Dvorkin M, Chen Y, et al. Durvalumab plus platinum-etoposide versus platinum-etoposide in first-line treatment of extensive-stage small-cell lung cancer (Caspian): a randomised, controlled, open-label, phase 3 trial. *Lancet*. 2019;394(10212):1929-1939. [CrossRef]
60. Goldman JW, Dvorkin M, Chen Y, et al. Durvalumab, with or without tremelimumab, plus platinum-etoposide versus platinum-etoposide alone in first-line treatment of extensive-stage small-cell lung cancer (Caspian): updated results from a randomised, controlled, open-label, phase 3 trial. *Lancet Oncol*. 2021;22(1):51-65. [CrossRef]
61. Fallon M, Giusti R, Aielli F, et al. Management of cancer pain in adult patients: ESMO Clinical Practice Guidelines. *Ann Oncol*. 2018;29(suppl 4):iv166-iv191. [CrossRef]
62. Sadate A, Occean BV, Beregi JP, et al. Systematic review and meta-analysis on the impact of lung cancer screening by low-dose computed tomography. *Eur J Cancer*. 2020;134:107-114. [CrossRef]
63. Melero I, Gaudernack G, Gerritsen W, et al. Therapeutic vaccines for cancer: an overview of clinical trials. *Nat Rev Clin Oncol*. 2014;11(9):509-524. [CrossRef]
64. Shu CA, Gainor JF, Awad MM, et al. Neoadjuvant atezolizumab and chemotherapy in patients with resectable non-small-cell lung cancer: an open-label, multicentre, single-arm, phase 2 trial. *Lancet Oncol*. 2020;21(6):786-795. [CrossRef]
65. Faivre-Finn C, Snee M, Ashcroft L, et al. Concurrent once-daily versus twice-daily chemoradiotherapy in patients with limited-stage small-cell lung cancer (CONVERT): an open-label, phase 3, randomised, superiority trial. *Lancet Oncol*. 2017;18(8):1116-1125. [CrossRef]
66. Temel JS, Greer JA, Muzikansky A, et al. Early palliative care for patients with metastatic non-small-cell lung cancer. *N Engl J Med*. 2010;363(8):733-742. [CrossRef]
67. Garassino MC, Whisenant JG, Huang LC, et al. COVID-19 in patients with thoracic malignancies (TERAVOLT): first results of an international, registry-based, cohort study. *Lancet Oncol*. 2020;21(7):914-922. [CrossRef]
68. Walsh SL, Wells AU, Sverzellati N, et al. An integrated clinico-radiological staging system for pulmonary sarcoidosis: a case-cohort study. *Lancet Respir Med*. 2014;2(2):123-130. [CrossRef]
69. Vorselaars ADM, Wuyts WA, Vorselaars VMM, et al. Methotrexate vs azathioprine in second-line therapy of sarcoidosis. *Chest*. 2013;144(3):805-812. [CrossRef]
70. Johannson KA, Vittinghoff E, Lee K, et al. Acute exacerbation of idiopathic pulmonary fibrosis associated with air pollution exposure. *Eur Respir J*. 2014;43(4):1124-1131. [CrossRef]
71. Allen RJ, Porte J, Braybrooke R, et al. Genetic variants associated with susceptibility to idiopathic pulmonary fibrosis in people of European ancestry: a genome-wide association study. *Lancet Respir Med*. 2017;5(11):869-880. [CrossRef]
72. O'Dwyer DN, Dickson RP, Moore BB. The lung microbiome, immunity, and the pathogenesis of chronic lung disease. *J Immunol*. 2016;196(12):4839-4847. [CrossRef]
73. Lehmann M, Buhl L, Alsafadi HN, et al. Differential effects of Nintedanib and pirfenidone on lung alveolar epithelial cell function in ex vivo murine and human lung tissue cultures of pulmonary fibrosis. *Respir Res*. 2018;19(1):175. [CrossRef]
74. Hurley K, Ding J, Villacorta-Martin C, et al. Reconstructed single-cell fate trajectories define lineage plasticity windows during differentiation of human PSC-derived distal lung progenitors. *Cell Stem Cell*. 2020;26(4):593-608.e8. [CrossRef]
75. Roldan N, Rapet A, Raggi G, et al. A lung-on-chip in vitro approach to study inflammation at the alveolar level. *Eur Respir J*. 2019;54(suppl 63):OA1903. [CrossRef]
76. Borie R, Le Guen P, Ghanem M, et al. The genetics of interstitial lung diseases. *Eur Respir Rev*. 2019;28(153). [CrossRef]
77. Devine MS, Garcia CK. Genetic interstitial lung disease. *Clin Chest Med*. 2012;33(1):95-110. [CrossRef]
78. Salisbury ML, Gu T, Murray S, et al. Hypersensitivity pneumonitis: radiologic phenotypes are associated with distinct survival time and pulmonary function trajectory. *Chest*. 2019;155(4):699-711. [CrossRef]
79. Raghu G, Remy-Jardin M, Myers JL, et al. Diagnosis of idiopathic pulmonary fibrosis: an official ATS/ERS/JRS/ALAT clinical practice guideline. *Am J Respir Crit Care Med*. 2018;198(5):e44-e68. [CrossRef]
80. Lynch DA, Sverzellati N, Travis WD, et al. Diagnostic criteria for idiopathic pulmonary fibrosis: a Fleischner Society White Paper. *Lancet Respir Med*. 2018;6(2):138-153. [CrossRef]
81. Foderaro A, Ventetuolo CE. Pulmonary arterial hypertension and the sex hormone paradox. *Curr Hypertens Rep*. 2016;18(11):84. [CrossRef]
82. Kawut SM, Archer-Chicko CL, DeMichele A, et al. Anastrozole in pulmonary arterial hypertension: a randomized, double-blind, placebo-controlled trial. *Am J Respir Crit Care Med*. 2017;195(3):360-368. [CrossRef]

83. Humbert M, Sitbon O, Chaouat A, et al. Survival in patients with idiopathic, familial, and anorexigen-associated pulmonary arterial hypertension in the modern management era. *Circulation*. 2010;122(2):156-163. [CrossRef]
84. Benza RL, Miller DP, Gomberg-Maitland M, et al. Predicting survival in pulmonary arterial hypertension: insights from the Registry to Evaluate Early and Long-Term Pulmonary Arterial Hypertension Disease Management (REVEAL). *Circulation*. 2010;122(2):164-172. [CrossRef]
85. Mathai SC, Hassoun PM, Puhan MA, Zhou Y, Wise RA. Sex differences in response to tadalafil in pulmonary arterial hypertension. *Chest*. 2015;147(1):188-197. [CrossRef]
86. Southgate L, Machado RD, Gräf S, Morrell NW. Molecular genetic framework underlying pulmonary arterial hypertension. *Nat Rev Cardiol*. 2020;17(2):85-95. [CrossRef]
87. Evans JD, Girerd B, Montani D, et al. BMPR2 mutations and survival in pulmonary arterial hypertension: an individual participant data meta-analysis. *Lancet Respir Med*. 2016;4(2):129-137. [CrossRef]
88. Montani D, Girerd B, Jaïs X, et al. Screening for pulmonary arterial hypertension in adults carrying a BMPR2 mutation. *Eur Respir J*. 2021;58(1). [CrossRef]
89. Patel RM, Kandefer S, Walsh MC, et al. Causes and timing of death in extremely premature infants from 2000 through 2011. *N Engl J Med*. 2015;372(4):331-340. [CrossRef]
90. Slaughter JL, Pakrashi T, Jones DE, South AP, Shah TA. Echocardiographic detection of pulmonary hypertension in extremely low birth weight infants with bronchopulmonary dysplasia requiring prolonged positive pressure ventilation. *J Perinatol*. 2011;31(10):635-640. [CrossRef]
91. Smith JA, Kitt MM, Butera P, et al. Gefapixant in two randomised dose-escalation studies in chronic Cough. *Eur Respir J*. 2020;55(3). [CrossRef]
92. Vertigan AE, Theodoros DG, Gibson PG, Winkworth AL. Efficacy of speech pathology management for chronic cough: a randomised placebo controlled trial of treatment efficacy. *Thorax*. 2006;61(12):1065-1069. [CrossRef]
93. Wong GWK. How should we treat patients with mild asthma? *N Engl J Med*. 2019;380(21):2064-2066. [CrossRef]
94. Barnes PJ. Targeting cytokines to treat asthma and chronic obstructive pulmonary disease. *Nat Rev Immunol*. 2018;18(7):454-466. [CrossRef]
95. Holguin F, Cardet JC, Chung KF, et al. Management of severe asthma: a European Respiratory Society/American Thoracic Society guideline. *Eur Respir J*. 2020;55(1):55(1):1900588. [CrossRef]
96. Suissa S, Ernst P, Benayoun S, Baltzan M, Cai B. Low-dose inhaled corticosteroid and the prevention of death from asthma. *N Engl J Med*. 2000;343(5):332-336. [CrossRef]
97. Nwaru BI, Ekström M, Hasvold P, Wiklund F, Telg G, Janson C. Overuse of short-acting β2-agonists in asthma is associated with increased risk of exacerbation and mortality: a nationwide cohort study of the global sabina programme. *Eur Respir J*. 2020;55(4). [CrossRef]
98. O'Byrne PM, FitzGerald JM, Bateman ED, et al. Inhaled combined budesonide-formoterol as needed in mild asthma. *N Engl J Med*. 2018;378(20):1865-1876. [CrossRef]
99. Singanayagam A, Glanville N, Cuthbertson L, et al. Inhaled corticosteroid suppression of cathelicidin drives dysbiosis and bacterial infection in chronic obstructive pulmonary disease. *Sci Transl Med*. 2019;11(507):eaav3879. [CrossRef]
100. Chalmers JD, Laska IF, Franssen FME, et al. Withdrawal of inhaled corticosteroids in COPD: a European Respiratory Society guideline. *Eur Respir J*. 2020;55(6). [CrossRef]
101. Chalmers JD, Boersma W, Lonergan M, et al. Long-term macrolide antibiotics for the treatment of bronchiectasis in adults: an individual participant data meta-analysis. *Lancet Respir Med*. 2019;7(10):845-854. [CrossRef]
102. Laska IF, Crichton ML, Shoemark A, Chalmers JD. The efficacy and safety of inhaled antibiotics for the treatment of bronchiectasis in adults: a systematic review and meta-analysis. *Lancet Respir Med*. 2019;7(10):855-869. [CrossRef]
103. Ramsey KA, Chen ACH, Radicioni G, et al. Airway mucus hyperconcentration in non-cystic fibrosis bronchiectasis. *Am J Respir Crit Care Med*. 2020;201(6):661-670. [CrossRef]
104. Shoemark A, Cant E, Carreto L, et al. A point-of-care neutrophil elastase activity assay identifies bronchiectasis severity, airway infection and risk of exacerbation. *Eur Respir J*. 2019;53(6). [CrossRef]
105. Trudzinski FC, Kaestner F, Schäfers HJ, et al. Outcome of patients with interstitial lung disease treated with extracorporeal membrane oxygenation for acute respiratory failure. *Am J Respir Crit Care Med*. 2016;193(5):527-533. [CrossRef]
106. Araya J, Kawabata Y, Jinho P, et al. Clinically occult subpleural fibrosis and acute interstitial pneumonia a precursor to idiopathic pulmonary fibrosis? *Respirology*. 2008;13(3):408-412. [CrossRef]
107. Arcadu A, Moua T. Bronchoscopy assessment of acute respiratory failure in interstitial lung disease. *Respirology*. 2017;22(2):352-359. [CrossRef]
108. Libby LJ, Gelbman BD, Altorki NK, Christos PJ, Libby DM. Surgical lung biopsy in adult respiratory distress syndrome: a meta-analysis. *Ann Thorac Surg*. 2014;98(4):1254-1260. [CrossRef]
109. Armstrong RA, Kane AD, Cook TM. Outcomes from intensive care in patients with COVID-19: a systematic review and meta-analysis of observational studies. *Anaesthesia*. 2020;75(10):1340-1349. [CrossRef]
110. Dondorp AM, Hayat M, Aryal D, Beane A, Schultz MJ. Respiratory support in COVID-19 patients, with a focus on resource-limited settings. *Am J Trop Med Hyg*. 2020;102(6):1191-1197. [CrossRef]
111. Bos LD, Weda H, Wang Y, et al. Exhaled breath metabolomics as a noninvasive diagnostic tool for acute respiratory distress syndrome. *Eur Respir J*. 2014;44(1):188-197. [CrossRef]
112. Dickson RP, Schultz MJ, van der Poll T, et al. Lung microbiota predict clinical outcomes in critically ill patients. *Am J Respir Crit Care Med*. 2020;201(5):555-563. [CrossRef]
113. Pien GW, Ye L, Keenan BT, et al. Changing faces of obstructive sleep apnea: treatment effects by cluster designation in the Icelandic sleep apnea cohort. *Sleep*. 2018;41(3):zsx201. [CrossRef]
114. Mazzotti DR, Keenan BT, Lim DC, Gottlieb DJ, Kim J, Pack AI. Symptom subtypes of obstructive sleep apnea predict incidence of cardiovascular outcomes. *Am J Respir Crit Care Med*. 2019;200(4):493-506. [CrossRef]
115. Sánchez-de-la-Torre M, Sánchez-de-la-Torre A, Bertran S, et al. Effect of obstructive sleep apnoea and its treatment with continuous positive airway pressure on the prevalence of cardiovascular events in patients with acute coronary syndrome (ISAACC study): a randomised controlled trial. *Lancet Respir Med*. 2020;8(4):359-367. [CrossRef]
116. McEvoy RD, Antic NA, Heeley E, et al. CPAP for prevention of cardiovascular events in obstructive sleep apnea. *N Engl J Med*. 2016;375(10):919-931. [CrossRef]
117. Burks SV, Anderson JE, Bombyk M, et al. Nonadherence with employer-mandated sleep apnea treatment and increased risk of serious truck crashes. *Sleep*. 2016;39(5):967-975. [CrossRef]
118. Chennaoui M, Arnal PJ, Sauvet F, Léger D. Sleep and exercise: a reciprocal issue? *Sleep Med Rev*. 2015;20:59-72. [CrossRef]

119. Guazzi M, Bandera F, Ozemek C, Systrom D, Arena R. Cardiopulmonary exercise testing: what is its value? *J Am Coll Cardiol*. 2017;70(13):1618-1636. [CrossRef]
120. Rizzi CF, Cintra F, Mello-Fujita L, et al. Does obstructive sleep apnea impair the cardiopulmonary response to exercise? *Sleep*. 2013;36(4):547-553. [CrossRef]
121. Mônico-Neto M, Antunes HKM, Dos Santos RVT, et al. Physical activity as a moderator for obstructive sleep apnoea and cardiometabolic risk in the EPISONO study. *Eur Respir J*. 2018;52(4):1701972. [CrossRef]. Erratum in: *Eur Respir J*. 2018;52(6).
122. Vivodtzev I, Tamisier R, Croteau M, et al. Ventilatory support or respiratory muscle training as adjuncts to exercise in obese CPAP-treated patients with obstructive sleep apnoea: a randomised controlled trial. *Thorax*. 2018:thoraxjnl-2017-211152. [CrossRef]
123. Mendelson M, Bailly S, Marillier M, et al. Obstructive sleep apnea syndrome, objectively measured physical activity and exercise training interventions: a systematic review and meta-analysis. *Front Neurol*. 2018;9:73. [CrossRef]
124. Ito K, Barnes PJ. COPD as a disease of accelerated lung aging. *Chest*. 2009;135(1):173-180.[CrossRef]
125. Meiners S, Eickelberg O, Königshoff M. Hallmarks of the ageing lung.*Eur Respir J*. 2015;45(3):807-827. [CrossRef]
126. Blanc PD, Annesi-Maesano I, Balmes JR, et al. The occupational burden of nonmalignant respiratory diseases: an official American Thoracic Society and European Respiratory Society statement. *Am J Respir Crit Care Med*. 2019;199(11):1312-1334. [CrossRef]
127. Martinez FD. Early-life origins of chronic obstructive pulmonary disease. Drazen JM, ed. *N Engl J Med*. 2016;375(9):871-878. [CrossRef]
128. Fletcher C, Peto R. The natural history of chronic airflow obstruction. *BMJ*. 1977;1(6077):1645-1648. [CrossRef]
129. Svanes C, Sunyer J, Plana E, et al. Early life origins of chronic obstructive pulmonary disease. *Thorax*. 2010;65(1):14-20. [CrossRef]
130. Stocks J, Dezateux C. The effect of parental smoking on lung function and development during infancy. *Respirology*. 2003;8(3):266-285. [CrossRef]
131. Moshammer H, Hoek G, Luttmann-Gibson H, et al. Parental smoking and lung function in children: an international study. *Am J Respir Crit Care Med*. 2006;173(11):1255-1263. [CrossRef]
132. Faner R, Rojas M, MacNee W, Agustí A. Abnormal lung aging in chronic obstructive pulmonary disease and idiopathic pulmonary fibrosis. *Am J Respir Crit Care Med*. 2012;186(4):306-313. [CrossRef]
133. Morley JE, Vellas B, van Kan GA, et al. Frailty consensus: a call to action. *J Am Med Dir Assoc*. 2013;14(6):392-397. [CrossRef]
134. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*. 2001;56(3):M146-M156. [CrossRef]
135. Lahousse L, Ziere G, Verlinden VJ, et al. Risk of frailty in elderly with COPD: a population-based study. *J Gerontol A Biol Sci Med Sci*. 2016;71(5):689-695. [CrossRef]
136. Thériault ME, Paré MÈ, Lemire BB, Maltais F, Debigaré R. Regenerative defect in vastus lateralis muscle of patients with chronic obstructive pulmonary disease. *Respir Res*. 2014;15(1):35. [CrossRef]
137. Nederveen JP, Joanisse S, Snijders T, et al. Skeletal muscle satellite cells are located at a closer proximity to capillaries in healthy young compared with older men. *J Cachexia Sarcopenia Muscle*. 2016;7(5):547-554. [CrossRef]
138. Maddocks M, Kon SS, Canavan JL, et al. Physical frailty and pulmonary rehabilitation in COPD: a prospective cohort study. *Thorax*. 2016;71(11):988-995. [CrossRef]
139. Reid RD, Mullen KA, D'Angelo MES, et al. Smoking cessation for hospitalized smokers: an evaluation of the "Ottawa Model". *Nicotine Tob Res*. 2010;12(1):11-18. [CrossRef]
140. Mullen KA, Manuel DG, Hawken SJ, et al. Effectiveness of a hospital-initiated smoking cessation programme: 2-year health and healthcare outcomes. *Tob Control*. 2017;26(3):293-299. [CrossRef]