Pulmonary, Critical Care, and Sleep Medicine

Zea Borok, MD

Division Chief

Professor of Medicine

Ralph Edgington Chair in Medicine

I have never been more proud to lead this Division that has been at the forefront of dealing with the challenges of COVID-19. The teamwork has been truly incredible and is a testament to each individual and the power of collaboration!

The Division of Pulmonary, Critical Care and Sleep Medicine (PCCSM) strives towards excellence in all three academic missions, providing exceptional clinical care, robust basic and clinical research programs and outstanding opportunities for training of the next generation of clinicians in our highly sought-after fellowship programs.

Division faculty and fellows provide services in seven Intensive Care Units, two at the LAC+USC Medical Center, four at the Keck Hospital of USC, and one at the USC Norris Cancer Hospital. They also care for patients with complex advanced pulmonary diseases in both the inpatient and outpatient settings, as well as perform many state-of-the-art pulmonary procedures.

Basic science and translational research areas in the Division include airway and alveolar epithelial cell biology, pulmonary fibrosis, stem cell biology and regenerative medicine, and gene regulation in lung injury and repair. Clinical research areas include cystic fibrosis, pulmonary hypertension, sleep medicine, ILD, asthma, lung cancer and bronchoscopy, medical education, and outcomes in critical care. Division faculty and fellows have also been actively engaged in leading several COVID-19-related clinical trials.

Clinical Activities

LAC+USC Medical Center

The Division of PCCSM operates a 40-bed Medical Intensive Care service at LAC+USC with two separate teams. The Division provides consultative services to inpatients and intensive care units of other divisions and departments, including internal medicine, surgery (including trauma), neurology, neurosurgery, burns, emergency medicine and cardiology. The Division also provides outpatient pulmonary consultative services (in-person and virtually) to support the Los Angeles County Department of Health Services. In addition, we provide advanced bronchoscopic, pleural, and other procedures for both inpatient and outpatient populations.

Keck Hospital of USC

The Division cares for inpatients with a wide spectrum of acute and chronic lung diseases and critical illness in the KH Intensive Care Units.

Our intensivists support the heart and lung transplant program by providing perioperative care of this complex patient population with co-management of advanced heart failure patients. We co-manage patients in the neurosurgical ICU and provide consultative services for other critical care units. The Division also leads the Code Blue and Rapid Response teams at Keck Hospital.

In response to the COVID-19 pandemic, and in partnership with nursing and administration, the Division led the establishment of a closed COVID ICU with processes designed to optimize the care of patients and the safety of providers. Division faculty assumed a leadership role in establishing a COVID ICU team to deliver best practices care to critically-ill COVID patients.

In addition, we have pulmonary subspecialty inpatient teams which care for complex advanced pulmonary disease patients with cystic fibrosis, pulmonary hypertension, lung transplantation, interstitial lung diseases, and end-stage COPD.

USC Norris Cancer Hospital

The Division of PCCSM operates the Intensive Care Unit at Norris Hospital, provides pulmonary consultative services to floor patients, and leads emergency responses in the form of Code Blue and Rapid Response emergencies for both the inpatient and outpatient clinic areas. The Division of PCCSM also supervises and directs the acute care nurse practitioner program at the USC/Norris Cancer Hospital, including their oversight of sepsis management throughout the entire hospital. Our division also provides outpatient pulmonary consultative services and interventional pulmonary support for the cancer hospital.

Dr. Santhi Kumar discussing a case with a fellow

Special Clinical Services

The Division of PCCSM has established several clinical Programs of Excellence, each of which offer specialized treatment for various pulmonary disorders, as well as an outstanding educational setting for fellow education.

The **USC Center for Advanced Lung Disease (CALD)** is a program that deals with the diagnosis and treatment of all types of complex lung diseases. Our #12 ranking by US and World Report reflects the expertise and care that is provided by our elite multidisciplinary team. The combined expertise of our social worker, respiratory therapist, dietician, pharmacist, nurses, and physicians supports the management of complex patients with chronic lung disease to ensure that they can achieve the best possible quality of life.

Within CALD, there are several subspecialty clinics, including an **Interstitial Lung Disease (ILD) Center of Excellence** led by Dr. Toby Maher who is internationally known for his research and expertise in this field. In addition to involvement in Idiopathic Pulmonary Fibrosis (IPF) clinical trials, we have established a monthly conference for multidisciplinary discussion and management of ILD patients involving key members from pulmonology, radiology, pathology, and rheumatology. This multidisciplinary ILD board is in-line with national best-practice recommendations regarding the diagnosis and management of ILD.

The **Anton Yelchin Adult Cystic Fibrosis (CF) Center** provides direct care and consultation for adult CF patients. Under the leadership of Dr. Adupa Rao, the CF Center received an unprecedented gift of $1 million from the Yelchin family to name the CF Center in memory of their son Anton. A multidisciplinary care team provides care from a nurse practitioner, pharmacist, respiratory therapist, dietitian, and social worker alongside a CF physician. The entire team is made of nationally recognized experts in their field, with a combined experience of more than 75 year of CF care. The center provides excellent clinical care and an opportunity to participate in the latest drug trials. During the pandemic, innovations and adaptations included close telemedicine follow up, home IV antibiotics, and the use of home spirometry to decrease the need for clinic visits for clinically stable patients.

We have also developed an innovative **Post-COVID Pulmonary Clinic**, which meets a new and growing need across the nation. COVID-19 survivors have not only persistent lung damage, but also other issues which require multidisciplinary care. Given our successes with similar multi-system disease states, such as cystic fibrosis, we are well positioned to care for this new subgroup of patients.

Due to the complex and fragile nature of patients seen at CALD, telemedicine visits are not always sufficient. Thus, we have re-designed the clinic to also support in-person visits with a high-level of safety measures incorporated. Providers wear full PPE and there is a new comprehensive cleaning process (disinfection of all surfaces with bleach, UV light sterilization) and increased airflow turnover in all rooms between each patient

The **USC Sleep Disorders Center** has seen continued growth and expansion and now occupies a separate area at KH with full staff support.

This year, Drs. Grbach, Castriotta and Dasgupta of the Sleep Disorders Center welcomed Lesley Killion Baber, CRNP, to the Sleep Disorders staff. As the USC Sleep Disorders Center remains a regional leader in providing non-CPAP alternatives for the treatment of Sleep Apnea, Mrs. Baber organizes the sleep device clinic for patients who have been implanted with the Upper Airway

Stimulation device or Phrenic Nerve Stimulation device. Since the pandemic forced the division to restructure its outpatient care, the Sleep Disorders Center created a novel solution incorporating telemedicine consultations with home sleeps studies (and select in-lab studies) to continue patient access to care. As our inpatient and outpatient sleep services continue to expand, we will engage this year with the USC Cardiology Electrophysiology department in joint research studies.

The **USC Interventional Pulmonary (IP) Program** provides a full spectrum of services for the minimally invasive diagnosis, staging, and management of lung cancer, benign airway disease and pleural procedures. The IP program was established in 2015 with the recruitment of Dr. Mahdavi as the first IP fellowship trained and IP board certified faculty member. The rapid rate of grow of the IP program led to the need to recruit a second IP faculty member. Dr. Diana Yu joined the IP program in November 2019. With her dedicated time and effort to expand the already established program, we now have approval from AABIP to start an IP fellowship program in July 2021. The IP fellowship will be supported by Keck Hospital and has been approved by the LAC+USC Graduate Medical Education office.

The **USC Multidisciplinary Lung Cancer Program** includes several faculty members from PCCSM who actively participate in the evaluation, diagnosis, and management of patients with thoracic cancers. Drs. Chang, Yu, and Mahdavi provide pulmonary expertise and advanced bronchoscopy/interventional pulmonary services for lung cancer patients, as well as other solid organ malignancies, at the LAC+USC Medical Center, Keck Medical Center, and the Norris Cancer Hospital. They are key members of the USC Thoracic Tumor Board as well as the USC Lung Cancer Screening Program and each have their own private clinics based at the cancer center.

Educational Activities

The **PCCM Fellowship Program** is a rigorous 36-month ACGME-accredited combined fellowship in pulmonary and critical care medicine. We recruit seven new fellows per academic year for a total of 21 fellows. Fellows rotate through three teaching hospitals (LAC+USC Medical Center, Keck Hospital of USC, and USC Norris Cancer Hospital) during their three years of training. This provides a unique and unparalleled experience of training in three different hospital systems with varying patient populations and needs.

The fellows are expected to also engage in Quality Improvement Projects and basic science or clinical research, both of which are requirements for graduation. Our training program also includes **two 1-year subspecialty fellowship tracks** in **Sleep Medicine** (2 fellows per year) and **Interventional Pulmonary** (1 fellow per year, starting 2021).

Research Activities

Basic and clinical research remain a major focus of the Division's interests and activities. The Division has a strong and expanding basic science research enterprise with a focus on lung injury, repair and regeneration. A number of investigators study pulmonary structure and function at the organ, tissue, cellular and molecular levels. .

Hastings Center for Pulmonary Research
The Hastings Center for Pulmonary Research (HCPR) was established in 2014 with an initial gift of $7.5 million over 5 years to create a center of excellence for lung research at USC under the direction of Dr. Zea Borok. The major goals of the HCPR are to recruit a cadre of excellent lung scientists, create a collaborative environment for study of lung disease and provide training opportunities for the next generation of scientists. In 2018, the Hastings Foundation renewed their commitment to support the HCPR for an additional ten years. Investigators in the HCPR interface with clinicians in the Division to advance translational research activities.

Special Basic/Translational Research Activities

Zea Borok, MD has a research program that is broadly focused on cell and molecular biology of the alveolar epithelium in the context of lung injury, repair and fibrosis. Her studies, which are funded by NIH/NHLBI, provide important insights into mechanisms that regulate repair of the alveolar epithelium following injury and could lead to the development of novel therapeutic approaches for lung fibrosis by preserving the epithelium. Her recent work has focused on the role of a tight junction protein, claudin-18, in regulating lung progenitor cell proliferation and tumorigenesis, identification of genes and proteins that are specifically expressed in lung type I cells and epithelial-fibroblast interactions. She has several important collaborations including with Dr. Beiyun Zhou to study the role of endoplasmic stress in alveolar epithelial cell injury and lung fibrosis, with Drs. Ite Offringa and Crystal Marconett in transcriptional and epigenetic regulation of alveolar epithelial cell differentiation, with Dr. Parviz Minoo in studies of lung development and with Dr. Amy Ryan on generation of pulmonary neuroendocrine cells from induced pluripotent stem cells (iPSC) as well as the role of claudin-18 in iPSC differentiation.

Toby Maher MD, PhD runs a translational program of research focused on biomarker discovery and early phase clinical trials for patients with scarring disorders of the lung. In addition, his laboratory research has identified the role played by bacteria in the lung (microbiome) in the development and progression of fibrosis through interaction with the host immune system.

Amy Ryan (Firth), PhD and her research group use primary lung cells and state-of-the-art gene-editing and stem cell approaches in iPSC to study mechanisms of human lung biology in a disease-, gene- and patient-specific manner.

Beiyun Zhou, PhD focuses her research on alveolar epithelial cell biology in general, and specifically delineation of mechanisms regulating AEC differentiation and plasticity in the context of lung injury and fibrosis. Most recently she has been focusing on the role of endoplasmic reticulum stress in alveolar epithelial cells in pulmonary fibrosis.

Ya-Wen Chen, PhD and her research group use lung cells generated from human pluripotent stem cells to study human lung development, disease modeling, lung injury repair and regeneration.

Special Clinical Research Activities

Richard G. Barbers, MD focused his research on the role of abnormal repair processes (which include inflammatory and immune mechanisms) in airway fibrosis (remodeling) in asthma. Dr. Barbers collaborates with Omid Akbari, PhD on the innate immune system and autophagy mechanisms in asthmatics. He is co-PI on two NIH grants related to these topics.

Ahmet Baydur, MD is the Director of the LAC+USC Outpatient Clinics and Pulmonary Rehabilitation Program and thus is the leader of a QI study that focuses on the reduction of asthma morbidity in African Americans and Hispanic/Latinos through evaluation of the effects of education in the use of inhalers.

Richard Castriotta, MD is the PI for clinical research projects regarding a novel nebulized antiviral agent for COVID-19, and the differences in circulation time in patients with Cheyne-Stokes respiration. Both involve mentoring of pulmonary/critical care fellows. He is a co-investigator for studies involving sleep apnea and arrythmias, and also for the use of oxygen in the management of central sleep apnea. Between July 2019 and June 2020, he published 7 papers in peer-reviewed journals, all as either first author or senior author. One of these recently published (in June) about COVID-19 already has 24 citations. He has an h-index of 20 and i10-index of 31.

Ching-Fei Chang, MD is the PI and/or Senior Author of numerous studies focusing on various aspects of bronchoscopy, lung cancer, and medical education. She is on the American Cancer Society's taskforce on lung cancer in women and has a special research interest in lung cancer health disparities in women and Asians. She is also co-PI on an upcoming study looking at long-term pulmonary function deficits in COVID-19 survivors, as well as the prevalence of asymptomatic carriage of COVID-19 among pulmonary and critical care practitioners.

Sivagini Ganesh, MD is involved in wide variety of research projects in pulmonary hypertension, Interstitial Lung Disease and Lung Transplantation. Her involvement in translational research has given her the opportunity to collaborate internationally through registries that are currently recruiting patients with pulmonary hypertension. Dr. Ganesh's motivation is to improve patient's quality of life with Novel treatment options for ILD/PH, COPD/PH as well as Sarcoidosis/PH patients.

Santhi Iyer Kumar, MD is the medical director of the Keck MICU service. In this role she is responsible for the operations of both the COVID and non-COVID ICU and

Dr. Peter Marshall walking with a patient at Keck Hospital of USC

has been involved in both observational and randomized control trials involving COVID care and therapy. She is also a TeamSTEPPs master trainer for the health system and studies the impact of team training on safety culture in the intensive care unit.

May Lee, MD is the Program Director for the PCCM Fellowship, and the Director of the LAC+USC Medical Intensive Care Unit. Thus, she is involved in various critical care and medical education research projects. She is currently involved in several trials of therapeutics in the treatment and management of COVID-19, a member of an International Task Force to develop guidelines on COVID-19, and is the primary investigator on a study of health disparities in COVID-19. In addition, she has been involved in a DHS-wide initiative of Time Limited Trials to Reduce Non-Beneficial Intensive Care Unit Treatments Among Critically-ill Patients with Advanced Medical Illnesses. She has also been involved in several medical education research projects which are currently in press.

Janice M. Liebler, MD has been involved with numerous research projects. Her clinical research is mainly focused on critically ill patients suffering from COVID and non-COVID diseases. The impact of the global pandemic has been felt all throughout the world and much of Dr. Liebler's time and energy has most recently been focused on the ongoing worldwide emergency of COVID-19. She is the co-PI for studies of Ravulizamab, Baricitanib study and DAS181 in COVID-19 patients. She is also a participant in the COVID task force of the American Thoracic Society, which is a large multidisciplinary group of clinicians from academic medical centers who evaluate evidence and give recommendations for various aspects of COVID-19 patient care.

Adupa P. Rao, MD is participating in an observational study that collects information acquired in the care of cystic fibrosis patients to address quality improvement initiatives and examine dynamic health case issues, including nutritional status, infection control, pulmonary treatment and/or metabolic issues rapidly and effectively.

Division Accomplishments

- Frontline leaders in the early preparation for COVID-19 and creation of a COVID ICU at the Keck Medical Center which allowed for a seamless transition and best-practices management of COVID-19 patients
- Frontline leaders in managing the enormous numbers of COVID-19 patients at LAC+USC with only limited resources available
- Rapid incorporation of telemedicine into our practice and strategic deployment of our PCCM workforce during the early stages of the pandemic
- Growth of the USC lung transplant program from 16 to 36 transplanted cases per year
- Official designation as a Center of Excellence for Bronchoscopic Lung Volume Reduction (one of only 2 sites in Southern California)
- Approval and establishment of a new Interventional Pulmonary Fellowship Program

Honors and Awards

Zea Borok, MD
Member, Scientific Advisory Board, Max Planck Institute for Heart and Lung Research, 2020-2024

May Lee, MD
Voted "Teacher of the Year" 2020 by Internal Medicine Residency Program

Brett Lindgren, DO
Voted "Teacher of the Year" 2020 by PCCM Fellowship Program

Super Doctor, Southern California Magazine
Richard Barbers, MD
Ahmet Baydur, MD
Ching-Fei Chang, MD
Richard Castriotta, MD
Sivagini Ganesh, MD
Ricardo Juarez, MD
Janice Liebler, MD
Richard Lubman, MD
Renli Qiao, MD, PhD
Adupa Rao, MD

FACULTY

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Toby Maher, MD
Renli Qiao, MD, PhD

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