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Icahn School of Medicine at Mount Sinai

BioMedical Engineering and Imaging Institute

bmeii.mssm.edu

Message from the Director

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Welcome to this special issue of our newsletter where we introduce you to the new formed BioMedical Engineering and Imaging Institute. We have come a long way since the inception of the Imaging Science Laboratories and then Translational Molecular Imaging Institute. Our goal is to continue to invest in the best capital and physical resources in order to produce the best biomedical engineering discoveries to better diagnose and cure diseases. We share the story of our inauguration celebration we had recently. In this issue we introduce our latest faculty recruits (Drs. Yang Yang and Li Feng) that bring further biomedical engineering talent to our Institute. We also introduce the Radiochemistry lab our latest resources expansion that is producing state-of-the-art in radiotracers and immunotherapeutics. Finally, we feature a newly published paper in Nature Medicine by Drs. Yang Yang and Zahi Fayad and our Phd trainee Xueyan Mei on their work using AI to study COVID-19 patients. Finally, we introduce our newly launched website!

BMEII News & Updates

Mount Sinai Establishes BioMedical Engineering and Imaging Institute

Read more at: https://www.mountsinai.org/about/

The Mount Sinai Health System announced the creation of the Biomedical Engineering and Imaging Institute (BMEII), the first of its kind in New York City, and one of a few in the world. The BMEII will leverage Mount Sinai's renowned imaging and nanomedicine programs to establish a broad biomedical engineering research and training programs for its graduate and medical students. It will develop novel medical inventions in the fields of imaging, nanomedicine, artificial intelligence, robotics, sensors, medical devices and computer vision technologies such virtual real, augmented and extended reality. The BMEII is projected to be fully operational by early 2020 and will recruit at least nine prestigious principal investigators and their teams. These researchers will join existing Mount Sinai teams to develop cutting-edge biomedical engineering and imaging technologies to improve the detection, diagnosis, treatment, and prevention of a wide range of human diseases such as cancer, cardiovascular, and neurological diseases. Mount Sinai's Translational and Molecular Imaging Institute, which is at the forefront of brain, heart, and cancer imaging research, along with research in nanomedicine for precision imaging and drug delivery, will be fully incorporated into the BMEII. This will enrich the BMEII's research programs and have a greater impact on biomedical discoveries and patient care.

"Our imaging and nanomedicine programs are leaders in the development and application of these novel technologies to improve patients' diagnosis and treatment," explains Zahi Fayad, PhD, Director of the BMEII. "By integrating artificial intelligence, sensors, robotics, and virtual reality into our programs, the BMEII will take a transformative leap forward in the implementation of next generation medicine and healthcare for our patients and society."

"The creation of Mount Sinai's Biomedical Engineering and Imaging Institute represents a crucial milestone for our medical center," says Eric J. Nestler, MD, PhD, Nash Family Professor of Neuroscience, Director of the Friedman Brain Institute, and Dean for Academic and Scientific Affairs. "Mount Sinai already has established expertise in several areas of imaging and biomedical engineering and we look to further leverage this excellence in creating one of the nation's leading efforts in this exciting area of medical research."

Dennis S. Charney, Anne and Joel Ehrenkranz Dean of the Icahn School of Medicine, and President for Academic Affairs for the Mount Sinai Health System, says, "Mount Sinai has consistently been at the forefront of advancing health care, and the BMEII will revolutionize how we use technology to treat a wide range of conditions. This is a unique endeavor that will create a hub for world-class researchers and innovators, and position us to find groundbreaking solutions for treating disease."

BMEII Human Research Ramp-Up

The BioMedical Engineering and Imaging Institute (BMEII) is open for all imaging services on all modalities. We remain committed to providing the highest quality research, in our state-of-the-art facilities in a SAFE environment for both our subject and our researchers. While BMEIIremained open for approved"For Benefit"studies during the pandemic, following the announcement from the school and PPHS regarding expanding allowable "For Benefit" and "Not For Benefit" human research face-to-face visits, BMEII Human Imaging Core (HIC) has put in place the special guidelines. These guidelines were developed based on guidelines put forth by the FPA, Ambulatory, & the department of Diagnostic, Molecular and Interventional Radiology.

Read more about guidelines on our new website: https://bmeii.mssm.edu

Upcoming Events

- June 18th, 12:30pm. Imaging Research Ramp-up Town Hall. Join Zoom Meeting:https://mssm.zoom.us/j/92693171269?pwd=U1UrTUI3VkhTS3ZIUEdtQi9WRDNsdz09

  Meeting ID: 926 9317 1269
  Password: 388365

Faculty Spotlight

New Faculty & Staff

Yang Yang, PhD

Yang Yang, PhD, is Assistant Professor of Radiology at the BioMedical Engineering and Imaging Institute (BMEII) at the Icahn School of Medicine at Mount Sinai, New York. His research is focused on fast magnetic resonance imaging (MRI) technique development and its translational/clinical applications. Dr. Yang was trained in Biomedical Engineering at University of Virginia on MRI physics, novel pulse sequence development and advanced image reconstruction for fast imaging on cardiac MRI. He worked on interdisciplinary combination of engineering and clinical expertise in cardiovascular imaging to translate new MRI techniques into clinical practice. Specifically, Dr. Yang involved in the projects to develop new spiral pulse sequence to quantify the myocardial perfusion with whole heart coverage to better assess patients with suspected coronary artery disease. He developed techniques for fast imaging to improve resolution and coverage, which includes variable density spiral trajectories design, outer volume suppression (OVS), simultaneous multi-slices (SMS) and iterative constrained image reconstruction with the combination of parallel imaging, compressed sensing and motion compensation. Dr. Yang got his BSE and MSE degrees from Biomedical Engineering at Xi'an Jiaotong University, China on medical device and robotics.

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Li Feng, PhD

Dr. Li Feng is an Assistant Professor at the Biomedical Engineering and Imaging Institute and he joined the Icahn School of Medicine at Mount Sinai in October 2019. He obtained his PhD in Biomedical Imaging from NYU School of Medicine in 2015. Li's research interest has focused on development of novel rapid motion-robust and quantitative MRI techniques combining non-Cartesian acquisition and constrained reconstruction methods. Over the last decade, Li has led the development of several fast and ultrafast MRI techniques, and some of them have been successfully translated into the clinic for a broader spectrum of applications and have resulted in increase in the utility, the simplicity, and the cost-effectiveness of MRI. Li is a Junior Fellow of the International Society for Magnetic Resonance in Medicine (ISMRM) (2015) and was a receiver of the Early Career Award in Basic Science from the Society for Cardiovascular Magnetic Resonance (SCMR) (2014).

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Newest Additions

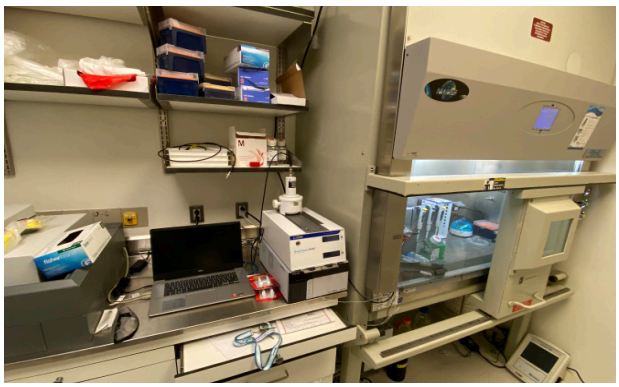
BMEII facility is expanding

The new Radiochemistry Lab

With the establishment of the Biomedical Engineering and Imaging Institute, the nanomedicine program has expanded its facilities to include a radiochemistry suite on SC-1 in the dose preparation room. This has been a long-desired vision and goal for the team and facility, as now nano-platform design, synthesis, radioactive labelling, imaging, and biodistribution studies can all take place within the institute. This greatly reduces reliance on other institutions in the creation of new radioactive tracers and immunotherapeutic nanoscale platforms.

Newly purchased equipment, such as an Shimadzu HPLC system (with UV and Radiodetectors), and a radio-TLC system, were placed within the newly shielded bio-safety cabinet. Other new additions include vortexes, thermomixers, microfluidics pumps and chips, a microcentrifuge, and a new computer. These additions complement the dose calibration room, which already included two dose calibrators, a large centrifuge, storage for radioactive isotopes, and a computer dedicated for dose tracking, which will soon be the main hub for NMIS.

SC-1 continues to be a full-stop shop for in vivo imaging and biodistribution studies, and with the addition of the radiochemistry suite, our abilities to create novel therapies and diagnostic tools have been significantly bolstered. For more information on the radiochemistry suite, please reach out to a member of the nanomedicine team lead by Professor Willem Mulder.
Scheduling contacts: Jazz Munitz (jazz.munitz@mssm.edu) and Bram Teunissen (bram.teunissen@mssm.edu).



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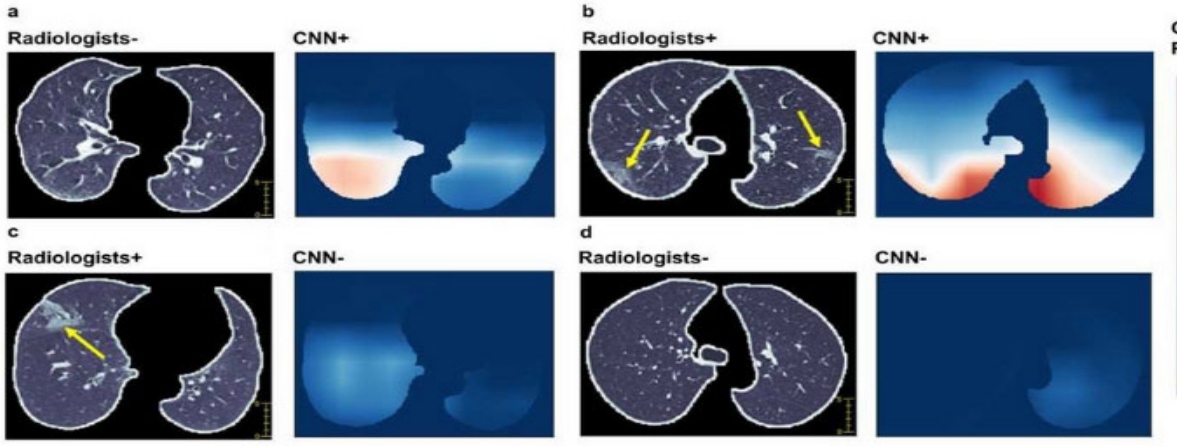
Groundbreaking discoveries

Mount Sinai First in U.S. to Use Artificial Intelligence to Analyze Coronavirus (COVID-19) Patients

Technology may lead to rapid diagnosis based on CT scans and patient data

Mount Sinai researchers are the first in the country to use artificial intelligence (AI) combined with imaging, and clinical data to analyze patients with coronavirus disease (COVID-19). They have developed a unique algorithm that can rapidly detect COVID-19 based on how lung disease looks in computed tomography (CT scans) of the chest, in combination with patient information including symptoms, age, bloodwork, and possible contact with someone infected with the virus. This study, published in the May 19 issue of Nature Medicine, could help hospitals across the world quickly detect the virus, isolate patients, and prevent it from spreading during this pandemic. "AI has huge potential for analyzing large amounts of data quickly, an attribute that can have a big impact in a situation such as a pandemic. At Mount Sinai, we recognized this early and were able to mobilize the expertise of our faculty and our international collaborations to work on implementing a novel AI model using CT data from coronavirus patients in Chinese medical centers. We were able to show that the AI model was as accurate as an experienced radiologist in diagnosing the disease, and even better in some cases where there was no clear sign of lung disease on CT," says one of the lead authors, Zahi Fayad, PhD, Director of the BioMedical Engineering and Imaging Institute (BMEII) at the Icahn School of Medicine at Mount Sinai."We're now working on how to use this at home and share our findings with others—this toolkit can easily be deployed worldwide to other hospitals, either online or integrated into their own systems." This research expands on a previous Mount Sinai study that identified a characteristic pattern of disease in the lungs of COVID-19 patients and showed how it develops over the course of a week and a half. The new study involved scans of more than 900 patients that Mount Sinai received from institutional collaborators at hospitals in China. The patients were admitted to 18 medical centers in 13 Chinese provinces between January 17 and March 3, 2020. The scans included 419 confirmed COVID-19-positive cases (most either had recently traveled to Wuhan, China, where the outbreak began, or had contact with an infected COVID-19 patient) and 486 COVID-19-negative scans. Researchers also had patients' clinical information, including blood test results showing any abnormalities in white blood cell counts or lymphocyte counts as well as their age, sex, and symptoms (fever, cough, or cough with mucus). They focused on CT scans and blood tests since doctors in China use both of these to diagnose patients with COVID-19 if they come in with fever or have been in contact with an infected patient. The Mount Sinai team integrated data from those CT scans with the clinical information to develop an AI algorithm. It mimics the workflow a physician uses to diagnose COVID-19 and gives a final prediction of positive or negative diagnosis. The AI model produces separate probabilities of being COVID-19-positive based on CT images, clinical data, and both combined. Researchers initially trained and fine-tuned the algorithm on data from 626 out of 905 patients, and then tested the algorithm on the remaining 279 patients in the study group (split between COVID-19-positive and negative cases) to judge the test's sensitivity; higher sensitivity means better detection performance. The algorithm was shown to have statistically significantly higher sensitivity (84 percent) compared to 75 percent for radiologists evaluating the images and clinical data. The AI system also improved the detection of COVID-19-positive patients who had negative CT scans. Specifically, it recognized 68 percent of COVID-19-positive cases, whereas radiologists interpreted all of these cases as negative due to the negative CT appearance. Improved detection is particularly important to keep patients isolated if scans don't show lung disease when patients first present symptoms (since the previous study showed that lung disease doesn't always show up on CT in the first few days) and COVID-19 symptoms are often nonspecific, resembling a flu or common cold, so it can be difficult to diagnose. "This study is important because it shows that an artificial intelligence algorithm can be trained to help with early identification of COVID-19, and this can be used in the clinical setting to triage or prioritize the evaluation of sick patients early in their admission to the emergency room," says Matthew Levin, MD, Director of the Mount Sinai Health System's Clinical Data Science Team, and a member of the Mount Sinai COVID Informatics Center. "This is an early proof concept that we can apply to our own patient data to further develop algorithms that are more specific to our region and diverse populations."



Examples of chest CT images of COVID-19 patients and visualization of features correlated to COVID-19 positivity. For each pair of images, the left image is a CT image showing the segmented lung used as input for the CNN (convolutional neural algorithm) model trained on CT images only, and the right image showe the heatmap of pixels that the

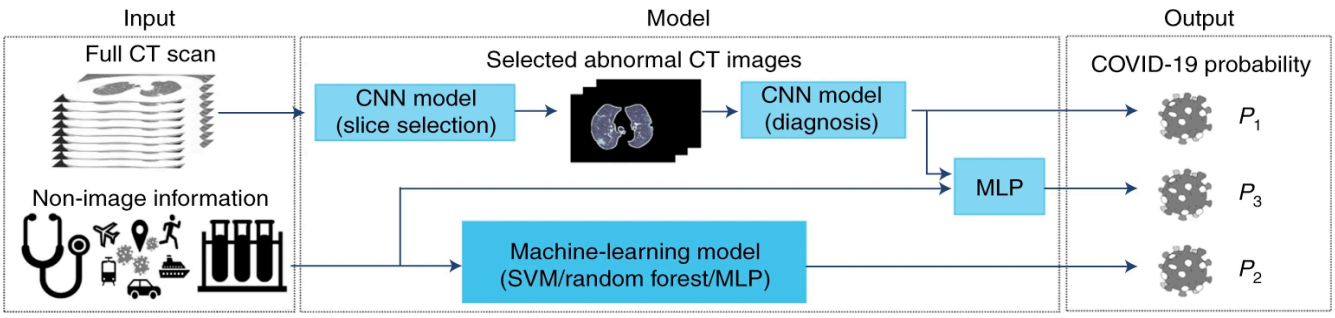


Illustration of the modeling framework; Three AI models are used to generate the probability of a patient being COVID-19 positive: the first is based on a chest CT scan, the second on clinical information; and the third on a combination of the chest CT scan and clinical information.

Read more in Nature Journal: https://www.nature.com/articles/s41591-020-0931-3

Mount Sinai researchers are now focused on further developing the model to find clues about how well patients will do based on subtleties in their CT data and clinical information. They say this could be important to optimize treatment and improve outcomes.

Xueyan Mei, a trainee in the Graduate School of Biological Sciences at the Icahn School of Medicine at Mount Sinai, and Yang Yang, PhD, Assistant Professor of Radiology at the Icahn School of Medicine at Mount Sinai, also contributed to this work.

Courtesy of Mount Sinai Inside. https://www.nature.com/articles/s41591-020-0931-3

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Cutting edge programs

Research collaborations

Advanced Neuroimaging Research Program (ANRP)

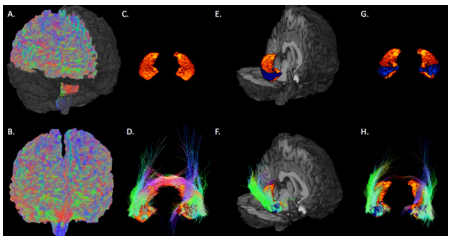
ANRP's scientific mission is to develop advanced imaging technologies and apply them to improve diagnosis, treatment and surgical planning for neurological diseases, ultimately leading to a deeper understanding of the brain in the normal and diseased state. As the director of ANRP, Dr. Balchandani envisions a growing number of ANRP-affiliated laboratories, spanning multiple departments in the Icahn School of Medicine at Mount Sinai (ISMMS), including Neuroscience, Neurosurgery, Psychiatry, Radiology and Neurology. She will be investing in and facilitating the most innovative brain imaging research which also leverages the technical and clinical advantages of ISMMS. This includes developing new acquisition methods, hardware, and analysis tools to provide advanced multi-modal imaging of the brain. She is also working towards ensuring that infrastructure for image acquisition and pre-processing is robust and seamless. Her goal is to increase overall NIH grants submissions and success rates within neuroimaging and to foster a cohesive set of core research projects to optimally position the ANRP for center and program grants.

Here are some ongoing achievements for the Advanced Neuroimaging Research Program (ANRP): building main infrastructure to support innovative and larger scale neuroimaging studies, providing the most advanced imaging sequences for 3T and 7T to support users and enable grants for all PIs in neuroimaging. Working with Siemens to finalize C2Ps for advanced ASL and fMRI sequences, development of new RF pulses and MRI pulse sequences for use by collaborators across multiple departments at ISMMS. Building new MR spectroscopy sequences that will better image metabolites of interest including neurotransmitters, developing new hardware infrastructure such as parallel Transmit capabilities for 7T, setting up multinuclear imaging, starting with sodium imaging at 7T, and developing new pulse sequences for multinuclear work, strengthening PET/MR research in neuro applications. Work closely with Trey Hedden to increase use of PET/MR and 7T for Alzheimer's research, focus on integration of multimodal data and share multimodal analysis methods with other PIs to provide multi-parametric markers for disease, presenting our program to other institutions, and establish collaborative relationships, generate users for our new methods and tools, working with Siemens to ensure quality control of hardware and availability of latest work-in-progress sequences. Secured an on-site Siemens physicist to develop and maintain sequences. Additionally ANRP is involved in guiding new PIs on neuroimaging capabilities and providing templates for IRB submissions for new projects, building research projects and cores for future program grant, strengthening collaborative ties with Psychiatry, Neurosurgery, Neurology and Rehabilitation Medicine, providing neuroimaging support to PIs in all these departments.

Also ANRP is responsible for testing, validating and integrating a data management service with an external vendor, Flywheel, to provide an efficient method for data storage and pre-neuroimaging data for our PIs.

It is a dedicated server to process and store images, Borg Queen, has been purchased, configured and equipped with the appropriate software. ANRP has established a pilot grant program to provide pilot scans contributing to preliminary data for NIH grant applications.

All ANRP recruitments and equipment acquisitions are intrinsically linked to the bioengineering initiative here at Sinai. Neuroimaging recruits will be integral members of BMEII and will contribute to imaging education. The programs will be connected, and their growth will be simultaneous.



Hippocampal subfield connectivity

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