BIOENGINEERING

An Open-Source COVID-19 CT Dataset with Automatic Lung Tissue Classification for Radiomics

Current datasets for lung computerized tomography (CT) scans are limited due to the quality and number of images, and the evaluation of these CT images are qualitative, making them difficult to standardize. In this study, Zaffino et al. provide an open-source dataset from 50 RT-PCR confirmed COVID-19 patients to augment machine learning algorithms’ translational capabilities and provide physician decision support. To assess the CT images, a radiologist assigned a clinical score, ranging from zero to five, based on the amount of ground glass opacities, consolidation, and denser tissue present in each CT scan. Zero represented 0% lung involvement, while five represented >75% lung involvement. The CT scans were segmented and filtered to define areas of interest based on voxel density. Zaffino et al. used these datasets to create a Gaussian mixture model (GMM) to detect tissue types and score each scan before validating the GMM using the clinical condition.

Cognitive impairment and altered cerebral glucose metabolism in the subacute stage of COVID-19

Hosp et al. sought to assess the impact of COVID-19 on the central nervous system in patients at the subacute stage of infection. In the Department of Internal Medicine of University Hospital Freiburg, patients with the following criteria were selected: a positive SARS-CoV-2 reverse transcriptase-PCR result, greater than 18 years of age, and presentation of at least one newly acquired neurological symptom. The cognitive state of patients was tested using the Montreal Cognitive Assessment (MoCA), followed by a neuropsychological test, CSF analysis, and structural MRI & PET with fluorodeoxyglucose (FDG PET). Final data was reported from 29 patients in which gustatory impairment was present in all patients, impairment of smell was found in 25/29 patients, and MoCA performance was impaired in 18/26 patients (3 refused the MoCA). 15 of the 29 patients participated in extended neuropsychological testing. The Word list learning on the Hopkins Verbal Learning Test-Revised, executive functions including digit span reverse and categorical fluency were most affected. Furthermore, of the 13 patients that underwent cerebral MRI, only four patients exhibited abnormalities in which microembolic subacute infarcts were detected. In contrast, FDG PET scans demonstrated that two-thirds of the patients presented predominant frontoparietal hypometabolism. While the researchers admit that the MoCA testing only provides limited information about cognitive performance and that CSF markers were not comprehensively assessed, they emphasize that their results highlight that physicians treating patients infected with SARS-CoV-2 should be aware that COVID-19 affects cognitive function and should include bedside tests evaluating function into the routine checkup.

Paper-based electrochemical biosensor for diagnosing COVID-19: Detection of SARS-CoV-2 antibodies and antigen

Yakoh et al address the need for more rapid accurate testing devices to be used in the field as a complement to the most common testing method, reverse transcription-polymerase chain
reaction (RT-PCR). In this study, the researchers created a highly sensitive immunosensor (ePAD) to detect SARS-CoV-2 antibodies using a new paper-based method of electrochemical potential corresponding to the presence of antibodies. The COVID19 ePAD employs a disruption of the redox conversion triggered by immunocomplex formation of captured immunoglobulins produced in humans in response to SARS-COV-2. Results were recorded in 30 minutes and had a significantly higher sensitivity than other lateral flow immunoassay (LFA) platforms used to detect the presence of antibodies. However, the detection limit has not yet achieved similar levels of real nasal swab specimens (n=17) collected in the study. In the future, the team proposes extending the project to include antigen detection to allow for new possibilities diagnosing COVID-19.

Role of nanotechnology behind the success of mRNA vaccines for COVID-19

Khurana et al. outline the rapid search for a COVID-19 vaccine and the advantages of a nanoparticle-based vaccine carrier. Pfizer and Moderna were the first mRNA-based, lipid nanoparticle (LNP) vaccines approved for emergency use by the FDA. These vaccines showed high efficacy in clinical trials, and the authors highlight the role nanoparticles play in this successful outcome. mRNA vaccines are non-infectious, do not require penetration of the nucleus, and can be produced rapidly compared to vaccines based on inactivated or live viruses. LNP-based carrier molecules allow for preservation of mRNA and enhanced uptake by cells. LNPs typically consist of an ionizable lipid portion, a stabilizing agent, a phospholipid portion to stabilize the bilayer, and polyethylene glycol (PEG) which makes them rigid and kinetically stable. Their simple synthesis, size, stability, biocompatibility, and efficacy in delivery with their physiological charge neutrality makes them a strong development from liposome systems. However, they can further be improved by stabilizing thermal degradation and enhancing cell penetration, specifically in the case of negatively charged cell membranes. Although mRNA vaccines have shown side effects and allergic reactions due to PEG, they are a promising development of nanoscale delivery systems for future applications in medicine.

NON-CLINICAL TRENDS

Impact of Covid-19 partial lockdown on PM$_{2.5}$, SO$_2$, NO$_2$, O$_3$, and trace elements in PM$_{2.5}$ in Hanoi, Vietnam

The goal of this study was to determine the impact of the COVID-19 partial lockdown on air pollutants in Hanoi, Vietnam. Concentration samples of PM$_{2.5}$, nitrogen dioxide (NO$_2$), ozone (O$_3$), and sulfur dioxide (SO$_2$) were taken from three sites. Results reveal that NO$_2$ concentrations decreased from 21.6 μg/m$^3$ to 5.2 μg/m$^3$ (75.8% decrease), SO$_2$ declined 60.7%, PM$_{2.5}$ decreased by 55.9% with an absolute decrease of 55.0 μg/m$^3$, O$_3$ decreased by 21.4%, and average concentrations of PM$_{2.5}$ were lower than ambient air quality standards during the partial lockdown. Authors suggest that the decline in air pollutants was attributed to a decrease in emissions from cars and shut down of industries during COVID-19.
NON-PHARMACEUTICAL/PUBLIC HEALTH INTERVENTIONS

Fitted Filtration Efficiency of Double Masking During the COVID-19 Pandemic

Sickbert-Bennett et al measured the fitted filtration efficiency (FFE) of face mask combinations with one female and two male volunteers during a series of movements defined by the Occupational Safety and Health Administration. The authors found that the usage of a medical procedure mask underneath a cloth mask led to the best FFE of the combinations tested. On average, double-masking increased the FFE from 55% to 66%, with two procedural masks not increasing the FFE and a cloth mask worn over a procedural mask increasing the FFE to 77%. FFE is likely improved by double-masking because the fit is improved (similar to the tight fit of an N95) and the leaks are minimized.

Incorporating HIV Screening With COVID-19 Testing in an Urban Emergency Department During the Pandemic

Routine screening of HIV has decreased greatly during the pandemic. Researchers found a decrease by 49% in testing for acute HIV from January 1 to April 30, 2020 at most study sites. In contrast, the emergency department at The University of Chicago Medicine was able to keep up their screening volumes by offering HIV screening at the same time as COVID-19 testing. Between January 1 and October 16, 2020 the emergency department at The University of Chicago Medicine conducted 19,111 HIV tests in tandem with COVID-19 tests and had 12 HIV-positive results. In fact, acute HIV diagnoses were higher at this emergency department compared to pre-pandemic rates. One of the twelve patients had both COVID-19 and acute HIV, while the other eleven had symptoms consistent with COVID-19 but received negative results. All were able to initiate antiretroviral therapy. This study showed that linking HIV screening with COVID-19 testing is a possible solution to the decreased rates of HIV screening during the pandemic.

Physical inactivity is associated with a higher risk for severe COVID-19 outcomes: a study in 48,440 adult patients

The goal of this retrospective observational study, conducted at Kaiser Permanente South California, was to determine if inactivity was associated with COVID-19 outcomes such as hospitalization, ICU admission, and death. Eligibility requirements included 1) 18 or older, 2) positive COVID-19 test, and 3) minimum of three outpatient appointments with an exercise vital sign (EVS) measure from March 19, 2018 – March 19, 2020. The three physical activity groups included: consistently meeting guidelines (EVS>150 min/week), some activity (EVS 11-149 min/week), and consistently inactive (EVS 0-10 min/week). The analysis included 48,440 participants and revealed that the consistently inactive group had a 2.26 increase in odds of hospitalization, 1.73 increased odds of ICU admission, and a 2.49 increased odds of death compared to patients who were in the consistently meeting guidelines group. Patients who meet physical activity guidelines were less likely to suffer from severe COVID-19; therefore, authors suggest that public health authorities should emphasize the importance of physical activity to prevent severe COVID-19.
REGION-SPECIFIC LESSONS LEARNED

Effect of socioeconomic inequalities and vulnerabilities on health-system preparedness and response to COVID-19 in Brazil: a comprehensive analysis

Rocha et al compiled data on state and municipal level indicators and used econometric methods to identify patterns in the spread of COVID-19 in Brazil. The authors found that socioeconomic vulnerabilities determined the initial spread of COVID-19 more than age structures or prevalence of health risk factors. States that were less socio-economically vulnerable were better able to increase hospital capacity, legislate COVID-19 measures, and achieve physical distancing in the community. States and municipalities that were more socio-economically vulnerable witnessed a disproportionate adverse burden of the pandemic. Targeted interventions to protect populations that are socioeconomically vulnerable are highly needed. Additionally, local government approaches and community behavior can help to counter-balance central government inactivity and strengthen health systems in areas that are socio-economically vulnerable.

TRANSMISSION PATTERNS

Laboratory modelling of SARS-CoV-2 exposure reduction through physically distanced seating in aircraft cabins using bacteriophage aerosol – November 2020

Aircrafts can increase an individual’s risk for exposure to SARS-CoV-2. Using a bacteriophage MS2 virus, the study assessed the exposure of SARS-CoV-2 for an aircraft with a single aisle (with two sections) and for an aircraft with a twin-aisle (with 3 sections). Findings showed that with physical distancing through keeping a middle seat unused, exposure was reduced by 23% in the single aisle scenario (one passenger sitting in the same row as another passenger but 2 seats away) compared to a full aircraft. There was also a 57% reduction in exposure in a twin-aisle scenario (different patterns of seating but always keeping the middle seat empty) compared to a full aircraft. When looking at relative exposure for one infectious passenger, exposure was reduced by 35%-36.4%. For two and three infectious passengers, relative exposure was reduced by 35.1%-38.2% and 35.9%-39.4%, respectively. The results of this study indicate that risk of exposure can be reduced by implementing physical distancing in aircrafts.

SARS-CoV-2 seropositivity and subsequent infection risk in healthy young adults: a prospective cohort study

In order to determine the infection risk in young adults, researchers evaluated protection by seropositivity against reinfection of SARS-CoV-2 in a largely male, healthy, cohort of Marines ages 18-20. They utilized the COVID-19 Health Action Response for Marines (CHARM) longitudinal prospective cohort study to identify infection and immune response. PCR testing was conducted from May 11 to August 24, 2020 at one site and from August 24 to November 2, 2020 at another site. The amount of SARS-CoV-2 IgG antibodies and serum virus neutralizing activity were measured. Overall, results showed that those with COVID-19 antibodies had reduced incidence of reinfection by 82%. Additionally, those that were seropositive and infected had lower antibody levels and were less likely to have neutralizing antibodies in comparison to those who were seropositive and not infected. Researchers concluded that antibodies are protective but may not entirely prevent
reinfection. They also discussed that it is unclear if transmission is likely among those vaccinated and those who have already been infected with COVID-19 before; however, they found that some reinfected people may be able to transmit the infection as much as those who are infected for the first time. In conclusion, reinfection is possible at one-fifth the rate of naive infection, and vaccination may be necessary even in young adults who are seropositive.

**UNIVERSAL SCREENING AND TESTING**

_Polyester nasal swabs collected in a dry tube are a robust and inexpensive, minimal self-collection kit for SARS-CoV-2 testing_12

This study evaluated the alternatives to SARS-CoV-2 collection devices and medias to identify a cheaper and efficacious mode of collection through polyester nasal swabs. Comparing polyester swabs to foam swabs in simulated nasal swabbing, polyester swabs were shown to absorb 150% more than foam swabs. When evaluating stability of the dry polyester, dry foam, and polyester in saline swabs after the swabbing simulation, all swabs demonstrated stability up to 48 hours and without a cold chain. For the stability of human matrix and clinical specimens, stability up to 72 hours in cold storage and at least up to 48 hours in warmer conditions was seen for the dry polyester swab. In assessing the feasibility of dry polyester swabs for home-based swabbing for adults and children, all home-collected specimens were suitable for testing even though their return time to the lab differed (< 24 hours, 25-48 hours, 49-80 hours, or >80 hours). Findings demonstrated the utility of dry polyester swabs as an inexpensive and useful method of specimen collection for COVID-19 testing.

**ADDITIONAL RESOURCES**

UCSF Library COVID-19 Research and Information Resources
UCSF Institute for Global Health Sciences COVID-19 Resources
UC Davis One Health Institute COVID-19 FAQs
Harvard Viswanath Lab Myths vs Facts
Accesocovid.com

**Note on this Document:** This document was assembled by undergraduate and doctoral students attending the University of California, Los Angeles and the University of California, San Francisco with the intent of facilitating the rapid dissemination of information to the global community. Alyssa Bercasio, Sara Covin, Elsa Dubil, Amaka Enueme, Sarah Gallalee, Hannah Han, Griffith Hughes, Anika Kalra, Jiho Kim, and Micaela Reyna contributed to these summaries. This work is volunteer based.

**References:**


