FLUIDIGM®

Mass Cytometry in COVID-19 Research

As of October 9, 2020

Publications, Preprints and Clinical Research Trials

Mass cytometry, powered by CyTOF® technology, is being used in dozens of labs around the world as well as several large consortia to understand the immune response to COVID-19 infection and provide critical information needed for the development and design of therapies and vaccines. The following is a current list of publications and clinical research trials where CyTOF is being utilized.

Publications

1 Arunachalam, P.S. et al. "Systems biological assessment of immunity to mild versus severe COVID-19 infection in humans." *Science* 369 (2020): 1,210–1,220.

2 Goshen-Lago, T. et al. "The potential role of immune alteration in the cancer-COVID19 equation—a prospective longitudinal study." *Cancers* 12 (2020): E2421.

3 Gruber, C. et al. "Mapping systemic inflammation and antibody responses in multisystem inflammatory syndrome in children (MIS-C)." *Cell* (2020): doi:10.1016/j.cell.2020.09.034

4 Hadjadj, J. et al. "Impaired type I interferon activity and inflammatory responses in severe COVID-19 patients." *Science* 369 (2020): 718–724.

5 Leng, Z. et al. "Transplantation of ACE2– mesenchymal stem cells improves the outcome of patients with COVID-19 pneumonia." *Aging and Disease* 11 (2020): 216–228.

6 Neidleman, J. et al. "SARS-CoV-2-specific T cells exhibit unique features characterized by robust helper function, lack of terminal differentiation, and high proliferative potential." *Cell Reports Medicine* (2020): 100081.

7 Ouyang, Y. et al. "Down-regulated gene expression spectrum and immune responses changed during the disease progression in COVID-19 patients." *Clinical Infectious Diseases* (2020): ciaa462.

8 Rodriguez, L. et al. "Systems-level immunomonitoring from acute to recovery phase of severe COVID-19." *Cell Reports Medicine* (2020): 100078.

9 Schulte-Schrepping, J. et al. "Severe COVID-19 is marked by a dysregulated myeloid cell compartment." *Cell* (2020): 1419–1440.e23.

10 Shi, H. et al. "The inhibition of IL-2/IL-2R gives rise to CD8+ cell and lymphocyte decrease through JAK1-STAT5 in critical patients with COVID-19 pneumonia." *Cell Death & Disease* 11 (2020): 429.

11 Silvin, A. et al. "Elevated calprotectin and abnormal myeloid cell subsets discriminate severe from mild COVID-19." *Cell* (2020): 1401–1418.e18.

12 Vanderbeke, L. et al. "Monocyte-driven atypical cytokine storm and aberrant neutrophil activation as key mediators of COVID19 disease severity." *Immunity* (2020): doi:10.2139/ssrn.3646561.

13 Wang, W. et al. “High-dimensional immune profiling by mass cytometry revealed immunosuppression and dysfunction of immunity in COVID-19 patients.” *Cellular & Molecular Immunology* 17 (2020): 650–652.

14 Wei, L. et al. “Dysregulation of the immune response affects the outcome of critical COVID-19 patients.” *Proceedings of the Journal of Medical Virology* (2020): jmv.26181.

15 Zhang, Y. et al. “Inflammatory response cells during acute respiratory distress syndrome in patients with coronavirus disease 2019 (COVID-19).” *Annals of Internal Medicine* 11 (2020): doi:10.7326/L20-0227.

16 Zheng, Y. et al. “A human circulating immune cell landscape in aging and COVID-19.” *Protein & Cell* (2020): 740–770.

Reviews and Commentary

1 Charney, A.W. et al. “Sampling the host response to SARS-CoV-2 in hospitals under siege.” *Nature* Medicine 26 (2020): 1,157–1,158.

2 Tan, A.S. et al. “The virological, immunological, and imaging approaches for COVID-19 diagnosis and research.” *SLAS Technology* (2020): 2472630320950248.

Preprints

1 Adamo, S. et al. “Lymphopenia-induced T cell proliferation is a hallmark of severe COVID-19.” *bioRxiv* (2020): doi:10.1101/2020.08.04.236521.

2 Barone, S.M. et al. “Unsupervised machine learning reveals key immune cell subsets in COVID-19, rhinovirus infection, and cancer therapy.” *bioRxiv* (2020): doi:10.1101/2020.07.31.190454.

3 Basar, R. et al. “Generation of glucocorticoid resistant SARS-CoV-2 T-cells for adoptive cell therapy.” *bioRxiv* (2020): doi.org/10.1101/2020.09.15.298547.

4 Bolouri, H. et al. “The COVID-19 immune landscape is dynamically and reversibly correlated with disease severity.” *bioRxiv* (2020): doi.org/10.1101/2020.09.18.303420.

5 Chevrier, S. et al. “A distinct innate immune signature marks progression from mild to severe COVID-19.” *bioRxiv* (2020): doi:10.1101/2020.08.04.236315.

6 Geanon, D. et al. “A streamlined CyTOF® workflow to facilitate standardized multi-site immune profiling of COVID-19 patients.” *medRxiv* (2020): doi:10.1101/2020.06.26.20141341.

7 Kared, H. et al. “CD8+ T cell responses in convalescent COVID-19 individuals target epitopes from the entire SARS-CoV-2 proteome and show kinetics of early differentiation.” *bioRxiv* (2020): doi:10.1101/2020.10.08.330688.

8 Livanos, A.E. et al. “Gastrointestinal involvement attenuates COVID-19 severity and mortality.” *medRxiv* (2020): doi.org/10.1101/2020.09.07.20187666.

9 Morrissey, S. et al. “Emergence of low-density inflammatory neutrophils correlates with hypercoagulable state and disease severity in COVID-19 patients.” *medRxiv* (2020): doi:/10.1101/2020.05.22.20106724.

10 Padgett, L.E. et al. “Interplay of monocytes and T lymphocytes in COVID-19 severity.” *bioRxiv* (2020): doi:10.1101/2020.07.17.209304.

11 Roussel, M. et al. “Mass cytometry and artificial intelligence define CD169 as a specific marker of SARS-CoV2-induced acute respiratory distress syndrome.” *bioRxiv* (2020): doi.org/10.1101/2020.09.22.307975.

12 Schulien, I. et al. “Ex vivo detection of SARS-CoV-2-specific CD8+ T cells: rapid induction, prolonged contraction, and formation of functional memory.” *bioRxiv* (2020): doi:10.1101/2020.08.13.249433.

13 Schwabenland, M. et al. “Deep spatial profiling of COVID-19 brains reveals neuroinflammation by compartmentalized local immune cell interactions and targets for intervention.” *Research Square* (2020): doi:10.21203/rs.3.rs-63687/v1.

Clinical Research Trials

Immunophenotyping Assessment in a COVID-19 Cohort (IMPACC) (NCT04378777)

Sponsor: National Institute of Allergy and Infectious Disease (NIAID); 12 participating institutions in North America

“This surveillance study will collect detailed clinical, laboratory, and radiographic data in coordination with biologic sampling of blood and respiratory secretions and viral shedding in nasal secretions in order to identify immunophenotypic and genomic features of COVID-19-related susceptibility and/or progression. The aim: for the results obtained from this study to assist in generating hypotheses for effective host-directed therapeutic interventions, to help to prioritize proposals for such interventions, and/or optimize timing for administration of host-response directed therapeutics.”

In-Depth Immunological Investigation of COVID-19. (COntAGIouS) (NCT04327570)

Sponsor: Universitaire Ziekenhuizen Leuven

“The COntAGIouS trial (COvid-19 Advanced Genetic and Immunologic Sampling; an in-depth characterization of the dynamic host immune response to coronavirus SARS-CoV-2) proposes a transdisciplinary approach to identify host factors resulting in hyper-susceptibility to SARS-CoV-2 infection, which is urgently needed for directed medical interventions.

“The overall aim of this prospective study is to provide an in-depth characterization of clinical and immunological features of patients hospitalized in UZ Leuven because of SARS-CoV-2 infection. Assessed characteristics will be compared between severe and non-severe COVID-19 patients, and between COVID-19.”

Prospective Natural History Study of Smoking, Immune Cell Profiles, Epigenetics and COVID-19 (NCT04403386)

Sponsor: National Institute of Environmental Health Sciences (NIEHS)

“This study is a prospective, longitudinal, observational, single-center, exploratory study to collect samples and data that will enable explorations of the interaction between smoking, immune system characteristics and Coronavirus Disease 2019 (COVID-19). This study will collect baseline samples and data prior to COVID-19 infection required to explore these interactions prospectively. Early evidence in the COVID-19 pandemic suggests that smokers have higher risk for morbidity and mortality associated with COVID-19 infection. We have identified smoking-associated altered epigenetics, transcription and changes in immune cell profiles. We propose that the immune system senescence associated with prior smoking is a susceptibility factor in COVID-19 morbidity.”

Mesenchymal Stem Cell for Acute Respiratory Distress Syndrome Due for COVID-19 (COVID-19) (NCT04416139)

Sponsor: Instituto Nacional de Ciencias Medicas y Nutricion Salvador Zubiran

"Acute Respiratory Distress Syndrome (ARDS) is the main cause of death from COVID-19. One of the main mechanisms for ARDS is the violent storm of cytokines and chemokines, which cause uncontrolled fatal systemic inflammation by the immune system on the body, with additional multiple organ failure. ...

"The plasticity of Mesenchymal Stem Cells (MSC) regulates inflammation and immunity. ... IV application of allogeneic MSC has been shown to control the inflammatory response in various diseases, such as the graft-versus-host reaction and the ARDS caused by H5NI.

"The objective of this study is to describe the clinical changes secondary to IV administration of allogeneic MSC, in patients with bilateral COVID-19 pneumonia complicated by severe ARDS ..."

Systematic Assessment of SARS-CoV-2 Neurotropic Capacity in Modestly and Critically Ill Patients, and Patients Who Died From COVID-19 (NCT04472013)

Sponsor: University Hospital, Basel, Switzerland

"This study is to analyze the microglia reaction or direct neurotropic effects of CNS COVID-19 in pathogenesis and brain stem dysfunction in critically ill patients. ...

"Primary endpoints of this project are the multidimensional integration of the analysis from the procedures described above and assessment of the correlation between the gained clinical data (MRI, mental/neurological state), the body fluid proteomic and mass-cytometric analysis (CSF and Plasma proteomics, peripheral blood mass cytometry) and the CODEX analysis of defined brain regions on autopsy specimens."