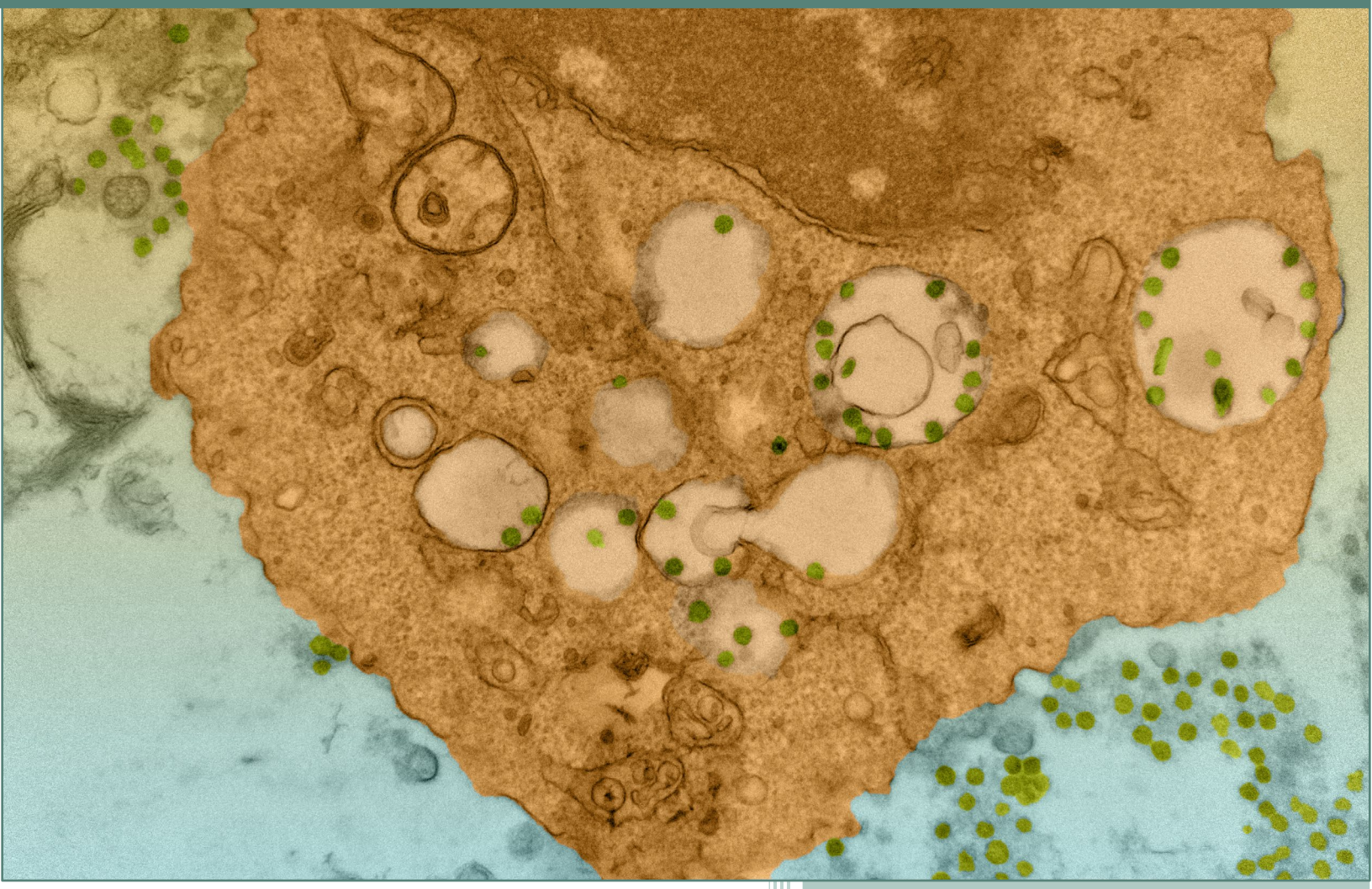
2021 Annual Report



NEIDL

Boston University National Emerging Infectious Diseases Laboratories

BOSTON UNIVERSITY

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Picture on front cover: Macrophage engulfing SARS-CoV-2 particles (green/yellow) in infected human lung tissue. Courtesy of Douam Lab.

Boston University National Emerging Infectious Diseases Laboratories

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Letter from the Director

As I write this annual letter, the United States finds itself in the midst of yet another surge of COVID-19 cases, caused by the latest variant of concern, the SARS-CoV-2 "delta" variant. This surge was largely avoidable. Had our fellow Americans better embraced the available and highly efficacious vaccines, we would be in a far better place. I, like others, worry about how our public health advances that resulted in the elimination of diseases like smallpox and polio would have been different had the current environment of vaccine hesitancy and politicization of public health measures existed when those vaccines were first made available. The continued suffering and increased deaths are a tragedy we need to come to grips with, at the same time other parts of the world, desperate to obtain vaccines, remain under-vaccinated. Consequently, the virus continues to circulate widely, likely destined to become a pathogen that we will have to contend with for years to come.

In the face of the global pandemic, the faculty and staff of the NEIDL have continued their work throughout the 20 months since the virus emerged. Many of them have continued to focus on SARS-CoV-2 and have worked to contribute to our understanding of the virus, the disease it causes, and to test the efficacy of novel therapeutics and vaccines. A list of the publications resulting from our work can be found later in this report. There was a significant amount of important work contributed by NEIDL faculty, and it is impossible to highlight them all. Among the many contributions that have been published, NEIDL scientists demonstrated that mutations that arise in the SARS-CoV-2 spike during persistent infection foreshadowed mutations that would arise in the circulating spike variants (Griffiths and colleagues). They were also the first to demonstrate that infection stimulates rapid intrinsic inflammatory responses in human type 2 alveolar cells, using a model (generated in collaboration with scientists in the Center for Regenerative Medicine) that continues to provide important information on how lung cells respond to the virus (Mühlberger, Saeed and colleagues). Our investigators have provided some of the first high throughput data identifying classes of inhibitors, the first step in developing therapeutics, for the SARS-CoV-2 virus (Davey laboratory). Much of the work that was undertaken was the result of the establishment of the Massachusetts Consortium on Pathogen Readiness, who not only funded some of our work, but were a source of new collaborations which continue to today to advance our studies into areas that would have otherwise not been possible.

NEIDL faculty also used their expertise to contribute directly to the public health enterprise during the course of the pandemic and will continue to do so. For example, our investigators, led by John Connor, have helped Boston University identify the SARS-CoV-2 variants of concern circulating on our campus, and kept the City and State informed of the results. David Hamer served as an advisor for Boston University's continuing efforts to help keep our campus safe during the outbreak. The protocols that were developed ensured that anyone who was infected could be identified early, and that any close contacts could be quarantined and followed accordingly. Fortunately, few of our staff were infected in the community, and early identification, quarantine and contact tracing kept others safe, and thus we were able to continue working throughout the pandemic, as we do today.

Our research programs were not just focused on SARS-CoV-2, but on a number of other important pathogens that continue to be threats to human health. These include enteroviruses, mosquito borne viruses, Respiratory Syncytial Virus, and Lassa Fever Virus to highlight a few. Of course, work continues on filoviruses, including Marburg Virus and

Ebola Viruses. The new outbreaks in West Africa remind us that these viruses remain important human pathogens, and continue to evolve and show up in new locations.

As the NEIDL has ramped up its research and operations over the last several years, many of us have noted that linking our activities to the policy and preparedness arenas has not been possible. This gap now has a champion in one of our faculty, Nahid Bhadelia, who has become the founding director of the BU Center for Emerging Infectious Diseases Policy and Research (BU CEID) to help fill this gap. While its initial home is within the NEIDL, we anticipate it rapidly outgrowing its space as its membership and programming increases, but we are delighted to enjoy the opportunities its presence brings to NEIDL investigators who are normally engrossed in otherwise "wet bench" research. Even after it moves, Dr. Bhadelia will remain associated with the NEIDL as an Associate Director, to help keep us grounded to the needs of pandemic policy and preparedness.

Our ability to continue our work required everyone working together – not only the scientific staff and trainees, but also our security team, facility engineers and mechanics, environmental health and safety professionals, and our information technology staff. None of the science could be done without this group of talented staff, and we all remain indebted to them for their important contributions during this trying period. Activities carried out by Facilities and Environmental Health and Safety staff are highlighted in this report. At the same time, we have continued to do our best to keep the community informed of the work that we are doing through the efforts of our community relations team, led by Valeda Britton. This team also spearheaded a number of activities to educate the community on what we do in the NEIDL, activities that are included in this report as well.

Ronald B. Corley, Ph.D.

Professor of Microbiology
Director, National Emerging Infectious Diseases Laboratories
September 1, 2021

Mission Statement

The Boston University National Emerging Infectious Diseases Laboratories (NEIDL) mission is to generate and translate fundamental knowledge on high priority emerging infectious diseases for the benefit of the public health, locally, nationally, and globally.

Emerging infectious diseases are defined as those that have newly appeared and been recognized in the population or have existed but are rapidly increasing in incidence or in geographic range. To meet our missions the NEIDL will:

1. Perform innovative basic, translational, and clinical research on emerging infectious diseases, especially those NIH/NIAID identifies as high Priority Category A, B, and C pathogens, in order to develop diagnostic tests, treatments and vaccines to promote the public's health.

2. Provide education and training in these areas of research, in order to develop the next generation of scientists in this field, and to support a national response in the event of a biodefense emergency.

3. Establish a research facility with the highest attention to community and laboratory safety and security.

Strategic Goals

To successfully fulfill its mission, NEIDL has developed and is implementing a strategic plan to:

i. Partner with academic departments across the university to recruit a cadre of investigators, as well as to develop research staff with expertise in the scientific disciplines required to investigate the pathogenesis of emerging infectious diseases caused by category A, B and C agents. We encourage and support the development of national and international research collaborations in order to carry out our mission.

ii. Develop physiologically relevant models for the comparative study of these pathogens, mimicking as closely as possible the human disease process. Not only does this require that we recruit faculty with expertise in animal modeling and veterinarian pathology, but also develop the needed services to support these investigations.

iii. Move promising basic research as rapidly as possible to translational, preclinical, and clinical research in animals and humans in partnership with appropriate collaborators.

iv. Create and establish the methodologies needed to advance the development and testing of vaccines, therapeutics, and diagnostics for these agents.

v. Train scientists and related support personnel in the requirements to perform maximum containment research in a safe and secure environment.

vi. Maintain the flexibility needed to support a national response in the event of a biodefense emergency.

vii. Ensure a "safety first" environment for the conduct of all activities in the NEIDL

NEIDL by the numbers

Core Faculty	14	Faculty with laboratory and office space in the NEIDL facility
Affiliated Faculty	8	Faculty with laboratory and office space at other campus locations
Total Faculty	22	

Trainees	38	Postdoctoral fellows, graduate and undergraduate students
Visiting Scientists	3	Scientists from other Institutions
Staff	103	Salaried employees working in support of NEIDL research

Total sponsored projects funded	72
Core Faculty	54
Affiliate Faculty	18

Total Amount Funded
$ 33.3 MM

Total Publications	111
Publications with Multiple NEIDL co-authors	28

0	Facility Tours (COVID-19 Pandemic got in the Way)
21	Virtual NEIDL community outreach events

BSL-3 trained staff	24
BSL-4 trained staff	45

Research Publications

The NEIDL faculty continue to publish innovative studies in high impact journals, many of them collaborative efforts with other Boston University faculty, or faculty at other institutions.

As a result of the rapid need to disseminate novel information during the COVID-19 pandemic, the research community increasingly took advantage of posting their data in "preprint" format, so that information could be made available to the community as early as possible. These include bioRxiv and medRxiv, and a number of the publications listed below were posted on these servers. Note these have not been subjected to peer review, but most of the data were also submitted for review and published at a later time.

Publications marked with a red asterisk * are coauthored by 2 or more **NEIDL core faculty** (blue font) or **Associate Faculty** (black font).

Scientific consensus on the COVID-19 pandemic: we need to act now.
Alwan NA, Burgess RA, Ashworth S, Beale R, **Bhadelia N**, Bogaert D, Dowd J, Eckerle I, Goldman LR, Greenhalgh T, Gurdasani D, Hamdy A, Hanage WP, Hodcroft EB, Hyde Z, Kellam P, Kelly-Irving M, Krammer F, Lipsitch M, McNally A, McKee M, Nouri A, Pimenta D, Priesemann V, Rutter H, Silver J, Sridhar D, Swanton C, Walensky RP, Yamey G, Ziauddeen H. Lancet. 2020 Oct 31;396(10260):e71-e72. doi: 10.1016/S0140-6736(20)32153-X. Epub 2020 Oct 15.PMID: 33069277 .

Early administration of interleukin-6 inhibitors for patients with severe COVID-19 disease is associated with decreased intubation, reduced mortality, and increased discharge. *
Sinha P, Mostaghim A, Bielick CG, McLaughlin A, **Hamer DH**, Wetzler LM, **Bhadelia N**, Fagan MA, Linas BP, Assoumou SA, Ieong MH, Lin NH, Cooper ER, Brade KD, White LF, Barlam TF, Sagar M; Boston Medical Center Covid-19 Treatment Panel. Int J Infect Dis. 2020 Oct;99:28-33. doi: 10.1016/j.ijid.2020.07.023. Epub 2020 Jul 25.PMID: 32721528

A clinician's primer on epidemiology for COVID-19.
Rashid A, Sy KTL, Cabrejas JM, Nichols BE, **Bhadelia N**, Murray EJ. Med (N Y). 2021 Apr 9;2(4):384-394. doi: 10.1016/j.medj.2021.02.007. Epub 2021 Feb 27.PMID: 33681831 Review.

Factors associated with progression to death in patients with Lassa fever in Nigeria: an observational study. *
Strampe J, Asogun DA, Speranza E, Pahlmann M, Soucy A, Bockholt S, Pallasch E, Becker-Ziaja B, Duraffour S, **Bhadelia N**, Ighodalo Y, Oyakhilome J, Omomoh EO, Olokor T, Adomeh DI, Ikponwonsa O, Aire C, Tobin E, Akpede N, Okokhere PO, Okogbenin SA, Akpede GO, Muñoz-Fontela C, Ogbaini-Emovon E, Günther S, **Connor JH**, Oestereich L. Lancet Infect Dis. 2021 Jun;21(6):876-886. doi: 10.1016/S1473-3099(20)30737-4. Epub 2021 Jan 20.PMID: 33484646

Neurologic Findings Among Inpatients With COVID-19 at a Safety-net US Hospital. *
Anand P, Zhou L, **Bhadelia N**, **Hamer DH**, Greer DM, Cervantes-Arslanian AM. Neurol Clin Pract. 2021 Apr;11(2):e83-e91. doi: 10.1212/CPJ.0000000000001031.PMID: 33842075

Novel ELISA Protocol Links Pre-Existing SARS-CoV-2 Reactive Antibodies With Endemic Coronavirus Immunity and Age and Reveals Improved Serologic Identification of Acute COVID-19 *via* Multi-Parameter Detection. *
Yuen RR, Steiner D, Pihl RMF, Chavez E, Olson A, Smith EL, Baird LA, Korkmaz F, Urick P, Sagar M, Berrigan JL, **Gummuluru S**, **Corley RB**, Quillen K, Belkina AC, Mostoslavsky G, Rifkin IR, Kataria Y, Cappione AJ 3rd, Gao W, Lin NH, **Bhadelia N**, Snyder-Cappione JE. Front Immunol. 2021 Apr 9;12:614676. doi: 10.3389/fimmu.2021.614676. eCollection 2021.PMID: 33897682

Institutional policies and readiness in management of critical illness among patients with viral hemorrhagic fever.
DiLorenzo MA, Baker CA, Herstein JJ, Evans L, Lowe JJ, Gibbs SG, **Bhadelia N.** Infect Control Hosp Epidemiol. 2021 Feb 15:1-6. doi: 10.1017/ice.2020.1416. Online ahead of print.PMID: 33583468

Science, not speculation, is essential to determine how SARS-CoV-2 reached humans. *
Calisher CH, Carroll D, Colwell R, **Corley RB**, Daszak P, Drosten C, Enjuanes L, Farrar J, Field H, Golding J, Gorbalenya AE, Haagmans B, Hughes JM, **Keusch GT**, Lam SK, Lubroth J, Mackenzie JS, Madoff L, Mazet JK, Perlman SM, Poon L, Saif L, Subbarao K, Turner M. Lancet. 2021 Jul 17;398(10296):209-211. doi: 10.1016/S0140-6736(21)01419-7. Epub 2021 Jul 5.PMID: 34237296

SARS-CoV-2 Infection of Pluripotent Stem Cell-Derived Human Lung Alveolar Type 2 Cells Elicits a Rapid Epithelial-Intrinsic Inflammatory Response. *
Huang J, Hume AJ, Abo KM, Werder RB, Villacorta-Martin C, Alysandratos KD, Beermann ML, Simone-Roach C, Lindstrom-Vautrin J, Olejnik J, Suder EL, Bullitt E, Hinds A, Sharma A, **Bosmann M**, Wang R, Hawkins F, Burks EJ, **Saeed M**, Wilson AA, **Mühlberger E**, Kotton DN. Cell Stem Cell. 2020 Dec 3;27(6):962-973.e7. doi: 10.1016/j.stem.2020.09.013. Epub 2020 Sep 18.PMID: 32979316

Bacterial polyphosphates interfere with the innate host defense to infection.
Roewe J, Stavrides G, Strueve M, Sharma A, Marini F, Mann A, Smith SA, Kaya Z, Strobl B, Mueller M, Reinhardt C, Morrissey JH, **Bosmann M.** Nat Commun. 2020 Aug 12;11(1):4035. doi: 10.1038/s41467-020-17639-x.PMID: 32788578

Gut Microbiota Restricts NETosis in Acute Mesenteric Ischemia-Reperfusion Injury.
Ascher S, Wilms E, Pontarollo G, Formes H, Bayer F, Müller M, Malinarich F, Grill A, **Bosmann M**, Saffarzadeh M, Brandão I, Groß K, Kiouptsi K, Kittner JM, Lackner KJ, Jurk K, Reinhardt C. Arterioscler Thromb Vasc Biol. 2020 Sep;40(9):2279-2292. doi: 10.1161/ATVBAHA.120.314491. Epub 2020 Jul 2.PMID: 32611241

Complement Activation during Critical Illness: Current Findings and an Outlook in the Era of COVID-19.
Bosmann M. Am J Respir Crit Care Med. 2020 Jul 15;202(2):163-165. doi: 10.1164/rccm.202005-1926ED.PMID: 32437622 .

STAT1 Isoforms Differentially Regulate NK Cell Maturation and Anti-tumor Activity.
Meissl K, Simonović N, Amenitsch L, Witalisz-Siepracka A, Klein K, Lassnig C, Puga A, Vogl C, Poelzl A, **Bosmann M**, Dohnal A, Sexl V, Müller M, Strobl B. Front Immunol. 2020 Sep 11;11:2189. doi: 10.3389/fimmu.2020.02189. eCollection 2020.PMID: 33042133

Response by Ascher et al to Letter Regarding Article, "Gut Microbiota Restricts NETosis in Acute Mesenteric Ischemia-Reperfusion Injury".
Ascher S, Wilms E, Pontarollo G, Kiouptsi K, Malinarich F, Kittner JM, **Bosmann M**, Jurk K, Reinhardt C. Arterioscler Thromb Vasc Biol. 2021 Jan;41(1):e74-e75. doi: 10.1161/ATVBAHA.120.315541. Epub 2020 Dec 23.PMID: 33356371 .

Fatal neuroinvasion of SARS-CoV-2 in K18-hACE2 mice is partially dependent on hACE2 expression. *
Carossino M, Montanaro P, O'Connell A, Kenney D, Gertje H, Grosz KA, Kurnick SA, **Bosmann M**, **Saeed M,** Balasuriya UBR, **Douam F, Crossland NA**. bioRxiv. 2021 Jan 15:2021.01.13.425144. doi: 10.1101/2021.01.13.425144. Preprint. PMID: 33469581

Complement control for COVID-19.
Bosmann M. Sci Immunol. 2021 May 25;6(59):eabj1014. doi: 10.1126/sciimmunol.abj1014.PMID: 34035117

Pro- and Antitumorigenic Capacity of Immunoproteasomes in Shaping the Tumor Microenvironment.
Leister H, Luu M, Staudenraus D, Lopez Krol A, Mollenkopf HJ, Sharma A, Schmerer N, Schulte LN, Bertrams W, Schmeck B, **Bosmann M**, Steinhoff U, Visekruna A. Cancer Immunol Res. 2021 Mar 11. doi: 10.1158/2326-6066.CIR-20-0492. Online ahead of print.PMID: 33707310

Actionable Cytopathogenic Host Responses of Human Alveolar Type 2 Cells to SARS-CoV-2. *
Hekman RM, Hume AJ, Goel RK, Abo KM, Huang J, Blum BC, Werder RB, Suder EL, Paul I, Phanse S, Youssef A, Alysandratos KD, Padhorny D, Ojha S, Mora-Martin A, Kretov D, Ash PEA, Verma M, Zhao J, Patten JJ, Villacorta-Martin C, Bolzan D, Perea-Resa C, Bullitt E, Hinds A, Tilston-Lunel A, Varelas X, Farhangmehr S, Braunschweig U, Kwan JH, McComb M, Basu A, **Saeed M**, Perissi V, Burks EJ, Layne MD, **Connor JH**, **Davey R**, Cheng JX, Wolozin BL, Blencowe BJ, Wuchty S, Lyons SM, Kozakov D, Cifuentes D, Blower M, Kotton DN, Wilson AA, **Mühlberger E**, Emili A. Mol Cell. 2020 Dec 17;80(6):1104-1122.e9. doi: 10.1016/j.molcel.2020.11.028. Epub 2020 Nov 19.PMID: 33259812

Macrophages govern antiviral responses in human lung tissues protected from SARS-CoV-2 infection. *
KenLuthraney DJ, O'Connell AK, Turcinovic J, Montanaro P, Hekman RM, Tamura T, Berneshawi AR, Cafiero TR, Abdullatif SA, Blum B, Goldstein SI, Heller BL, Gertje HP, Bullitt E, Trachtenberg AJ, Chavez E, Sheikh A, Kurnick S, Grosz K, **Bosmann M**, Ericsson M, Huber BR, **Saeed M**, Balazs AB, Francis KP, Klose A, Paragas N, Campbell JD, **Connor JH**, Emili A, **Crossland NA**, Ploss A, **Douam F**. 2021. bioRxiv doi:10.1101/2021.07.17.452554:2021.07.17.452554. *Submitted*

SARS-CoV-2 desensitizes host cells to interferon through inhibition of the JAK-STAT pathway.*
Chen DY, Khan N, Close BJ, Goel RK, Blum B, Tavares AH, Kenney D, Conway HL, Ewoldt JK, Kapell S, Chitalia VC, **Crossland NA**, Chen CS, Kotton DN, Baker SC, **Connor JH, Douam F,** Emili A**, Saeed M**. bioRxiv. 2020 Oct 28:2020.10.27.358259. doi: 10.1101/2020.10.27.358259. Preprint. PMID: 33140044

SARS-CoV-2 disrupts proximal elements in the JAK-STAT pathway. *
Chen DY, Khan N, Close BJ, Goel RK, Blum B, Tavares AH, Kenney D, Conway HL, Ewoldt JK, Chitalia VC, **Crossland NA**, Chen CS, Kotton DN, Baker SC, Fuchs SY, **Connor JH**, **Douam F**, Emili A, **Saeed M**.J Virol. 2021 Jul 14:JVI0086221. doi: 10.1128/JVI.00862-21. Online ahead of print.PMID: 34260266

A mosquito small RNA genomics resource reveals dynamic evolution and host responses to viruses and transposons.*
Ma Q, Srivastav SP, Gamez S, Dayama G, Feitosa-Suntheimer F, Patterson EI, Johnson RM, Matson EM, Gold AS, Brackney DE, **Connor JH**, **Colpitts TM**, Hughes GL, Rasgon JL, Nolan T, Akbari OS, **Lau NC**. Genome Res. 2021 Mar;31(3):512-528. doi: 10.1101/gr.265157.120. Epub 2021 Jan 8.PMID: 33419731

Examining the Role of Niemann-Pick C1 Protein in the Permissiveness of Aedes Mosquitoes to Filoviruses. *
Gold AS, Feitosa-Suntheimer F, Asad S, Adeoye B, **Connor JH**, **Colpitts TM**. ACS Infect Dis. 2020 Aug 14;6(8):2023-2028. doi: 10.1021/acsinfecdis.0c00018. Epub 2020 Jul 15.PMID: 32609483

Forebrain neural precursor cells are differentially vulnerable to Zika virus infection.
Shelton SM, Soucy AR, Kurzion R, Zeldich E, **Connor JH**, Haydar TF.eNeuro. 2021 Jul 16:ENEURO.0108-21.2021. doi: 10.1523/ENEURO.0108-21.2021. Online ahead of print.PMID: 34272257

Quantification of Viral and Host Biomarkers in the Liver of Rhesus Macaques: A Longitudinal Study of Zaire Ebolavirus Strain Kikwit (EBOV/Kik). *
Greenberg A, Huber BR, Liu DX, Logue JP, Hischak AMW, Hart RJ, Abbott M, Isic N, Hisada YM, Mackman N, Bennett RS, Hensley LE, **Connor JH, Crossland NA.** Am J Pathol. 2020 Jul;190(7):1449-1460. doi: 10.1016/j.ajpath.2020.03.003. Epub 2020 Apr 8.PMID: 32275904

Configurable Digital Virus Counter on Robust Universal DNA Chips.
Seymour E, Ünlü NL, Carter EP, **Connor JH**, Ünlü MS. ACS Sens. 2021 Jan 22;6(1):229-237. doi: 10.1021/acssensors.0c02203. Epub 2021 Jan 11.PMID: 33427442

Vibrational Spectroscopic Detection of a Single Virus by Mid-Infrared Photothermal Microscopy.
Zhang Y, Yurdakul C, Devaux AJ, Wang L, Xu XG, **Connor JH**, Ünlü MS, Cheng JX. Anal Chem. 2021 Mar 2;93(8):4100-4107. doi: 10.1021/acs.analchem.0c05333. Epub 2021 Feb 17.PMID: 33596049

Maladaptive oxidative stress cascade drives type I interferon hyperactivity in TNF activated macrophages promoting necrosis in murine tuberculosis granulomas. *
Brownhill, E., Yabaji, S. M., Zhernovkov, V., Rukhlenko, O. S., Seidel, K., Bhattacharya, B., Chatterjee, S., Chen, H. A., **Crossland, N.,** Bishai, W., Kholodenko, B. N., Gimelbrant, A., Kobzik, L. & **Kramnik, I.** 2020. bioRxiv, 2020.12.14.422743.

Recombinant subtype A and B human respiratory syncytial virus clinical isolates co-infect the respiratory tract of cotton rats. *
Rennick LJ, Nambulli S, Lemon K, Olinger GY, **Crossland NA**, Millar EL, **Duprex WP**.J Gen Virol. 2020 Oct;101(10):1056-1068. doi: Re: Invitation: Nico Observations Wilson - Question Prep for ABA meeting @ Tue Aug 10, 2021 4pm - 4:15pm (EDT) (bettina.durkop@gmail.com)10.1099/jgv.0.001471.PMID: 32723429

Lung-resident memory B cells protect against bacterial pneumonia. *
Barker KA, Etesami NS, Shenoy AT, Arafa EI, de Ana CL, Smith NM, Martin IM, Goltry WN, Barron AM, Browning JL, Kathuria H, Belkina AC, Guillon A, Zhong X, **Crossland NA**, Jones MR, Quinton LJ, **Mizgerd JP**. J Clin Invest. 2021 Jun 1;131(11):e141810. doi: 10.1172/JCI141810.PMID: 34060477

Inhalable Nanobody (PiN-21) prevents and treats SARS-CoV-2 infections in Syrian hamsters at ultra-low doses. *
Nambulli S, Xiang Y, Tilston-Lunel NL, Rennick LJ, Sang Z, Klimstra WB, Reed DS, **Crossland NA**, Shi Y, **Duprex WP**. bioRxiv. 2021 Feb 23:2021.02.23.432569. doi: 10.1101/2021.02.23.432569. Preprint. PMID: 33655253 Updated.

Elucidation of remdesivir cytotoxicity pathways through genome-wide CRISPR-Cas9 screening and transcriptomics.
Akinci E, Cha M, Lin L, Yeo G, Hamilton MC, Donahue CJ, Bermudez-Cabrera HC, Zanetti LC, Chen M, Barkal SA, Khowpinitchai B, Chu N, Velimirovic M, Jodhani R, Fife JD, Sovrovic M, Cole PA, **Davey RA**, Cassa CA, Sherwood RI. bioRxiv. 2020 Aug 28:2020.08.27.270819. doi: 10.1101/2020.08.27.270819. Preprint. PMID: 32869031

Pyronaridine tetraphosphate efficacy against Ebola virus infection in guinea pig.
Lane TR, Massey C, Comer JE, Freiberg AN, Zhou H, Dyall J, Holbrook MR, Anantpadma M, **Davey RA**, Madrid PB, Ekins S. Antiviral Res. 2020 Sep;181:104863. doi: 10.1016/j.antiviral.2020.104863. Epub 2020 Jul 16.PMID: 32682926

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High-Throughput Screening Assay to Identify Small Molecule Inhibitors of Marburg Virus VP40 Protein.
Luthra P, Anantpadma M, De S, Sourimant J, **Davey RA**, Plemper RK, Basler CF. ACS Infect Dis. 2020 Oct 9;6(10):2783-2799. doi: 10.1021/acsinfecdis.0c00512. Epub 2020 Sep 16.PMID: 32870648

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FY21 Funded Research

The work which resulted in the publications outlined above would not have been possible without the ability of our faculty to competitively seek funding to support their research activities. NEIDL faculty members - both core faculty (blue font) and affiliate faculty - received over **$ 33 MM** in funding in FY21 for the following projects:

AWARD TITLE	PI	SPONSOR (PRIME SP)	PROJECT PERIOD	AMOUNT FUNDED IN FY 2021
NEIDL CORE FACULTY				
AUSTERE ENVIRONMENTS CONSORTIUM FOR ENHANCED SEPSIS OUTCOMES (ACESO) UGANDA	BHADELIA R NAHID	Henry Jackson Found (DOD)	08/01/2019 — 06/30/2021	$77,223
B-BIC RADX-RAD: UNLU (BU) SUBCONTRACT	CONNOR H JOHN (CO-PI: UNLU SELIM)	Brigham Women's (NIH/NLBI)	12/21/2020 — 11/30/2021	$145,180
ADVANCEMENT OF A POXVIRUS INHIBITOR	CONNOR H JOHN	NIH/NIAID	03/12/2020 — 02/28/2025	**$590,147**
DETERMINANTS OF COVID19-INDUCED VENOUS THROMBOSIS AND TARGETED THERAPY ASSESSED WITH BIOENGINEERED VEIN-CHIP	CONNOR H JOHN	NIH/NLBI	05/01/2021 — 04/30/2025	**$721,633**
ANTIMICROBIAL SURFACE COATINGS TO REDUCE COVID-19 SPREAD	CONNOR H JOHN	Physical Sciences (DOD/Air Force)	11/18/2020 — 08/24/2022	**$241,405**
SARS-COV-2 VARIANTS IN THE TUFTS POPULATION	CONNOR H JOHN	TUFTS	04/01/2021 — 03/31/2022	**$11,600**
IN VITRO EVALUATION AND VALIDATION OF THE VIREX TEST STRIPS AND DEVICES	CONNOR H JOHN	Virex Health	01/01/2021 — 12/31/2021	**$80,093**
NATIONAL EMERGING INFECTIOUS DISEASES LABORATORIES OPERATIONS	CORLEY B RONALD	NIH/NIAID	06/01/2016 — 05/31/2021	$11,500,000
STAFF SCIENTISTS/VETERINARY TECHNICIANS AT THE NEIDL BSL33/4	CORLEY B RONALD	HARVARD (China Evergrande)	05/01/2020 — 04/30/2021	$600,000
STTR PHASE I: AMINOMETHYL BENZAMIDES AS NOVEL ANTI EBOLA AGENTS	DAVEY ROBERT	Chicago BioSolutions (NIH/NIAID)	08/16/2019 — 07/31/2022	$127,114
TESTING OF BREQUINAR IN COMBINATION WITH DIPYRIDAMOLE FOR CLEARCREEKBIO	DAVEY ROBERT	Clear Creek Bio	06/15/2021 — 06/30/2022	$62,716
SMALL MOLECULE INHIBITORS OF EBOLA VIRUS POLYMERASE FUNCTION	DAVEY ROBERT	Georgia State (NIH/NIAID)	08/01/2018 — 01/31/2022	$209,427
ASSAY DEVELOPMENT AND EXECUTION OF LIVE VIRUS TESTING IN SUPPORT OF THE HARVARD-ABBVIE RESEARCH COLLABORATION	DAVEY ROBERT	HARVARD (AbbVie)	03/01/2021 — 02/28/2024	$145,119
HTS FOR IDENTIFICATION AND EVALUATION OF EFFICACY FOR THERAPEUTICS AGAINST SARS-COV-2 INFECTION	DAVEY ROBERT	HARVARD (China Evergrande)	05/01/2020 — 04/30/2021	$400,000
INVESTIGATION OF THE ROLE OF PHOSPHATIDIC ACID METABOLISM IN FILOVIRUS BUDDING	DAVEY ROBERT	PERDUE (NIH/NIAID)	03/01/2021 — 02/28/2022	$82,500
ANTIVIRAL LEAD IDENTIFICATION TO TREAT FILOVIRUS INFECTIONS	DAVEY ROBERT	PERDUE (NIH/NIAID)	08/12/2019 — 07/31/2023	$216,992
NEUTRALIZATION AND BINDING OF ANTIBODY TO VIRUS BY REGENERON ANTIBODIES	DAVEY ROBERT	Regeneron (HHS/ASPR/BARDA)	07/08/2020 — 06/30/2022	$197,961
MODELING FILOVIRUS INFECTION OF AND TRAFFICKING THROUGH SKIN	DAVEY ROBERT	Univ of Iowa (NIH/NIAID)	08/01/2018 — 07/31/2021	$111,807
STRUCTURAL AND FUNCTIONAL CHARACTERIZATION OF THE EBOLA VIRUS REPLICATION COMPLEX	DAVEY ROBERT	WashU (NIH/NIAID)	07/01/2018 — 06/30/2021	$452,000

AWARD TITLE	PI	SPONSOR (PRIME SP)	PROJECT PERIOD	AMOUNT FUNDED IN FY 2021
CHARACTERIZATION OF A HUMAN-SPECIFIC POSITIVE REGULATOR OF FLAVIVIRUS INFECTION	DOUAM FLORIAN	NIH/NIAID	04/12/2021 — 03/31/2023	$162,000
THERAPEUTIC EFFECTS OF NAPC2 IN SARS-COV-2 INFECTION OF K18-HACE2 TRANSGENIC MICE (PI: BOSMANN)	DOUAM FLORIAN (CO-PI: BOSMANN)	ARCA Biopharma	03/15/2021 — 09/15/2021	$89,621
DEFINING THE IMPACT OF PER/POLYFLUOROALKYL SUBSTANCE EXPOSURE ON SUSCEPTIBILITY TO SARS-COV-2 INFECTION AND DISEASE.	DOUAM FLORIAN (CO-PI: SCHLEZINGER)	NIH/NIEHS	03/02/2021 — 02/28/2023	$92,199
STUDIES TO ASSESS THE MECHANISM OF INHIBITION OF PNEUMOVIRUS L AND N-P INHIBITORS	FEARNS RACHEL	Enanta Pharma	10/01/2020 — 09/30/2021	$156,504
DEVELOPING COMBINATION THERAPIES AGAINST PNEUMO- AND PARAMYXOVIRUSES CAUSING SEVERE RESPIRATORY INFECTION	FEARNS RACHEL	Georgia State (NIH/NIAID)	07/01/2018 — 06/30/2021	$16,500
EVALUATING THE MECHANISM OF ACTINO OF RSV L INHIBITORS TARGETING THE CRV REGION	FEARNS RACHEL	Janssen Vaccines	05/03/2019 — 12/31/2021	$141,688
INTERPLAY BETWEEN RESPIRATORY SYNCYTIAL VIRUS AND NUCLEOTIDE BIOSYNTHESIS PATHWAYS	FEARNS RACHEL	NIH/NIAID	02/07/2020 — 01/31/2022	$199,384
MECHANISMS OF MARBURG VIRUS GENE EXPRESSION	FEARNS RACHEL	NIH/NIAID	05/08/2018 — 04/30/2023	$529,282
CHARACTERIZE THE TRANSCRIPTIONAL AND GENOME REPLICATION MECHANISM OF PARAMYXOVIRUSES FOR THE DISCOVERY OF BROAD SPECTRUM ANTI-VIRALS	FEARNS RACHEL	Roche	09/01/2020 — 01/01/2023	$391,920
EFFICACY TESTING OF ANTIVIRAL DRUG IN A HAMSTER MODEL OF SARS COV-2 INFECTION	GRIFFITHS ANTHONY	Boston Pharma	08/01/2020 — 08/01/2021	$65,901
EFFICACY OF NANODISCS IN A HAMSTER MODEL OF SARS-COV-2 INFECTION	GRIFFITHS ANTHONY	BWHI	03/01/2021 — 08/31/2021	$24,282
EFFICACY OF MODIFIED ACE-2 IN A HAMSTER MODEL OF SARS-COV-2 INFECTION	GRIFFITHS ANTHONY	Children's Hosp (Emergent Ventures)	09/01/2020 — 10/31/2020	$33,293
NEUTRALIZATION OF SARS-COV-2 WITH RATIONALLY DESIGNED ANTIBODY-BASED THERAPEUTICS	GRIFFITHS ANTHONY	Cidara Therapeutics	08/21/2020 — 10/31/2020	$22,876
INACTIVATION OF SARS COV-2 USING LIGHT AT VARIOUS WAVELENGTHS	GRIFFITHS ANTHONY	EP Consultants	08/20/2020 — 11/20/2020	$53,305
DISCOVERY AND DEVELOPMENT OF ANTIBODY THERAPEUTICS FOR SARS-COV-2 AND OTHER HIGH-RISK EMERGING VIRUSES	GRIFFITHS ANTHONY	HARVARD (Abbvie)	09/01/2020 — 10/29/2023	$472,185
ACCELERATED DEVELOPMENT OF A SARS-COV-2 VACCINE BASED ON THE LIVE VSVG CHIMERIC VIRUS PLATFORM	GRIFFITHS ANTHONY	IAVI (DOD/DTRA)	02/26/2021 — 10/04/2022	$1,001,203
EFFICACY OF IMMUNOME ANTIBODIES AGAINST SARS COV-2 IN HAMSTERS	GRIFFITHS ANTHONY	Immunome (DOD/Army)	09/22/2020 — 12/31/2021	$250,562
RATIONALLY DESIGNED PAN-EBOLAVIRUS VACCINE	GRIFFITHS ANTHONY	Integrated BioTherapeutics (NIH/NIAID)	12/01/2019 — 05/31/2022	$179,616
MODEL DEVELOPMENT/ REFINEMENT STUDY EBOLA VIRUS MAKONA INTRANASAL CHALLENGE	GRIFFITHS ANTHONY	Janssen Vaccines	04/16/2021 — 04/16/2022	$582,349
PILOT STUDY TO ASSESS PROTECTION AGAINST FILOVIRUS CHALLENGE BY AN INFUSED MONOCLONAL ANTIBODY	GRIFFITHS ANTHONY	Leidos (NIH/NCI)	10/31/2019 — 09/23/2023	$1,074,893

AWARD TITLE	PI	SPONSOR (PRIME SP)	PROJECT PERIOD	AMOUNT FUNDED IN FY 2021
EXPLORATORY SINGLE-DOSE INTRAMUSCULAR IMMUNOGENICITY, PROTECTION FROM SARS-COV-2 AND EVALUATION OF VAERD STUDY IN GOLDEN SYRIAN HAMSTERS	GRIFFITHS ANTHONY	Merck (HHS/ASPR/BARDA)	10/05/2020 — 10/04/2025	$681,434
MODERNA SARS-COV-2 HAMSTER CHALLENGE STUDY (150)	GRIFFITHS ANTHONY	Moderna	03/20/2021 — 09/20/2021	$461,325
INACTIVATION OF SARS COV-2 USING RAPISCAN TRACE DETECTION SYSTEM	GRIFFITHS ANTHONY	Rapiscan Systems	08/25/2020 — 11/30/2020	$55,730
DEVELOPMENT OF SARS-COV2 NEUTRALIZING ANTIBODY	GRIFFITHS ANTHONY	RK Mellon Fdn	02/01/2021 — 07/31/2021	$30,000
INACTIVATION OF SARS COV-2 AND OTHER VIRUSES USING SIGNIFY LIGHTING TECHNOLOGIES	GRIFFITHS ANTHONY	Signify North America	11/01/2020 — 06/30/2021	$200,818
INACTIVATION OF SARS COV-2 USING SUPERCRITICAL CO2	GRIFFITHS ANTHONY	Spectra Systems	08/01/2020 — 10/01/2020	$55,730
INACTIVATION OF SARS COV-2 USING SUPERCRITICAL CO2	GRIFFITHS ANTHONY	Spectra Systems	08/01/2020 — 01/31/2021	$68,886
EFFICACY OF RNA-BASED THERAPEUTIC IN AN NHP MODEL OF SARS-COV-2 INFECTION	GRIFFITHS ANTHONY	UMASSMed	09/01/2020 — 01/31/2021	$269,100
EFFICACY OF WYSS-VACCINE PLATFORMS IN HAMSTER MODEL OF SARS-COV-2 INFECTION	GRIFFITHS ANTHONY	Wyss Inst	12/01/2020 — 03/01/2021	$27,042
DIETARY QUALITY, COGNITIVE DECLINE AND BRAIN HEALTH IN PUERTO RICAN ADULTS	KOO BANG BON	UMASS Lowell (NIH/NIA)	09/15/2017 — 05/31/2021	$39,042
SIDEROPHER-DEPEDENT INHIBITORS OF MYCOBACTERIUM TUBERCULOSIS	KRAMNIK IGOR	Univ of Alabama (NIH/NIAID)	06/22/2020 — 06/30/2021	$123,750
COVID FAST GRANTS	MUHLBERGER ELKE	Emergent Ventures	05/01/2020 — 02/28/2021	$400,000
ANALYSIS OF ANTIBODY-DEPENDENT ENHANCED INFECTION BY SARS-COV-2	MUHLBERGER ELKE	Regeneron (HHS/ASPR/BARDA)	10/22/2020 — 06/30/2021	$39,724
APPLIED RESEARCH ON DISINFECTION OF SURFACES AND HANDS TO PREVENT NOVEL CORONAVIRUS TRANSMISSION	MUHLBERGER ELKE	TUFTS (USAID)	07/01/2020 — 06/30/2021	$160,000
DEVELOPMENT OF DF-COV FOR THE TREATMENT AND PREVENTION OF COVID-19 AND ASSOCIATED IMMUNOPATHOLOGIC RESPIRATORY COMPLICATIONS	SAEED MOHSAN (PI: KOTTON)	Dana Farber (DOD/USAMRDC)	01/15/2021 — 01/14/2022	$20,733
Total NEIDL Core Faculty				**$24,145,794**

NEIDL Affiliate Faculty				
THERAPEUTIC EFFECTS OF NAPC2 IN SARS-COV-2 INFECTION OF K18-HACE2 TRANSGENIC MICE	BOSMANN MARKUS (CO-PI: DOUAM)	ARCA Biopharma	03/15/2021 — 09/15/2021	$89,621
NEW GENETIC MODELS FOR C5A RECEPTORS	BOSMANN MARKUS	NIH/NHLBI	07/01/2018 — 06/30/2023	$412,500
ROLE REVERSAL OF MAVS IN BACTERIAL SEPSIS	BOSMANN MARKUS	NIH/NHLBI	08/15/2018 — 06/30/2023	$482,381
BACTERIAL POLYPHOSPHATES IN SEPSIS	BOSMANN MARKUS	NIH/NIAID	02/22/2021 — 01/31/2025	$537,125
SIGNALS THAT ESTABLISH AND MAINTAIN HIV LATENCY	GUMMULURU RAHM	BMC (NIH/NIAID)	05/08/2018 — 04/30/2023	$65,609
PERSISTENT HIV EXPRESSION INDUCED TYPE 1 IFN RESPONSES AND INFLAMMAGING	GUMMULURU RAHM	NIH/NIA	08/01/2018 — 04/30/2023	$778,565
GM3 NANOPARTICLES FOR SUSTAINED DELIVERY OF ANTI-RETROVIRALS TO LYMPHATIC TISSUES	GUMMULURU RAHM	NIH/NIAID	11/08/2017 — 10/31/2022	$625,956

AWARD TITLE	PI	SPONSOR (PRIME SP)	PROJECT PERIOD	AMOUNT FUNDED IN FY 2021
SYNERGISTIC MECHANISMS OF CHRONIC INNATE IMMUNE ACTIVATION IN MICROGLIA BY OPIATES AND HIV INFECTION	GUMMULURU RAHM	NIH/NIDA	07/15/2020 — 04/30/2025	$701,970
CHAGAS EDUCATION FOR ESSENTIAL PROVIDERS	HAMER DAVIDSON	BMC (HHS/CDC)	09/30/2020 — 09/29/2025	$16,311
SEQUENCING OF KLEBSIELLA PNEUMONIAE ISOLATES FROM ZAMBIA	HAMER DAVIDSON	Gates Found	07/15/2020 — 06/30/2021	$100,000
FOGARTY GLOBAL HEALTH TRAINING FELLOWSHIP PROGRAM	HAMER DAVIDSON	Harvard SPH (NIH/FIC)	07/01/2017 — 06/30/2022	$35,338
STRUCTURE-FUNCTION ANALYSIS OF INFECTION- AND VACCINE-INDUCED B-CELL REPERTOIRES	KEPLER B. THOMAS	Children's Hosp (NIH/NIAID)	08/01/2017 — 07/31/2022	$87,000
IMMUNE MECHANISMS OF PROTECTION AGAINST MYCOBACTERIUM TUBERCULOSIS CENTER (IMPAC-TB)	KEPLER B. THOMAS	HARVARD (NIH/NIAID)	09/30/2019 — 03/31/2022	$106,422
THE B CELL REPERTOIRE AS A WINDOW INTO THE NATURE AND IMPACT OF THE LUNG VIROME	KEPLER B. THOMAS	NIH/NHLBI	05/01/2019 — 04/30/2022	$783,280
RESEARCH TRAINING IN IMMUNOLOGY	KEPLER B. THOMAS	NIH/NIAID	08/24/2020 — 07/31/2025	$561,299
THE INTERPLAY BETWEEN TRANSPOSONS AND PIRNA PATHWAYS	LAU NELSON	NIH/NIGM	08/10/2020 — 04/30/2024	$867,757
PNEUMONIA BIOLOGY	MIZGERD P JOSEPH	NIH/NLBI	01/11/2017 — 12/31/2023	$1,555,305
BIOLOGY OF THE LUNG: A MULTIDISCIPLINARY PROGRAM	MIZGERD P JOSEPH	NIH/NLBI	07/01/2021 — 06/30/2026	$825,487
THE BIOCHEMISTRY AND CELL BIOLOGY OF THE SPINDLY O-FUCOSYLTRANSFERASE OF TOXOPLASMA	SAMUELSON C JOHN	NIH/NIGM	01/01/2020 — 11/30/2023	$516,295
Total NEIDL Affiliate Faculty				**$9,148,221**
Total Awards				**$33,294,015**

Additional Support for Research from the NEIDL Director's Fund

The NEIDL is supported by Boston University, which also provides funding to the NEIDL Director. These funds are designed to be used to enhance the research activities in the NEIDL. This year, those funds were primarily used to further develop and enhance the research infrastructure. This included $108,000 for operational support, including general laboratory supplies for the BSL-2 and BSL-3 laboratories and the personnel using them. In addition, $99,600 was used to support equipment purchases, upgrades and repairs, as well as service contracts for high end instrumentation for BSL-2 and BSL-3 laboratories. Further development of the veterinary pathology and histology services was supported by $62,000, and $97,700 was directed toward infrastructure needed to support "well documented" studies, which are systems required for studies that will support the licensure of products (therapeutics, vaccines) by the FDA.

Featured Research

CORONAVIRUS RESEARCH

Study Reveals Recipe for Even More Powerful COVID-19 Vaccines

NEIDL, Broad scientists say next-generation vaccines could stimulate another arm of the immune system, imparting better protection against coronavirus variants

When Broad Institute researchers reached out for help exploring the molecular effects of coronavirus infection, Mohsan Saeed (center) and members of his NEIDL lab, Da-Yuan Chen (left) and Hasahn Conway (right), were ready to leap into action: they had already created human cell lines that could be readily infected with SARS-CoV-2. Photo courtesy of Saeed lab

THE BRINK, Pioneering Research from Boston University

By KAT J. MCALPINE, JUNE 11, 2021

A new study looking at the way human cells activate the immune system in response to SARS-CoV-2 infection could open the door to even more effective and powerful vaccines against the coronavirus and its rapidly emerging variants keeping the global pandemic smoldering.

Researchers from Boston University's National Emerging Infectious Diseases Laboratories (NEIDL) and the Broad Institute of MIT and Harvard say it's the first real look at exactly what types of "red flags" the human body uses to enlist the help of T cells—killers sent out by the immune system to destroy infected cells. Until now, COVID vaccines have been focused on activating a different type of immune cell, B cells, which are responsible for creating antibodies. Developing vaccines to activate the other arm of the immune system—the T cells—could dramatically increase immunity against coronavirus, and importantly, its variants.

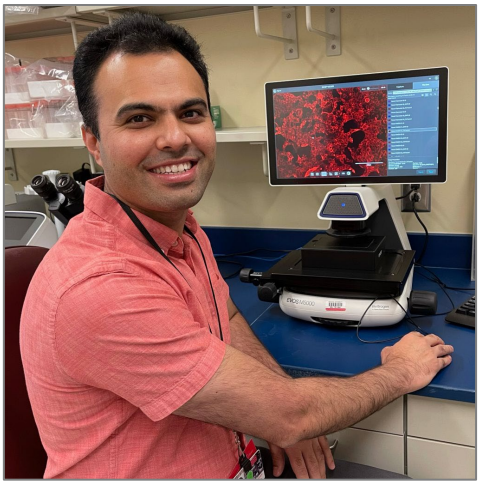
In their findings, published in Cell, the researchers say current vaccines might lack some important bits of viral material capable of triggering a holistic immune response in the human body. Based on the new information, "companies should reevaluate their vaccine designs," says **Mohsan Saeed**, a NEIDL virologist and the co-corresponding author of the paper.

Saeed, a BU School of Medicine assistant professor of biochemistry, performed experiments on human cells infected with coronavirus. He isolated and identified those missing pieces of SARS-CoV-2 proteins inside one of the NEIDL's Biosafety Level 3 (BSL-3) labs. "This was a big undertaking because many research techniques are difficult to adapt for high containment levels [such as BSL-3]," Saeed says. "The overall coronavirus research pipeline we've created at the NEIDL, and the support of our entire NEIDL team, has helped us along the way."

Saeed got involved after he was contacted by genetic sequencing experts at the Broad Institute, computational geneticists Pardis Sabeti and Shira Weingarten-Gabbay. They hoped to identify fragments of SARS-CoV-2 that activate the immune system's T cells.

"The emergence of viral variants, an active area of research in my lab, is a major concern for vaccine development," says Sabeti, a leader in the Broad Institute's Infectious Disease and Microbiome Program. She is also a Harvard University professor of systems biology, organismic and evolutionary biology, and immunology and infectious disease, as well as a Howard Hughes Medical Institute investigator.

"We swung into full action right away because my laboratory had [already] generated human cell lines that could be readily infected with SARS-CoV-2," Saeed says. The group's efforts were spearheaded by two members of the Saeed lab: Da-Yuan Chen, a postdoctoral associate, and Hasahn Conway, a lab technician.



Mohsan Saeed, BU NEIDL virologist, says the new findings could be a gamechanger for coronavirus vaccine design. Photo courtesy of Mohsan Saeed

From the outset of COVID pandemic in early 2020, scientists around the world knew the identity of 29 proteins produced by SARS-CoV-2 virus in infected cells—viral fragments that now make up the spike protein in some coronavirus vaccines, such as the Moderna, Pfizer-BioNTech, and Johnson & Johnson vaccines. Later, scientists discovered another 23 proteins hidden inside the virus' genetic sequence; however, the function of these additional proteins was a mystery until now. The new findings of Saeed and his collaborators reveal—unexpectedly and critically—that 25 percent of the viral protein fragments that trigger the human immune system to attack a virus come from these hidden viral proteins.

How exactly does the immune system detect these fragments? Human cells contain molecular "scissors"—called proteases—that, when the cells are invaded, hack off bits of viral proteins produced during infection. Those bits, containing internal proteins exposed by the chopping-up process—like the way the core of an apple is exposed when the fruit is segmented—are then transported to the cell membrane and pushed through special doorways. There, they stick outside the cell acting almost like a hitchhiker, waving down the help of passing T cells. Once T cells notice these viral flags poking through infected cells, they launch an attack and try to eliminate those cells from the body. And this T cell response isn't insignificant—Saeed says there are links between the strength of this response and whether or not people infected with coronavirus go on to develop serious disease.

"It's quite remarkable that such a strong immune signature of the virus is coming from regions [of the virus' genetic sequence] that we were blind to," says Weingarten-Gabby, the paper's lead author and postdoctoral fellow in the Sabeti lab. "This is a striking reminder that curiosity-driven research stands at the basis of discoveries that can transform the development of vaccines and therapies."

"Our discovery … can assist in the development of new vaccines that will mimic more accurately the response of our immune system to the virus," Sabeti says.

T cells not only destroy infected cells but also memorize the virus' flags so that they can launch an attack, stronger and faster, the next time the same or a different variant of the virus appears. That's a crucial advantage, because Saeed and his collaborators say the coronavirus appears to delay the cell's ability to call in immune help.

"This virus wants to go undetected by the immune system for as long as possible," Saeed says. "Once it's noticed by the immune system, it's going to be eliminated, and it doesn't want that."

Based on their findings, Saeed says, a new vaccine recipe, incorporating some of the newly discovered internal proteins making up the SARS-CoV-2 virus, would be effective in stimulating an immune response capable of tackling a wide swath of newly emerging coronavirus variants. And given the speed with which these variants continue to appear around the world, a vaccine that can provide protection against all of them would be a game changer.

This research was supported by the National Institute of Health, the National Institute of Allergy and Infectious Diseases, the National Cancer Institute (NCI) Clinical Proteomic Tumor Analysis Consortium, a Human Frontier Science Program Fellowship, a Gruss-Lipper Postdoctoral Fellowship, a Zuckerman STEM Leadership Program Fellowship, a Rothschild Postdoctoral Fellowship, the Cancer Research Institute/Hearst foundation, a National Science Foundation Graduate Research Fellowship, EMBO Long- Term Fellowships, a Cancer Research Institute/Bristol-Myers Squibb Fellowship, the Parker Institute for Cancer Immunotherapy, the Emerson Collective, the G. Harold and Leila Y. Mathers Charitable

Foundation, the Bawd Foundation, Boston University startup funds, the Mark and Lisa Schwartz Foundation, the Massachusetts Consortium for Pathogen Readiness, the Ragon Institute of MGH, MIT and Harvard, and the Frederick National Laboratory for Cancer Research.

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*Weingarten-Gabbay, S., Klaeger, S., Sarkizova, S., Pearlman, L.R., Chen, D.-Y., Gallagher, K.M.E., Bauer, M.R., Taylor, H.B., Dunn, W.A., Tarr, C., Sidney, J., Rachimi, S., Conway, H.L., Katsis, K., Wang, Y., Leistritz-Edwards, D., Durkin, M.R., Tomkins-Tinch, C.H., Finkel, Y., Nachshon, A., Gentili, M., Rivera, K.D., Carulli, I.P., Chea, V.A., Chandrashekar, A., Bozkus, C.C., Carrington, M., MGH COVID-19 Collection & Processing Team, Bhardwaj, N., Barouch, D.H., Sette, A., Maus, M.V., Rice, C.M., Clauser, K.R., Keskin, D.B., Pregibon, D.C., Hacohen, N., Carr, S.A., Abelin, J.G., **Saeed, M.,** Sabeti, P.C., Profiling SARS-CoV-2 HLA-I peptidome reveals T cell epitopes from outof-frame ORFs, Cell (2021), doi: https://doi.org/10.1016/j.cell.2021.05.046.*

New study will help investigate innate immune responses to viral infections

Reviewed by Emily Henderson, B.Sc., MAY 19, 2021 (https://www.news-medical.net/)

Researchers from Boston University School of Medicine (BUSM) report the formation of human cells containing a green fluorescent protein or GFP (one of the most important proteins in biology and fluorescence imaging) genetically fused with two interferon stimulated genes (ISGs), namely Viperin and ISG15. This new creation makes these cells highly valuable reagents for reporting innate immune responses to viral infections, including those caused by coronaviruses.

These engineered cells, which turn green when treated with interferon, are highly novel because this is the first time a reporter gene (a gene that enables the detection or measurement of gene expression), such as GFP, has been inserted into endogenous loci of ISGs.

Viral infections cause human cells to sound a biochemical alarm via interferon signaling, leading to a high-level expression of ISGs. However, ISGs are very tightly regulated genes, because too much expression and an inability to later tamp down ISG levels can be just as detrimental to cellular health.

This overactive innate immune signaling leads to a 'cytokine storm' (when an infection triggers the immune system to flood your bloodstream with inflammatory proteins called cytokines) that distinguishes a mild case of virus infection from fully debilitating symptoms, an outcome all too prevalent in the COVID-19 pandemic.

> *" Better research tools for studying ISG regulation are still needed, not just now for coronavirus research but for many other viruses that our society will contend with."*
>
> ***Nelson Lau, PhD**, Study Co-Corresponding Author and Associate Professor of Biochemistry, Boston University School of Medicine*

In order to successfully tag human antiviral genes with GFP, the researchers first needed to produce a new methodology for creating a long DNA repair template for more efficient and authentic CRISPR-Cas9 genome editing in animal cells. They named his template methodology the BL3SSO (sounds like "blasso") because it sets up the DNA for more accurate repair and for introduction of a fluorescent transgene like GFP into the site cut by Cas-9 during genome editing.

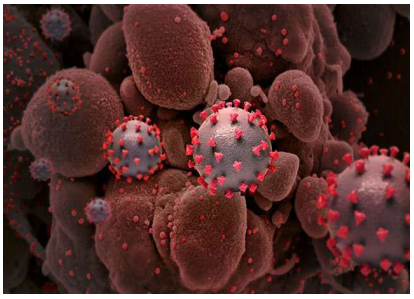
These findings are the result of a collaboration between the Lau lab and the lab of **Mohsan Saeed, PhD**, both faculty members in BUSM's department of biochemistry and investigators at the BU National Emerging Infectious Diseases Laboratories (NEIDL).

Journal reference:
*Saptaparni Bandyopadhyay, Joseph Douglass, Sebastian Kapell, Nazimuddin Khan, Fabiana Feitosa-Suntheimer, Jenny A Klein, Jasmine Temple, Jayce Brown-Culbertson, Alexander H Tavares, **Mohsan Saeed, Nelson C Lau**. (2021) DNA templates with blocked long 3′ end single-stranded overhangs (BL3SSO) promote bona fide Cas9-stimulated homology-directed repair of long transgenes into endogenous gene loci. G3: Genes, Genomes, Genetics. doi.org/10.1093/g3journal/jkab169.*

Intestinal Organoids Show How SARS-CoV-2 Affects The Gut

Technology Networks Cell Science, APRIL 14, 2021. (Original story from BUSM)

How could studying gastrointestinal cells help the fight against COVD-19, which is a respiratory disease? According to a team led by Gustavo Mostoslavsky, MD, Ph.D., at the BU/BMC Center for Regenerative Medicine (CReM) and **Elke Mühlberger, Ph.D.**, from the National Emerging Infectious Diseases Laboratories (NEIDL) at Boston University, testing how SARS-CoV-2 affects the gut can potentially serve to test novel therapeutics for COVID-19.



Creative rendition of SARS-CoV-2 particles (not to scale). Credit: NIAID, NIH

In order to study SARS-CoV-2, models are needed that can duplicate disease development in humans, identify potential targets and enable drug testing. BU researchers have created human induced pluripotent stem cells (iPSC)-derived intestinal organoids or 3D models that can be infected and replicated with SARS-CoV-2.

iPSC are stem cells derived from the donated skin or blood cells that are reprogrammed back to an embryonic stem cell-like state and then can be developed into any cell type in the body.

"Human induced pluripotent stem cell derived intestinal organoids represent an inexhaustible cellular resource that could serve as a valuable tool to study SARS-CoV-2 as well as other intestinal viruses that infect the intestinal epithelium," explained corresponding author Mostoslavsky, associate professor of microbiology at Boston University School of Medicine (BUSM) and co-director of the CReM.

Using human induced pluripotent stem cells (iPSC) the researchers differentiated the iPSC cells into colonic and small intestine 3D organoids. The organoids were then passed along to the Mühlberger lab at the NEIDL where they were infected with SARS-CoV-2 to analyze the effect of infection on the cells by staining against markers, by electron microscopy and by RNA-sequencing.

"Our findings suggests that different epithelial tissues (such as the lung and the gut) react in similar manner to SARS-CoV-2 infection and therefore can help identify common mechanisms of disease that can be targeted by drugs," added **Mühlberger**, director of Integrated Science Services at the NEIDL and professor of microbiology at BUSM.

Funding for this research was provided by Evergrande MassCPR, Fast Grants, and NIH NCATS grant UL1TR001430 awards to EM. AM is supported by the Kilachand Multicellular Design Program at Boston University. GM is supported by NIH Grants N0175N92020C00005 and 1R01DA05188901.

Journal reference
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Researchers Demonstrate Self-Sterilizing Polymers Work Against SARS-CoV-2

NC State University, Matt Shipman, FEBRUARY 15, 2021

Researchers from North Carolina State University, Boston University and Kraton Corporation have demonstrated a family of self-sterilizing polymers that are effective at inactivating coronaviruses, including SARS-CoV-2 – the virus that causes COVID-19. The work opens the door to a suite of applications that could help to reduce the transmission of COVID-19 and other diseases.

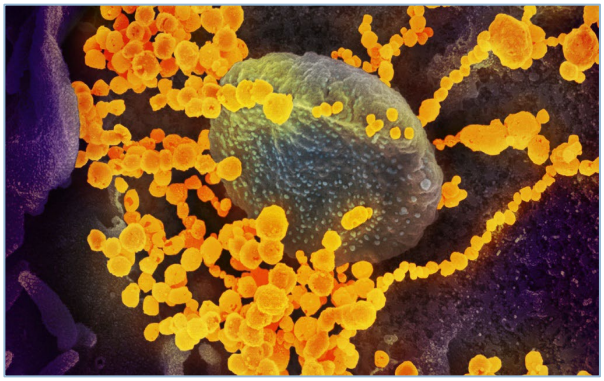
“Our work here provides conclusive evidence that these materials, anionic polymers, can inactivate human coronaviruses quickly and efficiently,” says Richard Spontak, co-author of a paper on the work accepted for publication in *Advanced Science*. Spontak is a Distinguished Professor of Chemical and Biomolecular Engineering and a professor of materials science and engineering at North Carolina State University.

“If we want to coat high-contact surfaces such as textiles, countertops or walls – it’s possible,” says Frank Scholle, co-author of the paper and an associate professor of biological sciences at NC State. “Virus inactivation will occur as long as there is sufficient humidity,” adds Scholle, who is also director of NC State’s Center for Advanced Virus Experimentation (CAVE).

When these anionic polymers absorb water, protons can travel through nanoscale channels to the surface, creating a highly acidic environment capable of inactivating viruses and killing bacteria and mold. The research team had previously demonstrated that several of the anionic polymers were effective against a range of pathogens, including methicillin-resistant *Staphylococcus aureus* (MRSA) and a strain of influenza.

"Based on what we've learned, we've been able to identify a fundamentally new inactivation mechanism and a family of polymers that expands the health care sector's arsenal for fighting the spread of coronavirus," Spontak says.

In laboratory experiments, the researchers demonstrated that specific anionic polymers could fully inactivate SARS-CoV-2 in just 5 minutes, and fully inactivate a human coronavirus surrogate called HCoV-229E in 20 minutes. Kraton Corporation is in the process of evaluating applications for how some of these polymers might be used in a variety of settings.



This scanning electron microscope image shows SARS-CoV-2 (round gold objects) emerging from the surface of cells cultured in the lab. Image credit: NIAID-RML.

"We are thankful for the opportunity to collaborate with NC State University and Boston University to address an important and urgent need for long-lasting antimicrobial performance," says Vijay Mhetar, Kraton's Chief Technology Officer. "Building upon this scientific discovery, Kraton Corporation is actively seeking regulatory approvals and evaluating application uses in transportation, health care, and building and infrastructure."

The paper, *"Rapid and Repetitive Inactivation of SARS-CoV-2 and Human Coronavirus on Self-Disinfecting Anionic Polymers,"* was published online Feb. 9. Co-first authors of the paper are Bharadwaja Peddinti, a former Ph.D. student at NC State, and Sierra Downs of Boston University. The paper was co-authored by Jiaqi Yan, a Ph.D. student at NC State; Reza Ghiladi, PhD, an associate professor of chemistry at NC State and member of CAVE; **Anthony Griffiths, PhD**, an associate professor of microbiology and member of the National Emerging Infectious Diseases Laboratories at Boston University; Steven Smith of The Procter & Gamble Company; and Vijay Mhetar and Roger Tocchetto of Kraton Corporation.

The work was performed with support from NC State's Nonwovens Institute and Comparative Medicine Institute; Halyard Health; Kraton Corporation; and Boston University.

Journal Reference:
"Rapid and Repetitive Inactivation of SARS-CoV-2 and Human Coronavirus on Self-Disinfecting Anionic Polymers"
*Authors: Bharadwaja S.T. Peddinti, Jiaqi Yan, Reza A. Ghiladi, Frank Scholle and Richard J. Spontak, North Carolina State University; Sierra N. Downs and **Anthony Griffiths**, Boston University; Steven D. Smith, Procter & Gamble Company; Vijay Mhetar and Roger Tocchetto, Kraton Corporation. Published: Feb. 9, Advanced Science.*

BU researchers uncover viral small RNAs in mosquito cells

Science Daily, BUSM NEWS RELEASE, JANNUARY 13, 2021

(Boston)--Researchers from Boston University School of Medicine (BUSM) provide a new genomics resource that details the small RNA transcriptomes (gene expression) of four bio-medically important mosquito species.

This is the first study to provide a platform for biologists to compare the characteristics of these small RNAs between these four mosquitoes as well as the most widely used insects for genetic experiments, the fruit fly, Drosophila. Although previous studies looked at each of the individual mosquito species separately, this study is the first to allow comparisons between all four species.

"Although mosquitoes are related to Drosophila, they have very different genomes. In addition, mosquitos bite humans for blood meals that allow them to reproduce and but unfortunately allows serious human pathogens like viruses to infect us and cause diseases like yellow fever virus, dengue fever virus, zika virus and eastern equine encephalitis virus," explained corresponding author **Nelson Lau, PhD,** associate professor of biochemistry at Boston University School of Medicine (BUSM).

The researchers obtained cell cultures and dissected samples of the mosquito species *Anopheles gambiae, Culex quinquefasciatus, Aedes aegypti* and *Aedes albopictus*. They extracted and purified the small RNA molecules, created libraries for high-throughput sequencing, and then developed a special bioinformatics platform to provide thorough genomic analysis of these small RNAs. They provide all this analysis in a database website for the public to access at https://laulab.bu.edu/msrg/.

The four mosquito species have global impacts on human health. Anopheles is the major vector for the parasite causing malaria, but is not known to transmit many viruses. In contrast, Culex and Aedes mosquitoes are well known to pass viruses between humans during mosquito bites, but it is still unknown why there is this difference between mosquito species for this capacity to spread viruses.

According to the researchers this study will allow for better biochemical studies in mosquito cells. "If we can find weaknesses in the small RNA pathways of mosquitoes to make them more intolerant of viruses, perhaps they won't be so able to pass the virus from biting one human to the next human victim."

This study was a collaboration between the Lau lab in the Department of Biochemistry and the **John Connor** and **Tonya Colpitts** labs of the BU National Emerging Infectious Disease Laboratory (NEIDL) as well as many other mosquito biologists in the USA and the United Kingdom.

Journal Reference:
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COVID-19 RESEARCH

How Coronavirus Damages Lung Cells within Mere Hours

Multipronged BU research team finds 18 FDA-approved drugs that could halt coronavirus infection earlier

THE BRINK, Pioneering Research from Boston University

by KAT J. MCALPINE, JANUARY 11, 2021

What if scientists knew exactly what impact the SARS-CoV-2 virus had inside our lung cells, within the first few hours of being infected? Could they use that information to find drugs that would disrupt the virus' replication process before it ever gets fully underway? The discovery that several existing FDA-approved drugs—including some originally designed to fight cancer—can stop coronavirus in its tracks indicates the answer is a resounding yes.

A team of Boston University researchers—hailing from BU's National Emerging Infectious Diseases Laboratories (NEIDL), the Center for Regenerative Medicine (CReM) at BU's Medical Campus, and BU's Center for Network Systems Biology (CNSB)—embarked on a months-long, collaborative and interdisciplinary quest, combining multiple areas of expertise in virology, stem cell–derived lung tissue engineering, and deep molecular sequencing to begin answering those questions. They simultaneously infected tens of thousands of human lung cells with the SARS-CoV-2 virus, and then tracked precisely what happens in all of those cells during the first few moments after infection. As if that was not complicated enough, the team had to cool their entire high-containment research facility inside the NEIDL to a brisk 61 degrees Fahrenheit.

The result of that challenging and massive undertaking? The BU team has revealed the most comprehensive map to date of all the molecular activities that are triggered inside lung cells at the onset of coronavirus infection. They also discovered there are at least 18 existing, FDA-approved drugs that could potentially be repurposed to combat COVID-19 infections shortly after a person becomes infected. Experimentally, five of those drugs reduced coronavirus spread in human lung cells by more than 90 percent. Their findings were recently published in Molecular Cell.

Now, academic and industry collaborators from around the world are in contact with the team about next steps to move their findings from bench to bedside, the researchers say. (Although COVID-19 vaccines are starting to be rolled out, it's expected to take the better part of a year for enough people to be vaccinated to create herd immunity. And there are no guarantees that the current vaccine formulations will be as effective against future SARS-CoV-2 strains that could emerge over time.) More effective and well-timed therapeutic interventions could help reduce the overall number of deaths related to COVID-19 infections.

"What makes this research unusual is that we looked at very early time points [of infection], at just one hour after the virus infects lung cells. It was scary to see that the virus already starts to damage the cells so early during infection," says Elke Mühlberger, one of the study's senior investigators and a virologist at BU's NEIDL. She typically works with some of the world's most lethal viruses like Ebola and Marburg.

"The most striking aspect is how many molecular pathways are impacted by the virus," says Andrew Emili, another of the study's senior investigators, and the director of BU's CNSB, which specializes in proteomics and deep sequencing of molecular interactions. "The virus does wholesale remodeling of the lung cells—it's amazing the degree to which the virus commandeers the cells it infects."

Viruses can't replicate themselves because they lack the molecular machinery for manufacturing proteins—that's why they rely on infecting cells to hijack the cells' internal machinery and use it to spread their own genetic material. When SARS-CoV-2 takes over, it completely changes the cells' metabolic processes, Emili says, and even damages the cells' nuclear membranes within three to six hours after infection, which the team found surprising. In contrast, "cells infected with the deadly Ebola virus don't show any obvious structural changes at these early time points of infection, and even at late stages of infection, the nuclear membrane is still intact," Mühlberger says.

The nuclear membrane surrounds the nucleus, which holds the majority of a cell's genetic information and controls and regulates normal cellular functions. With the cell nucleus compromised by SARS-CoV-2, things rapidly take a bad turn for the entire cell. Under siege, the cells—which normally play a role in maintaining the essential gas exchange of oxygen and carbon dioxide that occurs when we breathe—die. As the cells die, they also emit distress signals that boost inflammation, triggering a cascade of biological activity that speeds up cell death and can eventually lead to pneumonia, acute respiratory distress, and lung failure.

"I couldn't have predicted a lot of these pathways, most of them were news to me," says Andrew Wilson, one of the study's senior authors, a CReM scientist, and a pulmonologist at Boston Medical Center (BMC), BU's teaching hospital. At BMC, Boston's safety net hospital, Wilson has been on the front lines of the COVID-19 pandemic since March 2020, trying to treat and save the sickest patients in the hospital's ICU. "That's why our [experimental] model is so valuable."

"Science is the answer—if we use science to ask the lung cells what goes wrong when they are infected with coronavirus, the cells will tell us."

Darrell Kotton

The team leveraged the CReM's organoid expertise to grow human lung air sac cells, the type of cell that lines the inside of lungs. Air sac cells are usually difficult to grow and maintain in traditional culture and difficult to extract directly from patients for research purposes. That's why much coronavirus research to date by other labs has relied on the use of more readily available cell types, like kidney cells from monkeys. The problem with that is kidney cells from monkeys don't react the same way to coronavirus infection as lung cells from humans do, making them a poor model for studying the virus—whatever is learned from them doesn't easily translate into clinically relevant findings for treating human patients.

"Our organoids, developed by our CReM faculty, are engineered from stem cells—they're not identical to the living, breathing cells inside our bodies, but they are the closest thing to it," says Darrell Kotton, one of the study's senior authors. He is a director of the CReM and a pulmonologist at BMC, where he has worked alongside Wilson in the ICU treating COVID-19 patients. The two of them often collaborated with **Mühlberger**, Emili, and other members of their research team via Zoom calls that they managed to join during brief moments of calm in the ICU.

In another recent study using the CReM's engineered human lung cells, the research team confirmed that existing drugs remdesivir and camostat are effective in combating the virus, though neither is a perfect fix for controlling the inflammation that COVID-19 causes. Remdesivir, a broad-use antiviral, has already been used clinically in coronavirus patients. But based on the new study's findings that the virus does serious damage to cells within hours, setting off inflammation, the researchers say there's likely not much that antiviral drugs like remdesivir can do once an infection has advanced to the point where someone would need to be put on a ventilator in the ICU. "[Giving remdesivir] can't save lives if the disease has already progressed," Emili says.

Seeing how masterfully SARS-CoV-2 commandeers human cells and subverts them to do the manufacturing work of replicating the viral genome, it reminded the researchers of another deadly invader.

"I was surprised that there are so many similarities between cancer cells and SARS-CoV-2-infected cells," Mühlberger says. The team screened a number of cancer drugs as part of their study and found that several of them are able to block SARS-CoV-2 from multiplying. Like viruses, cancer cells want to replicate their own genomes, dividing over and over

again. To do that, they need to produce a lot of pyrimidine, a basic building block for genetic material. Interrupting the production of pyrimidine—using a cancer drug designed for that purpose—also blocks the SARS-CoV-2 genome from being built. But Mühlberger cautions that cancer drugs typically have a lot of side effects. “Do we really want to use that heavy stuff against a virus?” she says. More studies will be needed to weigh the pros and cons of such an approach.

The findings of their latest study took the four senior investigators and scientists, postdoctoral fellows, and graduate students from their laboratories almost four months, working nearly around the clock, to complete the research. Of critical importance to the team’s leaders was making sure that the experimental setup had rock-solid foundations in mimicking what’s actually happening when the SARS-CoV-2 virus infects people.

“Science is the answer—if we use science to ask the lung cells what goes wrong when they are infected with coronavirus, the cells will tell us,” Kotton says. “Objective scientific data gives us hints at what to do and has lessons to teach us. It can reveal a path out of this pandemic.”

He’s particularly excited about the outreach the team has received from collaborators around the world. “People with expertise in supercomputers and machine learning are excited about using those tools and the datasets from our publication to identify the most promising drug targets [for treating COVID-19],” he says.

Kotton says the theme that’s become obvious among COVID-19 clinicians and scientists is understanding that timing is key. “Once a patient is on a ventilator in the ICU, we feel limited in what we can do for their body,” he says. “Timing is everything, it’s crucial to identify early windows of opportunity for intervention. You can keep guessing and hope we get lucky—or you [do the research] to actually understand the infection from its inception, and take the guesswork out of drug development.”

This research was funded by the National Institutes of Health, the Australian National Health and Medical Research Council, the Pulmonary Fibrosis Foundation, the Massachusetts Consortium on Pathogen Readiness, the C3.ai Digital Transformation Institute, the Canadian Institutes of Health Research, and Fast Grants.

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Signify and Boston University validate effectiveness of Signify’s UV-C light sources on inactivating the virus that causes COVID-19

Voltinum UK , OCTOBER 21, 2020

Signify, the world leader in lighting, together with the National Emerging Infectious Diseases Laboratories (NEIDL)1 at Boston University in the US have conducted research that validates the effectiveness of Signify’s UV-C light sources on the inactivation of SARS-CoV-2, the virus that causes COVID-19.

- Test results show that the virus could no longer be detected after seconds of exposure
- Signify to make its UV-C lighting technology widely available to other lighting companies
- Signify has been at the forefront of UV technology for more than 35 years

Since the start of the SARS CoV-2 pandemic, **Dr. Anthony Griffiths**, Associate Professor of Microbiology at Boston University School of Medicine and his team have been working on developing tools to support scientific advancement in this field.2 During their research they have treated inoculated material with different doses of UV-C radiation coming from a Signify light source and assessed the inactivation capacity under various conditions. The team applied a dose of 5mJ/cm2, resulting in a reduction of the SARS-CoV-2 virus of 99% in 6 seconds. Based on the data, it was determined that a dose of 22mJ/cm2 will result in a reduction of 99.9999% in 25 seconds.

Our test results show that above a specific dose of UV-C radiation, viruses were completely inactivated: in a matter of seconds we could no longer detect any virus."

Dr. Anthony Griffiths - Associate Professor of Microbiology at Boston University School of Medicine

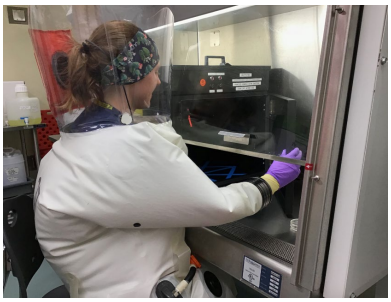
"We're very excited about these findings and hope that this will accelerate the development of products that can help limit the spread of COVID-19," he added.

Signify is the leader in UV-C light sources and has been at the forefront of UV technology for more than 35 years. It has a proven track record of innovation in UV-C lighting, which is designed, manufactured and installed in line with the highest safety standards.

I'm very happy about the fruitful cooperation with Boston University in the fight against the coronavirus. Boston University has validated the effectiveness of our light sources as a preventive measure for companies and institutions as they seek ways to provide virus-free environments." Eric Rondolat - CEO of Signify

"Given the potential of the technology to aid the fight against the coronavirus, Signify will not keep the technology for its exclusive use but make it available to other lighting companies. To service the growing need for disinfection we will increase our production capacity multifold in the coming months," he added.

- The NEIDL is a state-of-the-art research facility that encompasses significant containment laboratories at Biosafety Level -2, -3, and -4
- Dr. Griffiths' team develops vaccines and therapeutics for Risk Group 3 and 4 viruses, which include organisms that can cause serious or deadly diseases in humans
- Research variables are available upon request



Signify and Boston University validate effectiveness of Signify's UV-C light sources on inactivating the virus that causes COVID-19

Crystal IS and Boston University Research Demonstrates Klaran UVC LEDs' Effective Wavelength for Inactivating SARS-CoV-2

Businesswire, September 28, 2020

GREEN ISLAND, N.Y.--(BUSINESS WIRE)--Crystal IS, an Asahi Kasei company, and Boston University's National Emerging Infectious Diseases Laboratories (NEIDL) have performed research demonstrating the efficacy of Crystal IS' Klaran UVC LEDs to inactivate SARS-CoV-2.

Crystal IS initiated this research to understand how SARS-CoV-2, the virus which causes COVID-19, responds to ultraviolet light across the emission range of Klaran UVC LEDs (260 nm to 270 nm) and at different doses.

Log Reduction as a Function of Dose and LED Peak Wavelength

	1.25 mJ/cm^2	2.5 mJ/cm^2	3.75 mJ/cm^2	5 mJ/cm^2
	1 seconds	2 seconds	3 seconds	4 seconds
260 nm				2.6
268 nm	0.7	1.2	1.5	2.8
270 nm				2.8

Klaran UVC LED (Business Wire)

Data courtesy of Dr. Anthony Griffiths, NEIDL, Boston University Klaran UVC LED

During the study, an array of Klaran UVC LEDs were used to irradiate a surface containing SARS-CoV-2. The results in the table above show the log reduction achieved from exposing the virus to a UVC intensity of 1.25 mW/cm^2 at different time intervals. The test was then repeated using a dose of 5 mJ/cm^2 from LEDs which emit at a peak wavelength representing both ends of the Klaran LED wavelength specification (260 nm and 270 nm). The results indicate similar efficacy across the tested range.

Impact of Wavelength on Log Reduction

	3.75 mJ/cm^2	5 mJ/cm^2	37 mJ/cm^2
268 nm	1.5	2.8	
280 nm[1]	0.9		3.1

[1] = Hiroko Inagaki, Akatsuki Saito, Hironobu Sugiyama, Tamaki Okabayashi, & Shouichi Fujimoto (2020), Rapid Inactivation of SARS-CoV-2 with deep-UV LED irradiation. https://www.tandfonline.com/doi/full/10.1080/22221751.2020.1796529

"The research by NEIDL at Boston University demonstrates that SARS-CoV-2 can be effectively inactivated in a matter of seconds through exposure to low doses of UVC light in the key germicidal range," said Larry Felton, President at Crystal IS. However, comparing test results from this study against published results from the University of Miyazaki (which used UVC LEDs emitting at 280 nm) highlights a marked drop in efficacy beyond 270 nm wavelength. While there is much to be done in the fight against the coronavirus pandemic, Crystal IS believes this type of data can be used to help design innovative and effective disinfection solutions.

Klaran UVC LEDs are currently being used by a number of partners, including Healthe Air™ by Healthe, Inc., and Big Ass Fans Clean Air System Haiku with UV-C, which provides continuous disinfection and clean airflow in retail, restaurant, fitness and office settings. To learn more about Klaran UVC LEDs visit www.klaran.com.

About Crystal IS

Crystal IS, an Asahi Kasei company and ISO 9001:2015 certified, is a pioneer in the development and commercialization of Aluminum Nitride substrates. Crystal IS products are used to produce high performance UVC LEDs for disinfection and environmental monitoring in a variety of applications that enhance and sustain life and living around the world.

Journal Reference:
*Rapid and complete inactivation of SARS-CoV-2 by ultraviolet-C irradiation. Nadia Storm, Lindsay G. A. McKay, Sierra N. Downs, Rebecca I. Johnson, Dagnachew Birru, Marc de Samber, Walter Willaert, Giovanni Cennini & **Anthony Griffiths.** Scientific Reports, 10: 22421, Dec 2020*

CORONAVIRUS RESEARCH

In Deadly COVID-19 Lung Inflammation, BU Researchers Discover a Culprit in NFkB Pathway

Team now searching for a therapeutic that could block NFkB from unleashing unchecked inflammation at the onset of coronavirus infection

THE BRINK, Pioneering Research from Boston University

SEPTEMBER 24, 2020, By KAT J. MCALPINE

As the coronavirus pandemic ripped through the United States in March, scientists at Boston University's National Emerging Infectious Diseases Laboratories (NEIDL) and the Center for Regenerative Medicine (CReM) dropped all other research to focus exclusively on the SARS-CoV-2 virus. They joined forces to develop the most relevant research model possible for understanding how the virus impacts the lungs, engineering living, "breathing" human lung cells from stem cells for the task.

Those efforts from early on in the pandemic have borne a leap forward in our understanding of how COVID-19 infections trigger deadly levels of lung inflammation. Their discovery of a pathway that sets the lungs ablaze with

inflammation has launched a search for new therapeutics that could block this process before it can take off and turn fatal.

According to their findings, published online last week in Cell Stem Cell, the trouble starts soon after the air sacs in the lungs are infected with SARS-CoV-2, when the virus activates one of the body's biological pathways known as NFkB (the k is pronounced "kappa"). As that's happening, the virus also suppresses the lungs' ability to call in the help of the immune system to fight off the viral invaders.

When the signal for help finally goes out—several days after infection has taken hold—an army of immune cells swarms into lung tissue heavily laden with infected, dead, and dying cells and with unchecked levels of inflammation triggered by the early activation of NFkB. The incoming immune cells, by attempting to destroy every infected cell in their path, add more fuel to the fire. Every infected cell killed by the virus or by immune cells trying to thwart viral spread tips the scales of inflammation closer to sending the lungs and other organs into total failure.

The discovery of NFkB's role in this deadly cascade makes it a promising target for new therapeutics that could tamp down its activity early on after infection with the novel coronavirus. A new drug could help reduce inflammation before it gets out of control, and give the body critical time to recruit help from immune cells before conditions have deteriorated too far.

"We've learned [NFkB] is the primary pathway that drives inflammation [in COVID-19 patients]," says one of the study's corresponding authors, Darrell Kotton, who is a director of the CReM and a pulmonologist at BU's teaching hospital, Boston Medical Center (BMC). "Now the challenge is to find effective therapeutics that work in patients who are developing acute respiratory distress syndrome [ARDS]."

Kotton says the revelation about NFkB's role in severe coronavirus infections is important because the data was gathered directly from observing human lung cells infected with live SARS-CoV-2 virus. That's different from the vast majority of coronavirus research written about to date, which has been based on infecting much more commonly available types of cells for research: kidney cells derived from African green monkeys. Those kidney cells are easily grown and maintained in culture dishes, but don't accurately represent human lung cells.

"You learn a lot more about how human beings respond to the virus and how drugs might work in them when you infect human lung cells, not kidney cells from monkeys," Kotton says.

For study co–corresponding author Elke Mühlberger, a virologist at the NEIDL who typically works with some of the world's most lethal viruses, like Ebola and Marburg, it was remarkable to witness the effect SARS-CoV-2 virus has on human lung cells.

"It was scary to see how much damage the virus does to these cells," Mühlberger says. "It disrupts the [membrane surrounding the cell nucleus], and causes significant changes to the cell's organelles," which are the internal parts of a cell that carry out essential functions. "The cells really suffer," she says, and not even Ebola or Marburg viruses have as much impact on the cell's internal organelles as the novel coronavirus does, she adds.

"I don't think the senior members of our research team and I have ever experienced anything like this in our careers," Kotton says. He and co–corresponding author Andrew Wilson, also a CReM scientist and a pulmonologist at BMC, have avoided stepping foot in their own labs in the CReM in order to protect their colleagues from the coronavirus exposure risks they endure inside BMC's intensive care unit.

At BMC, Kotton and Wilson frequently saw patients infected with the coronavirus who, despite having mild cold-like symptoms and feeling pretty healthy for a week or so, would suddenly crash, needing to be intubated and ventilated. "We saw this process taking place right in front of our eyes. It was so evident to us that we were trying to keep patients alive after the damage to their lungs had already happened," Kotton says.

That fueled their interest in looking at what's happening inside the lungs' air sac cells at the onset of coronavirus infection.

"We had to get a glance at what the cells are doing when the disease first takes off, because after that, it's probably too late to stop the process except to help keep patients alive with a ventilator," Kotton says. "The first day a lung cell gets infected, what is the cell telling us? We hypothesized that time frame might be a much more effective window to intervene." Peering into that window, they identified NFkB as the primary culprit.

To make that discovery, Adam Hume, a co–lead author of the study and a senior research scientist in Mühlberger's lab, performed the SARS-CoV-2 infections on sophisticated lung models created by stem cell researchers in Kotton and Wilson's CReM labs—Jessie Huang, Rhiannon Werder, and Kristy Abo, also co–lead study authors. Their models of human lung tissue—three-dimensional structures of lung cells, called "lung organoids"—are grown from human stem

cells. The CReM's organoids have been used by researchers at BU and with collaborators elsewhere to study a range of chronic and acute lung diseases.

For coronavirus research, CReM scientists leveraged their organoid expertise to grow lung air sac cells, the type of cell that lines the inside of lungs. Air sac cells are usually difficult to grow and maintain in traditional culture and difficult to extract directly from patients for research purposes. That's why many labs rely on the use of more readily available cell types, like kidney cells from monkeys.

"Our organoids, developed by our CReM faculty, are engineered from stem cells—they're not identical to the living, breathing cells inside our bodies, but they are the closest thing to it," Kotton says.

The CReM team then placed the human air sac cells into an experimental model they had previously developed to study the effects of smoking cigarettes. The cells are plated on a mesh membrane; on one side they are exposed to air, just like air sac cells experience in the lungs when we breathe. On the other side of the membrane, the cells are fed by a liquid concoction that mimics the nutrients and growth factors supplied by lungs' blood vessel network.

From there, the NEIDL team stepped in to infect the lung model. Hume added droplets of live coronavirus on top of the lung cells, infecting them from the air side of the membrane, similar to the way the virus infects cells lining the inside of the lungs when air containing the virus is breathed into the body. He and Mühlberger have run these experiments inside one of the NEIDL's Biosafety Level 4 (BSL-4) laboratories, the highest possible level of biosafety containment used for infectious agents that pose especially high risk to humans.

Based on the experiments implicating NKfB's role in severe coronavirus cases, the CReM and NEIDL researchers are now collaborating with researchers at BU and beyond who have libraries of drugs and novel chemical compounds. Together, the collaborators plan to screen for potential therapeutics that could block the train of inflammation from leaving the station.

Using the CReM lung model at the NEIDL, the researchers have confirmed that existing drugs remdesivir and camostat are effective in combating the virus, though neither is a perfect fix for controlling the inflammation unleashed by NFkB.

Remdesivir, a broad-use antiviral, has already been used clinically in coronavirus patients. Camostat, an antiviral and cancer drug sometimes used to treat pancreatitis, has previously been tested in a type of cell found higher up in the lungs, in the airway, and found to be effective. With the BU team's experiments confirming it also works to treat coronavirus infection in the lungs' air sac cells, Kotton says camostat is a good candidate for clinical trials.

"It's been wonderful to finally be on the offense, rather than on the defense, like we were early on in April and May," Wilson says. At BMC, he recalls during the springtime surge of coronavirus cases, "There was a period of time where overhead announcements, calling code teams to assist with a patient doing poorly, would go off at least once an hour. It was really, really intense."

As patients struggled to survive, Wilson says he and other clinicians felt like there was relatively little they could offer in terms of specific therapies for the coronavirus. "That was so hard—you so badly want to do something to help someone get better," he says.

Now, untangling the workings of the virus through research, he feels there has been an important change of mindset.

"How can we attack this virus? The cells we're using in these experiments are the cell type most prominently affected in sick patients, the patients we're caring for who have developed ARDS," Wilson says. "It's really important to do research on the right type of cell. It tells us how the virus is working and also what parts of the body's normal immune mechanisms aren't working like they're supposed to."

This research is supported by Evergrande MassCPR awards, the National Institutes of Health, a CJ Martin Early Career Fellowship from the Australian National Health and Medical Research Council, an I. M. Rosenzweig Junior Investigator Award from the Pulmonary Fibrosis Foundation, a Harry Shwachman Cystic Fibrosis Clinical Investigator Award, the Gilead Sciences Research Scholars Program, Gilda and Alfred Slifka and Gail and Adam Slifka funds, a Cystic Fibrosis Foundation grant, and a Fast Grants award.

Journal Reference:
SARS-CoV-2 Infection of Pluripotent Stem Cell-Derived Human Lung Alveolar Type 2 Cells Elicits a Rapid Epithelial-Intrinsic Inflammatory Response. Jessie Huang, Adam J. Hume, Kristine M. Abo, Rhiannon B. Werder, Konstantinos D. Alysandratos, Carlos Villacorta-Martin, Mary Lou Beermann, Chantelle Simone-Roach, Jonathan Lindstrom-Vautrin, Judith Olejnik, Ellen L. Suder, Esther Bullitt, Anne Hinds, Arjun Sharma, ***Markus Bosmann****, Ruobing Wang, Finn Hawkins,* ***Mohsan Saeed****, Eric J. Burks, Andrew A. Wilson,* ***Elke Mühlberger*** *Darrell N. Kotton. Stem Cell Reports, September 18, 2020*

CORONAVIRUS RESEARCH

What Sets Off Deadly Levels of Lung Inflammation in Some COVID-19 Patients?

In human stem cell–derived lung tissue infected with coronavirus, BU scientists are studying the biological domino effect SARS-CoV-2 sets off

THE BRINK, Pioneering Research from Boston University

SEPTEMBER 8, 2020, By KAT J. MCALPINE

A team of infectious disease and regenerative medicine researchers at Boston University, studying human stem cell–derived lung tissue infected with SARS-CoV-2, are discovering new insights into how the novel coronavirus kicks off a cascade of tissue inflammation in the lungs.

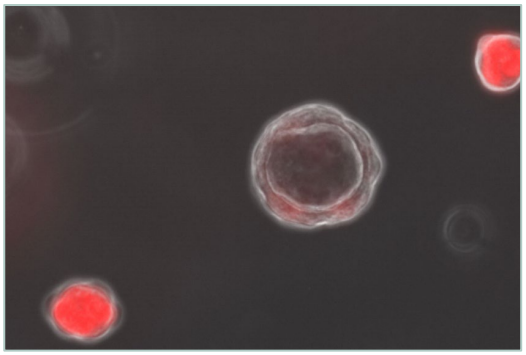
That reaction can be especially lethal for older people, who make up 8 out of every 10 deaths from COVID-19, the disease caused by the coronavirus. As people get older, their risk of having an underlying health condition increases, and at the same time, their immune system is aging. Both of those factors are thought to contribute to chronic inflammation—making older people far more susceptible to the added inflammation that a COVID-19 infection sets off in the body.

The researchers' experimental data appears to confirm a theory developing among clinicians and researchers that SARS-CoV-2 initially suppresses lung cells' ability to call in the help of the immune system to fight off the viral invaders.

The delay in recruiting defensive reinforcements then backfires, the signal going off several days after infection has set in. That delay attracts an army of immune cells into lung tissue laden with infected and already dead and dying cells, dousing those inflammatory conditions with even more fuel.

Like most other scientists racing to find promising new strategies to halt the spread of COVID-19, the BU team has publicly released their data in a "preprint" paper (a draft that has not been formally reviewed and published in a peer-reviewed journal) to share their research with the scientific and medical community as soon as possible while their findings are being peer-reviewed for publication in a scientific journal.

"The data is teaching us that [the cells lining the lungs] act something like a white blood cell," a patrolling watchdog cell that's part of the immune system, after infection with SARS-CoV-2, says study coleader Darrell Kotton, a lung biologist and director of the Center for Regenerative Medicine (CReM) on BU's Medical Campus. The infected lung cells "pour out inflammatory proteins." In the body of an infected person, those proteins drive up levels of inflammation in the lungs.



BU scientists have developed these human stem cell–derived lung cells, which grow as three-dimensional organoids. Infecting them with SARS-CoV-2, the researchers are studying how COVID-19 triggers fatal levels of inflammation in vulnerable patients. Photo courtesy of Jessie Huang/Darrell Kotton Lab/BU CReM.

The data is based on experiments the research team performed at BU's National Emerging Infectious Diseases Laboratories (NEIDL). Kotton and other members of CReM have developed sophisticated models of human lung tissue—three-dimensional structures of lung cells, called "lung organoids," grown from human stem cells—which they've used at BU and with collaborators elsewhere to study a range of chronic and acute lung diseases.

Adapting their expertise to engineer alveolar cells, which line the inside of lungs and are difficult to extract from patients for research purposes, the CReM lung model is being infected with SARS-CoV-2 by virologists at the NEIDL. The stem cell–derived lung model provides a better model of cells found in real human lungs than, as is commonly done, using cultures of animal-derived cells to investigate disease.

"Our organoids, developed by our CReM faculty, are engineered from stem cells—they're not identical to the living, breathing cells inside our bodies, but they are the closest thing to it," Kotton says.

For more than a decade, Kotton has worked with BU regenerative medicine and stem cell engineers Andrew Wilson and Finn Hawkins—who along with Kotton are faculty members at BU School of Medicine and pulmonologists at its teaching hospital, Boston Medical Center (BMC)—to develop these state-of-the-art stem cell models. The three physician-scientists work together at BMC, caring for patients with lung disease—including, over the last six months, people critically ill from coronavirus—while leading the CReM teams that engineer lung cells and organoids for research.

Mohsan Saeed, a BU NEIDL virologist working on this research with Kotton and other collaborators, says organoids are extremely valuable to infectious disease researchers. “During the Zika outbreak, scientists were using brain organoids, and similarly, liver organoids have been used to study hepatitis C,” Saeed says. “One of the things I noticed when the Zika outbreak came along is that when you immersed brain organoids in the virus, the infected cells—and neighboring cells like you would find in a true brain—reacted quite differently than traditional cultured cells.”

To study the novel coronavirus in lung tissue mimicking human lungs, Jessie Huang, a postdoctoral associate at the CReM, says the team adapted an experimental model previously developed to study the effects of smoking cigarettes.

“We plate all of the [lung cells] on a mesh membrane, and then we expose them to the air on the top,” Huang says. Below the membrane, a liquid substance filled with cellular growth factors feeds the cells, a substitute for the blood vessel network of the human body.

At the NEIDL, BU virologist Adam Hume, a senior research scientist in Elke Mühlberger’s lab, adds droplets of live coronavirus on top of the lung cells, infecting them from the air side of the interface, similar to the way the virus infects cells lining the inside of the lungs when air containing the virus is breathed into the body. They’ve been running these experiments inside one of the NEIDL’s Biosafety Level 4 (BSL-4) laboratories, the highest possible level of biosafety containment used for infectious agents that pose especially high risk to humans.

Mühlberger’s BSL-4 lab at the NEIDL typically handles some of the world’s most lethal viruses, like the ones that cause Ebola or Marburg fevers. But since the start of the coronavirus outbreak her team has pivoted to focusing on SARS-CoV-2, collaborating with colleagues from BU and universities across New England who don’t have their own infectious disease research facilities. (The BSL-4 lab they use to perform live SARS-CoV-2 experiments is one step of containment above the required BSL-3 that the Centers for Disease Control and Prevention says is required for working with live copies of the virus.)

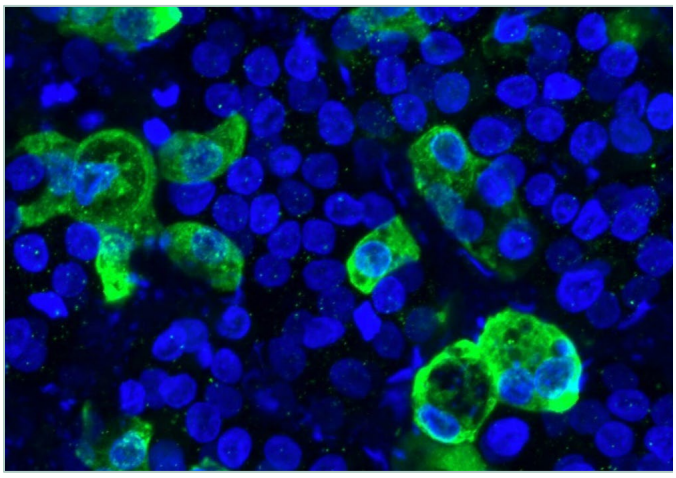
Since the pandemic took root in the United States, Hume has been clocking up to 30 hours a week inside the BSL-4, wearing the requisite full biocontainment suit with its own oxygen supply—an earthly version of a space suit, essentially.

He’s infected hundreds of cell cultures with live coronavirus using purified, highly concentrated doses of SARS-CoV-2 that he’s enhanced for experimental research purposes. The purified coronavirus removes the chance that any other cell components are present, so that other factors don’t influence experimental results. The doses also contain a high concentration of the coronavirus so that each attempt to study the disease in lab cultures has an extremely probable chance of achieving infection. This level of efficiency, Hume says, is critical for coronavirus research to proceed quickly.

Mühlberger says their experimental observations in the lung model confirms that SARS-CoV-2 blocks cells from activating the immune system early on after infection has set in.

The signal the cells would typically send out a tiny protein called interferon that they exude under threat of disease, are instead delayed for several days, giving SARS-CoV-2 plenty of time to spread and kill cells, triggering a buildup of dead cell debris and inflammation.

“SARS-CoV-2 blocks interferon’s response,” Mühlberger says, which indicates treatment with interferon might help protect cells from SARS-CoV-2’s attack.



Inside the BU NEIDL, Adam Hume used SARS-CoV-2 (green) to infect these stem cell–derived lung cells (blue). Photo courtesy of Kristy Abo/Andrew Wilson Lab/BU CReM.

Interferon is already being used experimentally in some patients based on initial research conducted elsewhere that revealed that SARS-CoV-2 dampened interferon’s signal in commercially available cell lines. But many of those cells have muted immune system responses anyway, Mühlberger says, because of the way they are produced and processed for mass experimental use. The CReM’s lung models, on the other hand, represent true “in the wild” cell types—they represent true “in the wild” cell types—they behave much more like the actual cells inside the lungs of living humans.

Now, Mühlberger says, the team is planning to investigate the impact of the SARS-CoV-2 virus on a mix of lung cells and white blood cells, the patrol cells of the immune system. Looking at both types of cells, infecting them together in

coculture, is important because white blood cells, after picking up distress signals sent out by infected lung cells, travel into lung tissue to kill SARS-CoV-2. Their arrival and subsequent attack on coronavirus-infected cells can add even more fuel to a raging five-alarm fire of inflammation.

Because, early on after infection, SARS-CoV-2 appears to slow down the body's ability to call in the help of the immune system, by the time white blood cells appear, they may tip the lungs into a dangerous level of inflammation that can lead to organ failure.

"Why do some people generate this very profound response, especially elderly people or people with underlying health conditions?" Hume says. "It's possible they are experiencing higher levels of inflammation, or that their immune systems aren't able to control the virus before inflammation takes hold."

This research is supported by Evergrande MassCPR awards, the National Institutes of Health, a CJ Martin Early Career Fellowship from the Australian National Health and Medical Research Council, an I. M. Rosenzweig Junior Investigator Award from the Pulmonary Fibrosis Foundation, a Harry Shwachman Cystic Fibrosis Clinical Investigator Award, the Gilead Sciences Research Scholars Program, Gilda and Alfred Slifka and Gail and Adam Slifka funds, a Cystic Fibrosis Foundation grant, and a Fast Grants award.

BU lab using microscopic 'lungs' to study COVID-19

Healthy cell clusters better way to find possible treatments

By Jim Morelli, Boston 25 News, August 05, 2020 at 6:35 pm EDT

BOSTON — Scientists sometimes use human lung cancer cells in medical research. But there's just one problem with that, said virologist Elke Mühlberger, PhD. "These cancer cells do not act like lung cells," she said. "They act like cancer cells."

For her research on Covid-19, Dr. Mühlberger, who works at Boston University's National Emerging Infectious Diseases Laboratories, has the next best thing to an actual human lung – a microscopic version known as an organoid.

Organoids are derived from adult blood cells that have essentially been stripped of their identities then put through a chemical process to grow them into specific cell types.

"So they could become a liver cell," Mühlberger said. "They could become a lung cell."And for Mühlberger, they became the specific type of lung cell commonly attacked by COVID-19.

"It's a cell type which is deep in our lung," Mühlberger said. "It's called an alveolar lung cell. People that get really sick – they have the virus in these specific cells."

By infecting these healthy alveolar cells with COVID-19, Mühlberger and colleagues are learning how the virus kills and what treatments might offer protection. One thing the research has already uncovered is that lung cancer cells infected with COVID-19 respond differently to some drugs than healthy lung cells do.

Mühlberger normally works on such lethal viruses as Ebola. She suggested there is a bright side and a dark side to COVID-19.

"Fortunately it is less pathogenic than many of these viruses that spill over from animals to humans," she said. "The problem with this virus is our immune system is not adapted to these viruses, so we have not co-evolved with this virus. And this is one of the reasons we have such a hard time coping with infection."

Mühlberger anticipates that the COVID-19 research won't stop at clusters of lung cells either because, unfortunately, the virus doesn't stop at the respiratory system on its rampage through some bodies.

BU COVID-19 research *Dr. Adam Hume, a Senior Research Scientists in Dr. Mühlberger's laboratory at BU NEIDL, infects lung epithelial cells with SARS-CoV-2.*

NEIDL Faculty and Staff Recognition

Faculty Promotions

Professor

Rachel Fearns, PhD, MED, Microbiology, is a virologist known for her work in the field of non-segmented, negative sense RNA viruses, specifically in dissecting the molecular mechanisms by which the viral genome is transcribed and replicated by the viral polymerase. Her expertise has been sought after to write definitive reviews on viral polymerases and transcription/ replication mechanisms, acknowledging her recognition as a leader in the field. In addition, she is sought out by grant review committees, both nationally and internationally, and she currently is a standing member of a NIH grant study section. She has been a member of various journal editorial boards, and currently serves as a review editor for PLoS Pathogens. She has maintained consistent funding from the NIH, various pharmaceutical companies, and private foundations.

Elke Mühlberger, PhD, MED, Microbiology, is a virologist who have contributed to our understanding of the filovirus family, including Ebola and Marburg viruses. Filoviruses cause a severe disease in humans with high case fatality rates and must be handled under biosafety level 4 (BSL-4) conditions. They belong to the group of non-segmented negative sense RNA viruses and have evolved a unique replication strategy. Dr. Mühlberger has established a reputation for innovation. She was one of the first to study the replication and transcription mechanisms of filoviruses and developed reverse genetics systems that allow for a detailed study of these processes. These systems are widely used in the field of filovirus research. She has since made numerous seminal discoveries, including dissecting the innate immune responses to these viruses, as well as identifying viral proteins that block them. Dr. Mühlberger has contributed significantly to our understanding of virus infection and replication in host cells, identifying the regulatory components on the viral genome that regulate viral replication and transcription, and elucidating the roles of the viral proteins involved in viral amplification and host responses. She has a strong focus on studying filovirus infection in disease-relevant human cells

An indication of the reputation of faculty is best exemplified by their selection as invited speakers in national and international forums, service on review panels and service on editorial boards of journals. Other forms of recognition include being sought after because of their experience and ability to use their expertise to explain a story to the news media about current events. NEIDL faculty continue to be recognized as summarized below.

Associate Professor

Nahid Bhadelia, MED, Medicine/Infectious Diseases, designs and deploys evidenced-based infection control and biosafety training for clinicians and leverages emerging scientific research with extensive clinical background to improve the standard of care for patients with viral hemorrhagic fevers. She contributes to national and international training programs, guidelines and expert working groups on clinical care, research and infection related to Ebola virus disease. She helps design and implement clinical research on evaluation of natural history of emerging infectious diseases and the efficacy of related therapeutics and is principal investigator of the Boston Medical Center's prospective COVID-19 patient cohort study. In addition, Dr. Bhadelia is Director of the Medical Response program associated with the NEIDL's Biosafety Level 4 program, and Medical Director of the Special Pathogens Unit at Boston Medical Center.

Other Academic Appointments

Nicholas Crossland, DVM was appointed Director, NEIDL Comparative Pathology Laboratory, July 2020

Nahid Bhadelia, MD was appointed Director of the New BU Center for Emerging Infectious Diseases, June 2021

Conference Presentations & Invited Lecturers (National & International)

Nick Crossland

- "High Dimensional Spatial Biology: from Discovery to High Throughput Studies." Invited Speaker at Webinar sponsored by Indica labs and Akoya Biosciences, September 2020.
- "Fatal neuroinvasion of SARS-CoV-2 in K18-hACE2 mice is partially dependent on hACE2 expression." Annual ASV meeting, July 2021.

Florian Douam

- "Humanized mouse models to investigate viral pathogenesis and immunity." Generation Bio Co. Boston, MA, USA. March 2021.

- "Humanized mouse models to investigate viral pathogenesis and immunity." Boston University Pulmonary Center Weekly Combined Clinical and Research (CCR) Conference. Boston, MA, USA. March 2021.
- "Humanized mouse models to investigate immunoregulations defining effective control of SARS-CoV-2 infection in the human lung. Center for Mitochondrial and Epigenomic Medicine." Perelman School of Medicine at the University of Pennsylvania. Philadelphia, PA, USA. May 2021.
- "Humanized mouse models to investigate immunological mechanisms defining effective control of SARS-CoV-2 infection in the human lung. "University of North Carolina at Greensboro. Greensboro, NC, USA. October 2021.

Rachel Fearns

- ASM COVID-19 Registry Virtual Journal Club – September 2020
- "The polymerase complex of the non-segmented negative strand RNA viruses: differences in initiation mechanisms." Invited Speaker to the 34th International Conference on Antiviral Research, Virtual Conference, March 2021.
- "Mechanistic insights into respiratory syncytial virus transcription and genome replication". Department of Microbiology and Immunology Speaker Series, SUNY Buffalo, NY, April 2021.

Anthony Griffiths

- "Advanced development of filovirus countermeasures yields insights into viral pathogenesis." Invited Speaker at Albert Einstein College of Medicine, New York, NY, 2020
- "Cellular Nanosponges inhibit SARS-CoV-2 infectivity." Invited Speaker at PepTalk Virtual Conference and Expo, January 19-21, 2021 2021
- "SARS-CoV-2 therapeutics from the hot side." National Covid-19 nanomedicine seminar, Northeastern University, Boston, MA, 2021
- "Advanced development of Ebola virus countermeasures yields insights into viral pathogenesis." Invited Speaker at the Italian Society for Virology, July 2021

David Hamer

- "Malaria and neglected tropical diseases" presented in Research Area Breakout Groups at the Fogarty Global Health Program for Fellows and Scholars orientation and training meeting
- "Global Perspective on the Impact of COVID-19 on Child Education and Development iSci Webinar" co-chair with Dr. Janna Paterson, organized by the Child Health Task Force
- "COVID-19 and travel" presentation and panel with Drs. Lin Chen and Robert Steffen organized by the Flight Safety Foundation at the International Air Safety Summit 2020
- "Setting Global Research Priorities for Private Sector Child Health Service Delivery: Results from a CHNRI Exercise" webinar organized by the Private Sector sub-group of the Child Health Task Force
- "Post-COVID-19 persistent symptoms and complications" presented at the "The world of risk post-pandemic will never be the same" organized by the Professional Risk Manager's International Association – Nov 2020
- "GeoSentinel" presented at the Tropical Diseases and Travel Medicine, Conference, Bucharest Romania- Nov 2020
- "Travelers and spread of antimicrobial resistance" presented at the Tropical Diseases and Travel Medicine Conference, Bucharest Romania – Nov 2020
- "Fever in the returning traveler: the GeoSentinel experience". Medical Grand Rounds, Washington Hospital Center, Washington, DC – Dec 2020
- Panel discussant with Nahid Bhadelia on COVID-19 planning for the fall semester for the Association of Independent Colleges and Universities of Massachusetts (AICUM) – April 2021
- Moderator for "COVID-19 Vaccines: Availability & implications for children globally and lessons from Kenya and Ghana" webinar organized by the Implementation Science subgroup of the Child Health Task Force – April 2021
- "GeoSentinel: Tracking emerging infectious and tropical diseases"; presented to the Novartis Institutes for Biomedical Research – May 2021
- "GeoSentinel update and networking session" presented with co-PI, Michael Libman at CISTM 17 (17th Conference of the International Society of Travel Medicine).
- Moderator for "The big beasts: travelers' diarrhea and malaria" at CISTM17 - May 2021
- "Pre-exposure rabies prophylaxis – must not be forgotten" presented in the Neglected Travel Medicine Infections symposium at CISTM 17 - May 2021
- "COVID-19: an update on epidemiology, clinical manifestations, diagnosis, treatment and prevention" webinar presented to the Kuwait Medical Society - May 2021

- "How to be a successful mentor: review of mentorship competencies and strategies", organizer, moderator, and speaker for the HBNU Mentor Capacity Strengthening Symposium. – June 2021
- "Design and implementation of the Zambia Chlorhexidine ApplicationTrial" presented to the Boston University and University of Liberia Emerging and Epidemic Virus Research Program (BULEEVR) fellows– June 2021

Anna Honko

- "Telemetry concepts". Invited lecturer at FDA/UTMB collaborative course: "Achieving Data Quality & Integrity in Maximum Containment Laboratories", June 16, 2021

Nelson Lau

- "Transposon landscape changes in aging Drosophila.", CSHL Mechanisms of Aging meeting 2020 (Virtual), Cold Spring Harbor Labs, NY [*Conference Presentation*], October, 2020
- "Integrated small RNA genomics of mosquito cells reveal dynamic evolutionary responses to viruses and transposons.", CSHL Transposable Elements meeting 2020 (Virtual), Cold Spring Harbor Labs, NY [*Conference Presentation*], November 2020
- "Transposable element landscape changes are buffered by RNA silencing in aging Drosophila.", FASEB Mobile DNA Conference 2021 (Virtual), FASEB, SRC NY [*Conference Presentation*]. June 2021

Jay Mizgerd

- 2020 Louisiana State University School of Veterinary Medicine, Baton Rouge, LA (Department of Pathobiological Sciences) (Canceled due to COVID-19)
- 2020 Unlocking the Potential of Trained Immunity to Treat Respiratory Diseases Scientific Symposium, International Conference of the ATS (Delivered on-line for ATS2020 due to COVID-19)
- 2020 Unlocking Immunity to Fight Infection expert panelist in hosted discussion forum, International Conference of the ATS (interactive webinar for ATS2020)
- 2020 Keynote Address, Annual Symposium for NIH COBRE: LSU Center for Lung Biology and Disease – remote due to COVID-19
- 2020 Tulane University School of Medicine, New Orleans, LA (Department of Microbiology and Immunology) – remote due to COVID-19
- 2020 University Lecture, Boston University ("From Cough to COVID: How Respiratory Infections Produce Problems and Our Bodies Fight Back")
- 2021 Webinar: expert panelist for society journal club (Section on Genetics and Genomics, ATS)
- 2021 New England Immunology Conference (Woods Hole, MA)
- 2022 University of Toronto, Toronto, Ontario, Canada (Grand Rounds, Critical Care Medicine)
- 2022 Gordon Research Conference: Biology of Acute Respiratory Infection (Ventura, CA)

Elke Mühlberger

- "The inflammatory response in Ebola virus infection", PISA 2020, Annual Meeting of the American Society for Investigative Pathology, November 2020.
- "Virology during the lockdown - SARS-CoV-2 and a bit Ebola". Invited speaker at Virology Seminar Series, Harvard Medical School, Boston, MA, March 2021.
- "iPSC-derived cells and organoids to study SARS-CoV-2 and Ebola virus infections". Department of Infectious Diseases, University of Georgia, Athens, GA, May 2021.

Mohsan Saeed

- Viral degradomics: unraveling the role of proteolysis during viral infections. Center for Infection and Immunity, Hannover Veterinary School, Germany. (19 April 2021; virtual)
- Innate immune evasion tactics of SARS-CoV-2. Keynote presentation at the California Northstate, University Research Symposium. Elk Grove. (29 January 2021; virtual)
- Animal models, organoids, and replication systems. Conference Chair at: HCV 2021. 7 July 2021. Co-chair: Alexander Ploss.

Committee activities

Ron Corley

- Chair, Director's Group, NBL-RBL Meeting, 2020

David Hamer

- Member, Scientific Program Committee, CISTM 17, 2019-2021

Anthony Griffiths

- World Health Organization SARS-CoV-2 Animal Model Development Panel 2020
- World Health Organization SARS-CoV-2 Assay Development Panel 2020

Anna Honko

- Member, Aerosol Challenge Executive Committee. DTRA Sponsored, 2020

Elke Mühlberger

- ad hoc member, Board of Scientific Counselors, NIH Vaccine Research Center 12/2020-2021

Editorial Boards

Nick Crossland

- Journal of Veterinary Medicine, 2019-current

Rachel Fearns

- Reviews Editor, PLOS Pathogens, 2020

David Hamer

- Guest Editor, Proceedings of the National Academy of Science (PNAS), 1/2021

Anna Honko

- Editorial board, MDPI Pathogens, section editor-in-chief of "Human Pathogens", 2020-Present

Honors

Florian Douam

- K22 NIAID Transition Award (awarded/activated)

Jay Mizgerd

- 2021 Scientific Achievements Award, ATS Assembly on Allergy, Immunology & Inflammation (AII)

Mohsan Saeed

- 2021 Keynote speaker at the California Northstate University Research Symposium
- 2020 Co-director of the ARC *"Respiratory viruses: A focus on COVID-19"*

Memberships

Nick Crossland

- Member, American Society for Investigative Pathology, 2020-current

Florian Douam

- Member, American society of virology – Full member since 2021

NIH Study Sections

Rachel Fearns

- NIH Virology B study section, USA 2019-2023

Anthony Griffiths

- NIH study section 2021/10 Vaccines against Microbial Diseases Study Section

Igor Kramnik

- Reviewer, F07A Infectious Diseases and Immunology Fellowship Panel: ZRG1 F07A-H (20) L, March 24 – 25, 2021
- Reviewer, Topics in Bacterial Pathogenesis 2021/01 ZRG1 IDM-B (81) S , November 5, 2020

Nelson Lau

- Reviewer, ZRG_GGG_F Study Section on R24 Resources Grant

Elke Mühlberger

- Reviewer, Special Emphasis Panel (ZAI1 ESB-M) - 10/2020
- Reviewer, NIH/NCATS, Special Emphasis Panel (ZTR1 NTU-2 (02) 1) - 03/2021
- Member, Virology A (VIRA) Study Section – 2019-2023

Patents

Florian Douam

- Jacob Schneiderman, **Florian Douam**. Novel Therapy for Acute Damage to Lung Tissue. 2021. US application 17235968.

Review Panels

Ron Corley

- Ad hoc reviewer, National Research Foundation, Singapore (2016, 2017, 2021)
- External reviewer, UTMB Department of Microbiology and Immunology (2021)
- Member, Internal Oversight Committee, Providence/Boston Center for AIDS Research (CFAR) (12/2017 – present)

Rachel Fearns

- Member Deutsche Forschungsgemeinschaft (DFG) grant review panel, Germany (2021)

Elke Mühlberger

- Reviewer for The M.J. Murdock Charitable Trust, reviewer 8/2020

Education

In partnership with the Department of Microbiology and the GMS Immunology Training Program, the NEIDL co-sponsors the Microbial Pathogenesis and Immunology Seminar Series. Below is a list of virology guest speakers who presented at the NEIDL.

Date	Speaker	Title	Host
10/7/2020	**Britt Glaunsinger, Ph.D.** University of California, Berkley	"Controlling the Message: Viral Restriction of Host Gene Expression"	Tonya Colpitts
10/14/2020	**Bert Semler, Ph.D.** University of California, Irvine	"Exploitation of Nuclear Functions by Cytoplasmic RNA Viruses"	Mohsan Saeed
10/21/2020	**Jason McLellan, Ph.D.** University of Texas, Austin	"Structure-Function Studies of the SARS-CoV-2 Spike and Development of COVID-19 Interventions"	Rachel Fearns
10/28/2020	**Joseph Zaia, Ph.D.** Boston University	"Quantifying Changes in Spike Protein Glycosylation during Viral Evolution"	Ron Corley
11/18/2020	**Sebastian Joyce, Ph.D.** Vanderbilt University Medical Center	"Taking Antigen Presentation to the Bazar!"	Andy Henderson
2/3/2021	**Samantha Bell, PhD.** Texas A&M	"Cytosolic Detection of Mycobacterium tuberculosis Activates Potent Immune Responses"	Rahm Gummuluru
2/10/2021	**Kiera Clayton, Ph.D.** Ragon Institute	"Macrophages: Hide outs for HIV and drivers of inflammation"	Rahm Gummuluru
2/17/2021	**Parisa Kalantari, Ph.D.** Tufts University	"Molecular Pathways Restraining Immunopathology in Schistosomiasis"	Rahm Gummuluru
2/24/2021	**Robert Abbott, Ph.D.** La Jolla Institute for Immunology	"To B or not to B? The Story of B Cell Precursors and Complex Vaccine Antigens"	Rahm Gummuluru
3/17/2021	**Wilton Williams, Ph.D.** Duke University	"Fab-dimerized Glycan-reactive Antibodies are a Novel Structural Category of Natural Antibodies"	Thomas Kepler
4/7/2021	**Michaela Gack, Ph.D.** Cleveland Clinic	"Innate Immune Regulatory Circuits and Antagonism by SARS-CoV-2"	Michael Breen
4/14/2021	**Sallie Permar, M.D., Ph.D.** Weill Cornell Medical Center	"Rational Design of a Vaccine to Prevent Congenital Cytomegalovirus: We are Halfway There"	Thomas Kepler

Community Outreach

With the increased focus on infectious diseases on a local, national, and global scale, the media attention on the NEIDL has been higher than ever. During these challenging times when misinformation has been spreading like wildfire among different media platforms, our Community Relations team rose to the occasion to reinforce our commitment to transparency and building trust among the community. This has been the main focus of our outreach efforts; to ensure that more external and internal stakeholders understand the value of the research conducted at the NEIDL and its impact on public health. Of equal importance, have been the efforts to show that the NEIDL and the BU Medical Campus are part of a bigger strategy to promote access to more equitable career and training exposure and opportunities in the STEM fields, especially for our next generation of young people.

Community Liaison Committee

The CLC continues to be a key resource for is to making sure that the public receives information about the NEIDL facility and research. Despite having to move to video conference meetings, their participation and comfort level in asking questions and voicing concern has remained strong. During this past year we have held 6 virtual meetings. The majority of the topics were suggested by the CLC members.

CLC Meeting Schedule		
Date	**Topic of Discussion**	**Guest Speakers**
Apr & Jun-20	NEIDL research projects on SARS CoV-2 and Covid-19	Dr. Ron Corley, NEIDL Director
Sep-20	Research presentation: "Supporting Covid -19 Response at NEIDL: SARS-CoV-2 and Nanosponges."	Dr. Anna Honko, Associate Research Professor of Microbiology
Nov-20	NEIDL Annual Public Meeting	NEIDL faculty and staff
Feb-21	Presentation and discussion on Covid-19 Pandemic	Dr. David Hamer, Professor of Public Health
Apr-21	Introducing CARB-X – accelerating research and product development to combat the rising global threat of drug-resistant bacteria	Prof. Kevin Outterson, Professor of Law, Executive Director of CARB-X
Jun-21	Presentation "Tracking Covid-19 and Variants of Concern in the Boston Area "	Dr. John Connor, Associate Professor of Microbiology
Coming up Fall 2021 Guest speaker Dr. Nahid Bhadelia will present the new Center for Emerging Infectious Diseases Policy & Research (CEID) NEIDL Annual Public Meeting at the BPHC. Open to the public		

CLC member diversity – In our continued efforts to build our reputation as a scientific resource on infectious diseases and establish trust within the community it is important for CLC members to be representative of all the surrounding the NEIDL facility. This year we have replaced retiring members with 3 new members from Roxbury and Dorchester. The CLC is now at 13 members.

Also worth highlighting is that CLC members actively participate in NEIDL Emergency Response simulations and provide valuable feedback. Comments and suggestions from internal and external participants are included in after action reports that outline corrective measures to improve emergency responses in the future.

NEIDL Tours

Prior to the pandemic, the NEIDL tours were a wonderful way to introduce community and other stakeholders to the NEIDL and reinforce the safety of the facility and the importance of the research. Given the current pandemic, and the fact that we will have a mayoral race and new City Councilors that have never been inside the NEIDL, we must work on developing virtual tours and ask the CLC to partner with us to make these effective and informative.

NBL/RBL Network

Our Community Relations staff collaborates regularly with other members of the NBL/RBL Network via calls and virtual meetings for the purpose of sharing information and learning about best practices from our colleagues. This year we even fielded a request for advice from the University of Saskatchewan. Our colleague, Ken Pekoc, in Missouri was helpful in making the connection to us. We discussed with the Director of Research Profile & Impact for the University of Saskatchewan best practices in community relations around a BSL-4 facility. We were then able to direct her to the Public Relations Staff at BU MARCOM for more brainstorming and advice around communication issues at a BSL-4 facility.

While the 12th Annual NBL/RBL Network meeting was cancelled for 2020, we are starting to explore whether this meeting can be held physically in Boston in the Spring of 2022 or whether we can develop other creative solutions for the Network to meet and share (besides the well-known and practiced "zoom meetings").

Educational Programs/Career Development

As mentioned previously, there is considerable community interest in the NEIDL and the BU Medical Campus as an educational and training resource. Our NEIDL faculty and staff enjoy sharing their story on how they chose a career in their field, be it science, technology, or biosafety, with young students. This year we participated as judges and volunteers in the **2021 Boston Public Schools Science and Engineering Fair** from March 3-5. We reviewed a number of middle school and high school projects ranging from sleep deprivation, carbon dioxide impact on planet growth and a favorite among many of us: "how were zoo animals dealing with the decrease in zoo attendance due to the Covid-19 pandemic?

Featured guest speaker program: "My Journey to…"

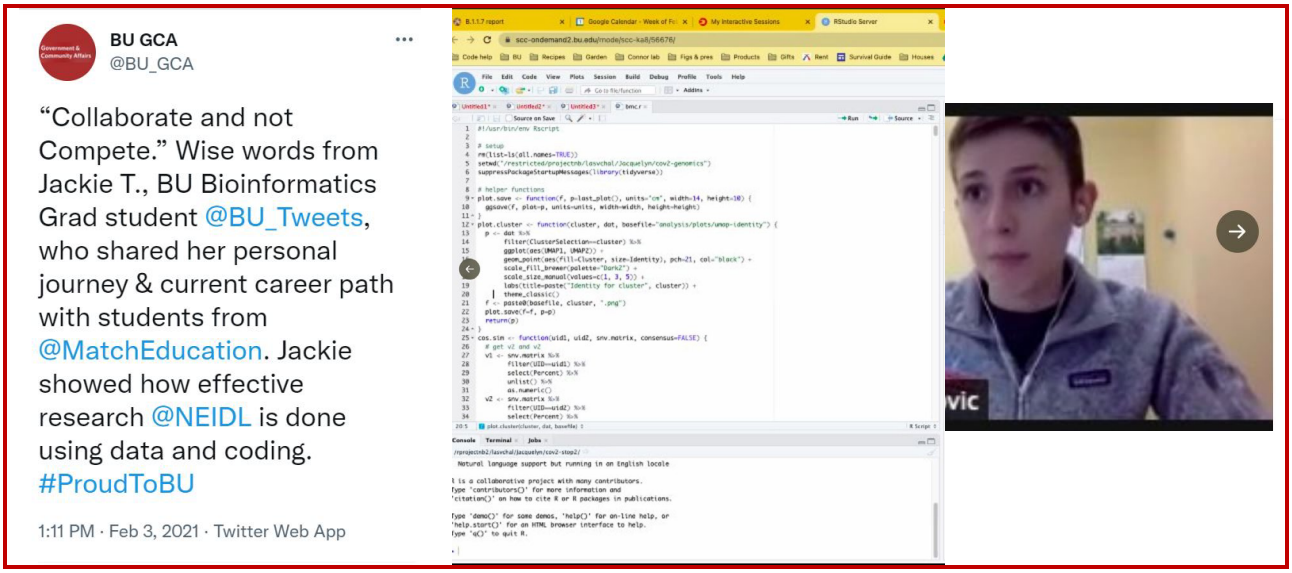
The **"My Journey To…" Speaker Series** is a virtual career exploration program focused on exposing students to careers they may not be familiar with. Featuring various BU professionals, the Speaker Series allows for students to engage with industry experts around college preparedness, job skills, and their personal roadway to their respective careers. Each professional is asked to give a brief demonstration of their career or personal passion. This demonstration is generally done live, but in some instances, it has also been pre-recorded. We partnered with two schools in the Boston Public Schools system to hold this monthly Speaker Series for the 2020-2021 school year; the Madison Park Technical Vocational High School, located in Roxbury and the Match Charter Public High School, located on Commonwealth Ave in Boston,

The series with **Madison Park Technical Vocational High School** focused primarily on the careers offered at the National Emerging Infectious Diseases Laboratories (NEIDL), and the relevancy and importance our work here. Students asked questions and gained valuable insight on the necessary skills and educational pathways for a career in STEM.

The **Match High School** offered a broader scope of careers; Boston University professionals from across the university spoke about a variety of , including STEM, Athletics, Marketing, and more.

My Journey to … at Madison Park High School		
Date	**Career Topic**	**NEIDL guest speaker**
Oct-20	Research Environmental Health and Safety in high containment laboratories	Shannon Benjamin & Dr. Nadya Yun NEIDL EH&S
Nov-20	Information Technology in high containment laboratories	John McCall, Director of NEIDL IT
Jan-21	On balancing a career in Community Outreach and his love for DJing	Chimel Idiokitas, NEIDL Community Outreach programs
Feb-21	On becoming an Engineer and working in a research building	Nafisah Nakhid, NEIDL Facilities
Mar-21	Infectious Disease Medicine and Public Health	Dr. Nahid Bhadelia, Professor of Medicine
Apr/May '21	Sessions cancelled due to scheduling conflicts	

My Journey to … at Match High School		
Date	**Career Topic**	**BU guest speakers**
Nov-20	Research Laboratory Technician in BSL-3 containment	Afzaal Shareef, Research Technician, Fearns Lab
Dec-20	Careers in College Athletics; Communications, Marketing and Digital Media, and supporting the college athlete	Pat Lawlor, Leo Pare, & Tylor Hart BU Athletics
Jan-20	On balancing a career in Community Outreach and his love for DJing	Chimel Idiokitas, BU Government & Community Affairs
Feb-21	Using data to conduct Biomedical Research	Jacquelin Turcinovic, Graduate Student, Bioinformatics Program
Mar-21	Her career journey as a Photojournalism	Cydney Scott, BU Staff photographer
Apr-21	Her writing journey to BU	Kat McAlpine, The Brink Editor
May-21	Promoting the Arts on campus and in our lives	Ty Furman, BU Arts Initiative



Since July 2020, we have engaged with over 75 students from various neighborhoods throughout the City, State, and Country.
Many of our BU colleagues were more than willing to give their time to speak with students. This allowed for Boston University Government and Community Affairs to coordinate additional Speaker Series sessions with other student groups who belong to organizations we support. Organizations like Sociedad Latina, Steps to Success, BU SPH Population Health Exchange and Master Academy, all took advantage of this opportunity to engage with professionals.

My Journey to … for sponsored community partners			
Date	**Career Topic**	**NEIDL guest speakers**	**Community Partner**
Jul-20	Information Technology Support in research laboratories	Ben Slutsky, NEIDL IT Administrator	Sociedad Latina
Aug-20	Research Environmental Health and Safety in high containment laboratories	Shannon Benjamin, NEIDL EH&S	Sociedad Latina
Dec-20	Information Technology in maximum containment laboratories	John McCall, Director of IT, NEIDL	Sociedad Latina
Dec-20	Using data to conduct Biomedical Research	Jacqueline Turcinovic, Graduate Student, Bioinformatics	Steps to Success
Jun-21	Careers in Lab Research Safety and Facilities Engineering	Shannon Benjamin, Dr Nadya Yun, NEIDL EH&S, and Nafisah Nakhid, NEIDL Facilities	Master Academy in Population Health
Jul-21	Careers in Emergency Planning and Management, Working with dangerous pathogens in high containment, and safety.	Sierra Downs, Lauren Malsick, and Dr. Nadya Yun, NEIDL Staff	PophealthExperience (PHX)

More about our community partners:

Master Academy in Population Health *is a BU SPH Summer Program designed for high school students in the US and Canada to teach them about the fundamental skills of Public Health. The program provides rising 10th – 12th graders an engaging and intensive exposure to a wide range of public health experiences. Students will be immersed in a range of public health topics, participate in hands-on research activities, discover career choices, and develop leadership skills. (populationhealthexchange.org/learning-opportunities/master-academy-in-population-health)*

PophealthExperience (PHX) *is a BU SPH Summer Program serving middle school students from across Massachusetts in grades 7-9th. The program offers and engaging and immersive introduction to the field of public health. Students learn from Boston University School of Public Health faculty and graduate students about a range of public health topics, participate in hands-on research activities, discover career choices, and develop leadership skills. (populationhealthexchange.org/learning-opportunities/pop-health-experience)*

Sociedad Latina *partners with Latino youth and families to end the cycle of poverty, inequality to access of health services, and lack of educational and professional opportunities in our community. Their model supports positive creative youth development from ages 11 to 21, creating a community that values young people and enables them to be leaders in their community while fostering pride in their rich cultural heritage. Over a thousand of these young people participate in our daily programming focused in four key areas that meet the needs and interests of the community: Education, Workforce Development, Civic Engagement, and Arts and Culture. (https://www.sociedadlatina.org/)*

Steps to Success *builds and directs programs geared at promoting equity for students from low-income families in Brookline by expanding their horizons, building upon their skills, and supporting their educational journey in order to maximize their life choices. Steps to Success serves Brookline students through afterschool programs, vacation programs and camp access, career readiness through paid internships and workshops, and college success through advising, mentoring, and financial aid access. (https://www.stepstosuccessbrookline.org/)*

Now that the 2021 Academic year has been completed, we hope to grow this series to an in-person model for the upcoming 2021-2022 academic year. In order to better connect with students, we hope to work with more departments at the NEIDL and throughout the wider campus to identify individuals who have compelling stories to share and are willing to impart knowledge and guidance to the next generation. Our plan is to return to Match High school with an in-person component, and add another school (middle or high school), located in close proximity to the BU Medical Campus. We want to continue to engage with students around career exploration and help grow the next generation of leaders.

Our Faculty in the News

INFECTIOUS DISEASES

Nahid Bhadelia to Head New BU Center for Emerging Infectious Diseases

Will connect policy with research and use lessons from Ebola and COVID to prepare lawmakers and the public for next crisis

BU Today, by Doug Most, May 18, 2021

Photo by Jackie Ricciardi

The first-floor classroom is empty inside the Boston University School of Medicine on a gray and chilly May morning in the South End. The whiteboard is marked up from earlier instruction and the only sound is the hum of fluorescent lights overhead. With an audience of one, and from behind her blue mask, Nahid Bhadelia slips on one hat after another, pivoting seamlessly from healthcare policy wonk to infectious diseases physician to MED associate professor to expert researcher in highly communicable diseases.

Listening to her, it's easy to see why Bhadelia is such a sought-after expert voice on the coronavirus pandemic—no question, no subject, is out of her comfort zone.

With so many roles, it's difficult to imagine Bhadelia finding time for another. But, in fact, she's poised to take on perhaps her most ambitious professional challenge yet. On June 1, BU will launch the Center for Emerging Infectious Diseases Policy & Research (CEID), with Bhadelia as its founding director. The center's purpose is to marry technical expertise in emerging infectious diseases—like COVID-19, Zika, and Ebola—with policy research and to provide recommendations to governments, communities, and academic institutions to help them prepare, and respond to, epidemics and pandemics at local, national, and global levels.

It's precisely the sort of multipronged, multidisciplinary center that was needed, say, back in January 2020, when news about this strange new, fast-spreading, deadly virus emerged from China. The public began asking questions about testing, wearing masks, handwashing, and contaminated surfaces, and public health experts began researching answers.

Bhadelia, who has lost three relatives to the coronavirus, says the new center will be "a place we work to answer the known unknowns when a crisis happens, and we build evidence for how we keep ourselves safe and keep the next big one from happening."

"COVID-19 has taught us that a truly effective response to a pandemic must be based on science and sound government policy. With Professor Bhadelia' s leadership and the research in the NEIDL,
Boston University is well positioned to lead at this critical

President Robert A. Brown

"I think the center would have helped [in early 2020]," she says. "It would have been there to create just-in-time policy for legislators, to say, hey, here is a two-page brief that can help you understand what the science behind the big topics and policy implications are. It would have been a place for the public to go to get evolving scientific information, and a place where multidisciplinary researchers can determine best practices for responding to this crisis from a healthcare perspective."

Bhadelia, who is also being named an associate director at BU's National Emerging Infectious Diseases Laboratories (NEIDL), stresses that the center will not be the "source of all knowledge," and much of its foundation is still taking shape. The center will be closely aligned with NEIDL. One of just six Biosafety Level 4 laboratories around the United

States, NEIDL's mission is to help deal with exceedingly dangerous diseases like Ebola. The CEID will live on the fourth floor of NEIDL.

"I feel like we're building a ship while sailing it," Bhadelia says. "If NEIDL is the 'wet lab' and the 'what' of responding to emerging pathogens—by discovering diagnostics, vaccines, and therapeutics—then CEID is the 'dry lab' and the 'how' of responding to these types of threats—by determining the implications of events, technologies, policies, and interventions."

The center will serve as the catalyst for creating and sharing the most important and accurate knowledge with public health experts, lawmakers, decision-makers, and the general public, at a time when facts and falsehoods have too often blurred together to cause confusion and frustration. "One of the biggest surprises to me is how much misinformation and disinformation is out there," Bhadelia says. "I hope the center will contribute research on what is the best way to depoliticize scientific data during outbreaks." As for the timing of the center's launch, the charter document for CEID, which Bhadelia wrote, says it all: "The threat of pandemics will not end with COVID-19."

Lessons from Ebola

For Bhadelia, who is 43, the opportunity to head a leading academic center with a global health mission is a natural step in a career built around the fight against, and the research into, dangerous pathogens. She's an American who was born in India, grew up in Sweden and Saudi Arabia, and came to the United States as a young teenager (her father was a world-traveling physician)—all experiences that helped shape her passion for, and understanding of, how healthcare is accessed by people in different countries and circumstances.

In addition to her bachelor's degree from Tufts University, she has a master's degree in international affairs from the Fletcher School at Tufts (her thesis topic was how HIV/AIDS impacted the economic productivity in many sub-Saharan African countries).

It was her background understanding both policy and pathogens that helped her land at BU in 2011, as director of medical response to maximum containment research at NEIDL.

"COVID-19 has taught us that a truly effective response to a pandemic must be based on science and sound government policy," BU President Robert A. Brown says. "With Professor Bhadelia' s leadership and the research in the NEIDL, Boston University is well positioned to lead at this critical interface."

Members of the Boston Medical Center Special Pathogens Unit (SPU) perform a training exercise in hazmat suits. Bhadelia has built from the ground up a Special Pathogens Unit at BMC that specializes in the care of highly communicable infectious diseases, serving as its medical director. Photos courtesy of Nahid Bhadelia

A video monitor displaying a training exercise of the Boston Medical Center Special Pathogens Unit (SPU). A doctor and SPU members in hazmat suits stand over a mannequin dummy patient in a hospital room.

Ronald Corley, director of the NEIDL and a MED professor and chair of microbiology, adds that it is impossible to predict where and when the next infectious disease outbreak will occur, making the center's role even more imperative. "Having data-driven policies informing these responses can mitigate the impact of the outbreak beginning at its earliest detection," Corley says. "Dr. Bhadelia and the CEID will play a critical role in establishing these policies."

Over the last 10 years, Bhadelia has built from the ground up a medical unit that specializes in the care of highly communicable infectious diseases, serving as its medical director. The Special Pathogens Unit (SPU) is situated within

Boston Medical Center (BMC), BU's primary teaching hospital. Her work has involved everything from engineering and infection control to training hundreds of associated healthcare workers, developing clinical care policies, and taking part in national conversations about how we develop and stockpile treatments for emerging diseases. When COVID-19 hit Boston in early 2020, SPU nurses and the associated BMC floor were the first responders to the crisis, forming the front line for providing care for patients and contributing to the training of other parts of the hospital.

Ebola virus disease (EVD) is what drew Bhadelia to visit West Africa in 2014. Her work there over multiple trips caring for Ebola patients and working alongside healthcare workers helped shape her thinking for the role that the CEID should play. Her first trip took her to Sierra Leone with a World Health Organization team, while subsequent trips were with Partners in Health. Working in so-called hot zones, and covered head to toe in a biohazard safety suit, she moved in and out of wards caring for patients, astounded on a daily basis by both the terrible toll of the disease and the bravery of the workers trying to contain it and console victims and families. Over these four trips, she also helped identify techniques for healthcare workers to protect themselves from contamination against dangerous diseases and worked with Ebola survivors.

In her travels, Bhadelia saw the struggles in understanding how Ebola could be spread and the misery in seeing patients isolated and depressed. Photo by Nahid Bhadelia

In her work with Ebola patients and healthcare workers, Bhadelia, who also takes photographs in her travels as a hobby, saw the struggles in understanding how the disease could be spread, the misery in seeing patients isolated and depressed, the slow economic and cultural recovery after an infectious disease crisis, and the politics of how to keep it from spreading globally. Those issues all resurfaced in the past year with COVID-19.

Since the West African EVD epidemic, Bhadelia has continued her work with viral hemorrhagic fever. She helped found and now codirects the National Institutes of Health–funded Boston University and University of Liberia Emerging and Epidemic Virus Research Program, which aims to provide Liberian researchers with a PhD at BU. "We need the global research agenda to be driven by researchers in communities that are most heavily affected by many of these emerging pathogens," she says.

Bhadelia has also been working in Uganda for the last three years as the clinical lead of a viral hemorrhagic fever research unit, called Joint Mobile Emerging Disease Intervention Clinical Capability (JMEDICC), at the border of the Democratic Republic of the Congo (DRC). "We have been part of the Ugandan response to the last couple of EVD outbreaks in DRC," she says. "The goal is to improve the care of patients with these types of infections."

In fact, after witnessing the 2014 bola epidemic, improving patient care has been her burning mission.

"How do you improve mental health, you know, in recovery, in patients who are isolated?" Bhadelia asks. "This is not just about this pandemic. We went through that with Ebola—patients being isolated, their families not being able to connect with them. We tackled how to provide the best quality of care while keeping healthcare workers safe. We dealt with the legacy of loss for communities. It's important that we're not reinventing the wheel every single time there's a new spread. And we have to figure out how to take politics out of the response."

And the research has to be ongoing, even after a disease has been contained.

"We just learned that Ebola survivors can potentially pass on the disease five or six years after recovering," she says. "What are the implications of this finding to keeping them and their communities safe? How do we avoid the potential stigma they may face if this is confirmed?"

Helping research drive policy

Four themes will drive the work at CEID, Bhadelia says: resilience among communities and healthcare systems, governance, trust, and innovation. "What sets CEID apart is that it connects policy research to deep scientific technical expertise," she says.

"Dr. Bhadelia has been our clinical and policy expert on emerging infectious diseases, such as Ebola and Zika, in the last few years, and now the COVID-19 outbreak, both for us and for the public," says Karen Antman, dean of MED and

provost of the Medical Campus. “She is able to translate complicated epidemiology and policy, so the public readily understands it. Her leadership will drive this new center.”

Dr. Nahid Bhadelia suits up in PPE suit, mask, gloves, and apron, in West Africa before treating Ebola patients.

Dr. Nahid Bhadelia training a group of people in West Africa

Bhadelia expects to hire a few people to start, focusing on finance, administrative needs, and communications. And she envisions working with partners to create a fellowship program, specifically offering opportunities for midcareer professionals or those interested in government work to gain firsthand experience in infectious diseases research and patient care.

Having data-driven policies informing these responses can mitigate the impact of the outbreak beginning at its earliest detection. Dr. Bhadelia and the CEID will play a critical role in establishing these policies.
Ronald Corley, director of NEIDL

“Wouldn’t it be incredible if people who make policies also got a deep dive and understanding of biocontainment research, like what is conducted at NEIDL, and the challenges of providing care for patients with highly communicable diseases by experiencing the work of healthcare workers who are part of the Special Pathogens Unit?” Bhadelia says.

The biggest opportunities she sees are capitalizing on BU’s multidisciplinary approach, teaming with faculty from the College of Engineering, the Center for Antiracist Research, the College of Communication, the School of Law, the Frederick S. Pardee School of Global Studies, the School of Public Health, NEIDL, the Questrom School of Business, and possibly others. And those who become affiliated faculty with CEID, she says, would get resources to accelerate their work and apply for grants.

“This initiative is timely and is perfectly aligned with the diverse strengths of Boston University,” NEIDL’s Corley says. “We should use the lessons from the ongoing COVID-19 pandemic—what did we do right? What did we do wrong? And how can we improve? The solutions can only come by melding considerations from diverse disciplines, including public health, political science, and economics, as well as research on the pathogens that cause these diseases, and implementing them locally and globally.”

New pathogens seem to be emerging almost every year somewhere in the world, Bhadelia says. Before COVID-19, there was Ebola and Zika and H1N1, mysterious diseases from other parts of the world that briefly, and in relatively small numbers, touched American lives. The coronavirus was different, so far killing almost 600,000 Americans, more than 3 million worldwide, and causing a global pandemic. The coronavirus was the first one that affected everybody.

“I would say the need [for the center] has been there for a while,” Bhadelia says. “I think that what changed was people’s ability to see that it’s relevant, because now it’s relevant to their own lives, right? They have lived experiences of how vulnerable we are to these threats.”

Nahid Bhadelia has identified several people who will be core members of the CEID faculty: Kevin P. Gallagher, a Pardee School of Global Studies professor of global development policy; Kevin Outterson, a School of Law professor of health law and corporate law; Traci Hong, a College of Communication associate professor of media science; Gerald Keusch, a MED professor of medicine and of international health; David Hamer, a MED professor of global health and medicine; Cassandra Pierre, a MED assistant professor of medicine, and Boston Medical Center's associate hospital epidemiologist and medical director of public health programs; Eleanor Murray, a School of Public Health assistant professor of epidemiology; Laura White, an SPH associate professor of biostatistics; and Gianluca Stringhini, a College of Engineering assistant professor of electrical and computer engineering.

COVID VACCINES

Pausing J&J Vaccine Rollout Is a Move to Keep Public Trust

In this Q&A, a BU vaccine researcher says it's the right course, but that the vaccine's benefits "without doubt outweigh the risks"

THE BRINK, Pioneering Research from Boston University

By KAT J. MCALPINE, APRIL 14, 2021

On Tuesday, the US Centers for Disease Control and Prevention (CDC) recommended that states pause their rollout of the Johnson & Johnson one-shot COVID-19 vaccine, citing six people who suffered rare cases of blood clotting in a vein carrying blood away from the brain. The six cases occurred in American women between the ages of 18 and 48, and one of the women died.

The news comes as Johnson & Johnson was also dealing with a processing plant that botched 15 million doses before distribution. Tuesday's Johnson & Johnson pause, which could last days or a week, is also an obstacle to President Biden's administration as it tries to assure vaccine-hesitant Americans that the coronavirus vaccines are safe. On Tuesday, Anthony Fauci, the nation's leading infectious disease expert, said at a White House press briefing: "This is a really rare event. If you look at what we know so far, there have been six out of the 6.85 million doses, which is less than one in a million."

For help explaining the news, *The Brink* reached out to **Florian Douam**, a virologist and vaccine expert at BU's National Emerging Infectious Diseases Laboratories (NEIDL). At the NEIDL, Douam is developing humanized mouse models that can help lead to better vaccines against COVID-19 in humans. Douam, who is also a BU School of Medicine assistant professor of microbiology, gave us his take on how the J&J news will impact national and global COVID vaccination efforts as well as vaccine hesitancy among the public.

Q&A

WITH FLORIAN DOUAM

***The Brink*: Were you surprised by the news today?**

Douam: Partially. You've probably heard about what is going on with the AstraZeneca vaccine in Europe—the European Medicines Agency has established a link between the AstraZeneca vaccine and some thrombosis cases. Both the AstraZeneca and Johnson & Johnson vaccines are derived from an adenovirus. So, when I heard the news, my first thought was, this might be bad news in general for adenovirus-based vaccines.

Can you explain what you mean by that?

It's the first time we've vaccinated so many people with an adenovirus-based vaccine. [These vaccines use a protein shell, derived from a virus, and encased around the genetic material from the coronavirus, delivering the coronavirus genetic code into the body which triggers an immune response to build antibodies against the coronavirus.] What we're uncovering is a very small risk that the vaccine may cause clotting in some individuals. With the J&J vaccine we're talking about six cases among seven million people vaccinated. These events are providing us with a better overview of the risks and benefits associated with the J&J vaccine; it's very informative from a vaccine development perspective.

That being said—the benefits still far outweigh the risks. I understand the cause for concern, for the need to step back and see what's going on, but I don't think these six cases should be a cause for people to fear the J&J vaccine. For comparison, if you consider the yellow fever vaccine—more than 500 million people have been vaccinated. Even though

it's one of the most efficient vaccines ever created, there's a slight risk. About .4 to .8 percent of every 100,000 vaccines will cause severe illness (that's about .0004 percent of people vaccinated). But yellow fever has a 25 to 50 percent mortality rate. So, the vaccine benefit outweighs the risk. In the case of a massive-scale pandemic like coronavirus, the benefits without doubt also outweigh the risks. What we're witnessing here is .00008 percent of people might develop a severe reaction—much, much less than the chances of getting COVID-19. So, this pause announced today should not be a cause for widespread fear. As we try to shut down a global pandemic, the benefit of the J&J vaccine, which only requires one dose, is huge.

So, with such a small number of people being affected by clotting, why the big pause in rolling out the J&J vaccine?

Given that only six people out of seven million have had reactions, pausing vaccination is a bit of a surprising move. But I think it's the best decision to try and not lose public trust, to show the population that [public health] authorities are taking this handful of reactions very seriously. I think that's the right move. If, instead, they did not pause vaccination but just moved forward, pretending that nothing had happened, it would undermine public trust. This is almost like a political move [on the part of public health authorities] to keep people's trust, because the most important factor in successfully rolling out COVID-19 vaccines is to keep that trust. That being said, the news media have a critical role to play—making the public understand that reviewing the safety profile of a vaccine is very different from saying that a vaccine is dangerous. That distinction is key.

I assume [the public health authorities] are now going to look at the medical history of these individuals; I have low expectations that they will find out exactly what happened with these individuals. But if they can identify a specific clinical condition in these patients that contributed to these adverse reactions, especially in the person that died, I think that will help the J&J vaccine rollout and [the US in keeping up with its goal pace of vaccinations].

I have many family members and friends in France, where Europeans are grappling with the same concerns about AstraZeneca. I've received a lot of calls from family and friends, telling me that they've been offered AstraZeneca but are afraid to take it because of the thrombosis cases—even though I've told them they ought to take the first vaccine that becomes available to them. They say they would rather wait to get the Moderna or Pfizer-BioNTech vaccines. This suggests to me that even though the benefits of adenovirus-based vaccines [like the ones manufactured by J&J and AstraZeneca] clearly outweigh their risks, the public is starting to associate mRNA vaccines with being a potentially safer option. This is good news for mRNA vaccine manufacturers [like Moderna and Pfizer-BioNTech] and for the future of mRNA vaccine technology in general.

Can you remind us what's different about the mRNA vaccines versus adenovirus vaccines, and how that might impact reactions to vaccination?

The advantage of mRNA vaccines is that they are [easily and quickly] produced in large scale. After synthesizing mRNA (in the case of COVID-19 vaccines, "messenger" RNA is genetic material that instructs the body to build antibodies against SARS-CoV-2), you just need to encapsulate that mRNA inside a lipid shell (a lipid is a naturally occurring fatty acid) to create a vaccine. In contrast, making a viral vector—like adenovirus—is a bit more complicated [and time-consuming]. So, the biggest advantage is that mRNA vaccines can be developed faster in response to emerging infectious diseases.

The lipid shell surrounding the mRNA is also [not very] immunogenic—meaning it doesn't trigger an immune reaction from the human body. The adenovirus shell does trigger an immune response, so the body is recognizing and mounting an immune response both to the adenovirus shell and to the SARS-CoV-2 genetic material inside it. This heightened immune response could trigger some adverse effects, so there is a slightly higher risk of a more adverse reaction when using an adenovirus shell.

What do you hope the outcome will be when it comes to the J&J vaccine?

We'll see what information the investigation yields. But I have absolutely no concerns about the safety profile of the J&J vaccine. I am concerned, however, about the public losing trust in this critical [public health] tool that could bend the trend of this pandemic [in the right direction]. It needs to be explained that getting this vaccine still remains a huge benefit, because [vaccination is] the only path toward [us all having] a more normal life again. Even if a clear connection isn't found to explain why these six individuals developed blood clotting, there should be a clear explanation to the public that the benefits [of the J&J vaccine] still outweigh the risks. The extremely low frequency of adverse reactions suggests that they are really, really rare and should not be cause for concern.

To my knowledge, a situation like this has never happened before, where a vaccine rollout of this scale has been paused for so few adverse reactions [.0008 percent of people vaccinated]. But it's also the first time we're doing such a massive global vaccination effort in such short timing. Everything is historic at the moment. I am hopeful that in a few days' time, the J&J rollout will be back on track. I think this pause is being done to preserve public trust and conduct a

thorough review of what has happened with these six cases. However, how the conclusions of this review will be [described and communicated] is going to be very important to preserve public trust in [COVID-19] vaccines.

If we lose public trust toward the J&J vaccine—like what is happening in Europe with the AstraZeneca vaccine—the rollout of the mRNA vaccines will have to be intensified, which will be a complicated process. This will create a slowdown of the vaccine rollout overall, which would mean more COVID-19 cases and deaths. It's obviously still too early to say if what happened Tuesday will have a [long-term] impact on the rollout, but I really hope it does not. The news media has a big role to play here; [they need to continuously explain] that these adverse reactions represent a very small percentage of [all vaccinations], and that the benefits of the J&J vaccine outweigh the risks. If we do start seeing more and more people refuse to get the J&J vaccine over the next few weeks, it may be that the mRNA vaccines will become even more useful than we ever thought they would be.

Global disparities highlighted by uneven access to COVID vaccines

PBS NEWSHOUR, Feb 24, 2021 6:45 PM EDT

The West African country of Ghana on Wednesday became the first nation to receive a delivery of COVID-19 vaccines through a global initiative called COVAX, which aims to give more equitable access to the vaccine. Nick Schifrin reports and speaks to Dr. Nahid Bhadelia, medical director of the special pathogens unit at Boston Medical Center, to learn more about global inequities.

Judy Woodruff: Who gets the vaccine and when are not only serious questions in the U.S., but also around the globe. A group of rich countries is buying up billions of doses. But, as Nick Schifrin reports, the United Nations is stepping into the breach with its own plan to increase vaccine equity.

Nick Schifrin: On a tarmac in Western Africa, Ghanaians welcome a European vaccine delivered by an Arab airline manufactured in India sponsored by the United Nations. That global effort is the U.N.'s COVAX program, and Anne-Claire Dufay is UNICEF's Ghana representative

Anne-Claire Dufay: This is really a historic moment. Today, we're very happy to receive the first batch of COVID-19 vaccine through the COVAX facility.

Nick Schifrin: The 600,000 doses of AstraZeneca vaccine is the beginning of what the U.N. calls the largest procurement, distribution, and supply operation in world history. It's designed to deliver 1.3 billion vaccines this year to more than 90 low-and middle-income countries. Vaccine equity has been a global call. From South Africa, which has recorded half of the continent's deaths, President Cyril Ramaphosa.

Cyril Ramaphosa: We are all not safe if some countries are vaccinating their people and other countries are not vaccinating.

Nick Schifrin: To Mexico, which last week received the Pfizer vaccine, President Andres Manuel Lopez Obrador:

Andrés Manuel López Obrador (through translator): These are things that we want to see in the U.N., that there be equity.

Nick Schifrin: The U.N. says residents in just 10 countries have received 80 percent of the world's shots. Europe has ordered 2.5 billion doses half-a-billion residents. COVAX is hampered by that limited supply and logistical challenges. The U.N. calls that a — quote — "catastrophic moral failure." Secretary-General António Guterres:

António Guterres (through translator): The latest moral outrage is the failure to ensure equity in vaccination efforts.

Nick Schifrin: But countries ahead of the curve are pursuing vaccine diplomacy. Israel has vaccinated a higher percentage of its population than any country. And now Prime Minister Benjamin Netanyahu, who visited a gym on Sunday, promises to share excess vaccine with partners in the region and world. Russia launched an English-language campaign, V For victory, or V for Sputnik V vaccine.

Man (through translator): Sputnik V is the first registered vaccine against COVID-19 in the world.

Nick Schifrin: The largest effort comes from China, whose state television broadcasts deliveries of Chinese vaccines all over the world. In the U.S., last week, President Biden pledged $4 billion to help COVAX.

Pres. Joe Biden: Competition must not lock out cooperation on issues that affect us all.

Nick Schifrin: For more on all of this, we turn to **Dr. Nahid Bhadelia**, the medical director of the Special Pathogens Unit at Boston Medical Center and an associate professor of infectious diseases at Boston University School of Medicine. She also served as a clinician during the Ebola outbreaks in West and East Africa in 2014 and 2015.

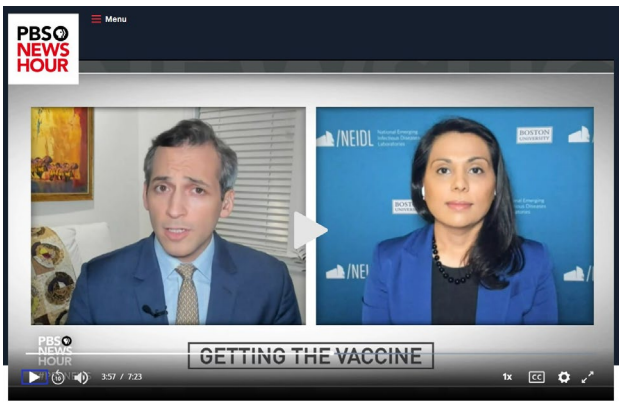
Dr. Bhadelia, welcome to the "NewsHour." How important is it that vaccine distribution is equitable globally?

Dr. Nahid Bhadelia:

Hi there, Nick. It's critical. And it's not just critical because it's the right thing to do, because you have now a setup where a majority of the world or parts of the world that may not get this vaccine for years. And what you see is that, with a protracted pandemic, you can't recover the economy and you continue to lose the gains that have been made and health indicators and education indicators, because it's all related, the longer you see turmoil.

And not only that, but you have countries, entire countries that have not vaccinated any of their health care workers. And as you see loss of health care workers, that might affect health indicators in other ways as well.

But there are selfish reasons to do this as well. One is the variants. We're seeing now that these variants, with increased transmission of this disease anywhere in the world, you're going to see new variants appear, and that's why that equity is important for us, as well as for others.



Nick Schifrin:

Western countries have bought more vaccines than they have people, but there is still a supply shortage. There is still a lot of pressure in individual countries, on governments to vaccinate their own people, of course.

How quickly should Western governments be releasing supply?

Nahid Bhadelia:

Well, I think a big part of this is, every country is going to have to make a decision, but I would say as soon as we can.

You know, last week's dedication, the commitment that President. Biden made was important, because it also then made further commitments possible from the European Union and others

But money is actually not the only issue, right? Because what the director general of the WHO has said is, it's just the availability of the vaccines. And so, part of this is going to be tied to how quickly the richer countries can make manufacturing capacity grow, not just for their own constituents, but also for the global community.

I think we should be donating a portion, personally, as we go along, because this will help ensure the resilience remains in the rest of the world, and it protects us from those variants, as I said.

Nick Schifrin:

Part of the question of that supply, of course, is the newer vaccines.

Just today, Johnson & Johnson got pretty good marks from the FDA, and it does not need the ultra-cold cold storage that we have seen previous vaccines need. How important is it that new vaccines come along to try and solve that supply problem?

Nahid Bhadelia:

Well, the big, good news about Johnson & Johnson is not just the fact that it can handle refrigeration at normal rates, vs. the Pfizer vaccine, which currently requires ultra-freezing temperatures, which may — actually may change, because they have submitted new data to FDA for warmer temperatures.

But it's also that it's one dose. And it can actually reduce risk for death and hospitalization to 100 percent after 28 days. And so it's both the dosing, but also because, in many resource-limited settings, maintaining that cold chain to get to the last mile is going to be important.

So, absolutely important we have candidates that do that now, the AstraZeneca and Johnson & Johnson, and we're hoping potentially Novavax as well.

Nick Schifrin:

At the end of our story, we noted the vaccine diplomacy, vaccine nationalism that we're seeing out of Russia and China.

On Russia, more than 200 countries have signed up for Sputnik V, but Russia is struggling creating enough supply and vaccinating its own people. Are there countries that are overpromising distribution of vaccine and underdelivering?

Nahid Bhadelia:

Well, currently, I think it's a little too early to tell. I think part of this will be how — not only how much can be sent, but how much can be actually timely distributed in those resource — the resource-limited countries. I — the thing that worries me in some of these setups of more well-resourced countries distributing vaccines is that we need to ensure that it's not tied to other commitments, right? I think, in all global health diplomacy, you kind of have this give-and-take. But one would hope that, in these settings, particularly in a public health emergency, where vaccinating everybody is important, that sort of secondary gains and political commitments are not part of the game that occurs.

Nick Schifrin: Dr. Nahid Bhadelia, thank you very much.

Nahid Bhadelia: Thank you.

INFECTIOUS DISEASES

Joseph Mizgerd, a pulmonary researcher, and principal investigator, in his lab in the Medical Campus Housman Building, will give the 2020 University Lecture November 17. Photo by Cydney Scott

Tonight's University Lecture: On the Front Lines against COVID in the Lab, Science Will Win

Nothing "has had as much intense interest from everybody on earth," says MED's Joseph Mizgerd

BU Today, by Joel Brown, November 17, 2020

Joseph Mizgerd hasn't lost anyone to COVID-19 personally, but that doesn't mean the pandemic hasn't affected him.

"I've had several deaths in the family that were not due to COVID, but they were still deaths that we would like to be getting together and having funerals for, and we haven't done that," he says. "We have not traveled to see each other, including parents and children and siblings, even though really horrible things like losses, and that's been a profound and difficult change for us."

Anyone questioning social distancing, masks, and other coronavirus precautions would do well to heed his example. Mizgerd, a School of Medicine professor of medicine, microbiology, and biochemistry, director of the University's Pulmonary Center, and an investigator at the National Emerging Infectious Diseases Laboratories (NEIDL), has been on the front lines of the struggle to understand COVID-19 and the body's response to it.

Mizgerd has been tapped to deliver the 2020 University Lecture, titled From Cough to COVID: How Respiratory Infections Produce Problems and Our Bodies Fight Back, today, Tuesday, November 17, at 5 pm via Zoom. The event is free and open to the public, but registration is required.

Established in 1950, the annual University Lecture highlights the outstanding and thought-provoking research of a BU faculty member to the BU community and the public.

"I don't think anything has had as much intense interest from everybody on earth as COVID-19 has, and as somebody who's been studying respiratory infections for a lot of years, I get a lot of questions directed to me," Mizgerd says.

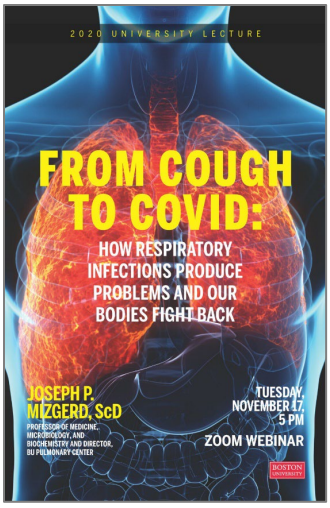
The most common one is about the availability of a vaccine, and although it is not his specialty, he, like everyone else, hopes it will come soon. Next most asked: why is the virus' effect so variable? "How come some people get very severe infections and die, and other people don't even have symptoms—that doesn't make sense to a lot of people, but in fact, that's very common to respiratory infections," he says. "A lot of what we are learning about COVID-19 is very similar to other respiratory infections."

In Boston, “most people do take COVID really seriously, they believe it is a threat, and they believe it is up to them to try to prevent themselves from getting it and prevent others from getting it from them,” he says. “Things are getting worse here, like elsewhere, and it is going to keep getting worse for the next couple of months, but it is better than a lot of other places. “His own personal COVID precautions include working remotely as much as possible. This semester, he’s teaching one class a week, with two-thirds of the students participating remotely. “I have Zoom meetings all day every day, just like everyone else does,” he says. And when he does go out, to BU or anywhere else, he is masked, observes social distancing, and avoids crowded environments. And he washes his hands a lot.

Mizgerd’ s hobby of playing squash—which means breathing hard in close quarters with others—has gone by the wayside in favor of lots of long walks, “but I haven’t learned to play the piano or anything,” he says.

What he has been doing is working—a lot—in his MED lab or collaborating with other scientists at the NEIDL, and keeping the Pulmonary Center running. “We are ramping up to do everything we can, because we feel our expertise is needed right now,” he says. “I spend a lot of time mentoring younger researchers, and the administrative tasks are also very important. There are a lot of things we have to do to make sure we’re being safe in the Pulmonary Center and making sure we are part of the solution and not part of the problem.”

Mizgerd says being selected to deliver the University Lecture made him feel “shocked and humbled and really, truly honored to be asked. And it’s a challenge. I give talks all the time, it’s part of life for an academic. But I’m always talking to other scientists. It’s a challenge to give a talk to try to make what you do interesting to such a diverse audience, which can include law students and history professors and other members of the community, and still make it interesting to other scientists. But I look forward to it.”



Each year’s speaker is chosen by the provost from recommendations by the University Lecture Committee, which selects from nominations by the BU community. “We cannot imagine a better—or more opportune—lecturer than Professor Mizgerd,” says Jean Morrison, University provost and chief academic officer. “The lasting medical advances he has made as a researcher, his talent and innovation as a storyteller working with broad audiences, and of course, the timeliness and interdisciplinary appeal of his work in the age of COVID make him an ideal choice.”

Mizgerd will bring some of his personal history to today’s lecture, but the focus will be on his current research. His work is basic science, not clinical—he works with cells and tissues and data, not patients.

“Lung infections are caused by a wide range of microbes, lots of different bacteria, lots of viruses that have basically nothing in common except that they like warm, wet places like our respiratory tract,” he says. “I think it’s not really about the microbe, it’s about how we respond to the microbe.”

He spent years studying the innate immune response—the first things that happen when a microbe gets into the lung and how the body reacts within hours. But a few years ago, at the suggestion of a graduate student, he began focusing more on adaptive immunity, the longer-term response that involves antibodies and T cells. The body has a sort of immune memory, he says, in that how we respond to one respiratory pathogen can affect how we react to the next one, even though it’s not exactly the same. “That ‘heterotypic immunity’ is really key to our ability to respond effectively to a microbe in our lungs,” he says.

One huge question now, he says, is how that affects our response to SARS-CoV-2 (the virus causing COVID-19), a pathogen we’ve never before encountered. Are there some aspects of heterotypic immunity that can actually damage the lungs as part of our response to infection? It is becoming clear that subsets of COVID patients have immune responses leading to milder cases, while others have different immune responses that lead to especially severe cases. Deciphering which immune pathways are active and whether they are beneficial or harmful in people with this infection will guide improved care strategies for COVID-19.

Mizgerd applauds the University’s efforts against COVID, from promoting social distancing on campus to setting up its own testing lab. “BU has done a fantastic job stepping up to fight this challenge,” he says. “I’m really pleased and proud of how seriously the entire institution has been doing it and how much under control the University community, including the undergraduate campus, has been handling it so far.”

He was buoyed by two announcements last week—Pfizer’s report of a 90 percent effective vaccine that could get fast-track approval from the FDA, and President-elect Joe Biden naming his COVID advisory panel members.

“The Pfizer news is exciting,” he says. “It’s early days, and I haven’t seen full results, but what I heard from media reports sounds extremely promising and is reason for optimism. And the fact that Biden is prioritizing a national strategy

to combat the pandemic, while relying on scientists with appropriate expertise and experience, is yet further reason for hope. It won't be easy and there's much work left to do, but we are steps closer to winning this COVID battle thanks to this news."

The late fall and winter are going to be tough for everyone, Mizgerd says, but people should comfort themselves with the long view.

"I would like to suggest continued vigilance, and emphasize that the numbers are getting worse while we're having this conversation and likely to get worse over the next couple of months. But I would also like to emphasize that things are going to get better," he says. "I talk to so many people who are verging on depression. We are going to beat this. We are going to have vaccines that work.

"So much science is being thrown at this problem. The word unprecedented is overused, but in this case it's true. Around the world scientists are fighting this. The number of discoveries that have come out in just the last few months is mind-boggling. It will lead to benefits for the rest of us for other kinds of disease, paradigm-shifting changes that will really help in public health and medicine. This concerted effort is great news for the worlds of pulmonary medicine and infectious diseases."

COVID-19 VACCINES

With Two COVID-19 Vaccines on the Way, "We Are in New Territory"

BU NEIDL scientists weigh in on Pfizer and Moderna announcements, and what is still unknown about how they'll work

THE BRINK, Pioneering Research from Boston University

By KAT J. MCALPINE, NOVEMBER 17, 2020

A week after Pfizer caused excitement by announcing that its coronavirus vaccine has been more than 90 percent effective in early trials, Moderna came out with its own announcement that its version of a coronavirus vaccine had reached more than 94 percent effectiveness.

Anthony Fauci (Hon.'18), director of the National Institute of Allergy and Infectious Diseases, called Moderna's early results "stunningly impressive," and the stock market rallied as investors took it as a sign that there may soon be powerful new public health tools to control the sprawling pandemic.

Like the Pfizer vaccine, the Moderna vaccine is developed using mRNA, which stands for messenger RNA. This single strand of genetic information is "read" by biological machinery inside cells, acting like an instruction manual that directs the cell to build proteins of certain specifications. The coronavirus, once it has infected a cell, uses mRNA to trick the cell into manufacturing more copies of the virus. But Pfizer and Moderna are using mRNA to tell the cell how to build proteins that resemble the SARS-CoV-2 virus that causes COVID-19 infections, similar enough to impart immunity on a vaccinated person, but not cause an infection.

With two vaccines now racing toward US Food and Drug Administration approval, The Brink reached out to **Ronald Corley**, director of BU's National Emerging Infectious Diseases Laboratories (NEIDL) and a BU School of Medicine professor, and NEIDL virologist and vaccine expert **Florian Douam**, a MED assistant professor, to get their takes on how the Pfizer and Moderna vaccines could change the course of the pandemic.

Q&A

WITH RON CORLEY AND FLORIAN DOUAM

The Brink: The Pfizer and Moderna vaccines sound like very similar formulations. How do these mRNA vaccines work compared to other popular vaccines (flu, measles/mumps/rubella, etc.)?

Corley: mRNA vaccines are designed to deliver mRNA, encoding a particular component of the virus into the host's cells, which then make the protein encoded by the mRNA. The person being vaccinated then makes an immune response to these proteins. Other forms of vaccines generally have the already-made proteins in their formulations, and deliver them with other components (vectors and adjuvants) that are designed to boost the immune response to the viral proteins.

Why is the mRNA approach well-suited to prevent coronavirus?

Corley: There are a number of potential advantages to mRNA vaccines: they can be more readily optimized, they can be administered repeatedly, and they might be more scalable over time. Yet, we are in new territory until we know more. It is unclear whether the mRNA vaccines will be better than other conventional vaccines at this time. There remain many unknowns: are the vaccines similarly effective across demographic lines (age, sex, ethnicity, etc.), do they prevent disease (in both trial groups, vaccinated persons did get infected, but many fewer than in the placebo groups), and how long does immunity last?

Douam: I would not say that mRNA vaccines are particularly well-suited for coronavirus, specifically. They can be suited to prevent any infection. The advantage of mRNA vaccines over other types is 1) they are easy to make and can be made faster than a lot of other vaccines and 2) their safety. That being said, mRNA vaccines are likely to [induce less of an immune response] than other types of vaccines, like live-attenuated vaccines or viral vector-based vaccines (like the Johnson & Johnson adenovirus-based COVID-19 vaccine), but because we can produce a lot [of mRNA COVID-19 vaccines] faster than these other types of vaccines, this is why the mRNA vaccines are leading the race right now.

Long-term, however, it is unclear whether they will remain as the major SARS-CoV-2 vaccines. More [effective immune-stimulating] vaccines will likely emerge over the next months and years that will not require booster doses like mRNA vaccines. I see these different types of vaccines as highly complementary: the mRNA vaccines are used to set up an initial but imperfect protective barrier against SARS-CoV-2 within our populations, prior to the arrival of more [powerful and long-lasting] vaccines that require more time to be tested and produced in large amounts. It's like sending a small garrison of troops to start weakening your enemies prior to sending the bulk of the troops.

So far, the Moderna vaccine appears to be even more effective than the Pfizer vaccine, achieving more than 94 percent efficacy in early trials. What is your reaction to this news? With two seemingly effective vaccines barreling down the pipeline, do you think broad vaccination will begin to turn the tide of COVID-19?

Corley: It is not clear to me that there is a difference between 90 percent and 94 percent at this time. More data will be required. That said, the preliminary news from both companies is really encouraging.

The conventional wisdom is that these vaccines could receive emergency use authorization by the end of the year, if not sooner. Millions of doses will be ready by the end of the year, but it will take many, many months to generate the doses required to vaccinate the hundreds of millions of Americans—assuming that most Americans will allow themselves to be vaccinated. Further, we must take a global approach; we won't be able to contain this pandemic until and unless effective vaccines are distributed to countries on all continents.

Douam: It is premature, I believe, to say that one vaccine is more effective than the other, as we only have preliminary data from Phase 3 trials. Moderna got its 94 percent effectiveness estimate based on [the first] 95 people [to get symptoms] out of 30,000 trial volunteers. This is promising, but we need to wait for a bit longer to be sure that these numbers are representative of the level of protection mRNA vaccines will confer.

How much of an advantage will the Moderna vaccine have if it can last in refrigeration and at room temperature longer than the Pfizer vaccine?

Corley: The current need to keep the Pfizer vaccine at -70 degrees Celsius or colder is a potential big hurdle for distribution, but Pfizer has apparently planned for this. That said, being able to store a vaccine in a simple freezer (or even refrigerator) will be important in permitting wider distribution into areas where ultra-low freezers do not exist, likely including rural America.

Douam: I think it is a big advantage, as the disadvantage of conventional mRNA vaccines is their instability over time. The fact that the Moderna vaccine can be kept at -20 degrees Celsius for up to six months is really great. That shows that the [fatty nanoparticle capsule] formulation, used to package up and deliver these mRNA into the body, is as important as the mRNA itself. The Moderna [capsule] formulation, more than their mRNA, might be then the key that would put their vaccine ahead of Pfizer in the vaccine race.

With more than one vaccine emerging, will every type of vaccine have a role or will one superior vaccine become the gold standard?

Corley: We cannot predict at this time the role that different vaccines will play, until we know more about their effectiveness and durability. The manufacturers will be getting data on this in real time once their vaccines are authorized for use.

Douam: As I said earlier, I believe mRNA vaccines will be critical to quickly establish preliminary vaccination coverage as a first barrier against SARS-CoV-2 spread—but we will need improved versions of these vaccines to reinforce and

extend such coverage. I am hopeful that widespread vaccination with the mRNA vaccines should start as early as next spring, and other more [powerful and long-lasting] vaccines might start to be distributed by summer or fall 2021.

Despite the announcements about efficacy, scientific data have not yet been released for Pfizer or Moderna vaccines. How optimistic should the public be that these vaccines represent a light at the end of the tunnel? Could we be a few months away from widespread vaccination?

Corley: Caution is essential until more data is released, and even once the vaccines are rolled out we will be learning more about their general effectiveness and durability. Right now, we still know very, very little. But, I am cautiously optimistic.

Douam: The data are highly encouraging. I am more optimistic than last week, because unlike Pfizer, Moderna has given us clear numbers: out of their 95 volunteers who got sick, 90 of them had received the placebo, and only 5 had received the vaccine. Those who developed severe illness were only part of the placebo group. So overall, I feel we should all be optimistic, but still with a dose of caution as we are still waiting for the final data of these Phase 3 trials. Nevertheless, it is likely that both Pfizer and Moderna will be granted with emergency use application of their vaccines within the next two months, and that widespread vaccination using these vaccines will start early next year. I personally believe that this is a good thing, as I am confident that these vaccines will meet our expectations.

COVID-19 VACCINES

What Does Pfizer's Vaccine News Mean for the Coronavirus Pandemic?

Two BU COVID-19 researchers express cautious optimism, but also raise questions, about the vaccine announcement that's causing so much buzz

THE BRINK, Pioneering Research from Boston University

By KAT J. MCALPINE, NOVEMBER 10, 2020

As the coronavirus pandemic rages on, with the United States recently reaching a peak of more than 120,000 new cases in a single day, a glimmer of hope appeared on the horizon this week. Pfizer announced that early data from its coronavirus vaccine clinical trial shows that the vaccine is at least 90 percent effective in protecting against COVID-19 infections.

But while that certainly places Pfizer squarely in the lead amidst the race to develop COVID-19 vaccines, its trial is not yet completed, and the scientific data was not released alongside the announcement about its vaccine's projected efficacy.

The Brink asked two experts at Boston University's National Emerging Infectious Diseases Laboratories (NEIDL) for their take on the news, and what it means for curbing the pandemic. According to coronavirus researchers **John Connor**, a NEIDL virologist and a School of Medicine associate professor, and **Florian Douam**, a NEIDL virologist and a School of Medicine assistant professor, even the promise of Pfizer's vaccine doesn't mean a quick fix to the pandemic is around the corner.

Q&A

WITH JOHN CONNOR AND FLORIAN DOUAM

The Brink: What were your thoughts upon hearing the news that Pfizer's vaccine preliminarily looks to be 90 percent effective?

Connor: As it is stated, this is a very encouraging number. The more I think about it though, the more information I feel is not offered. Is it 90 percent effective in those at highest risk? If it is 100 percent effective in healthy individuals with no health complications, and 40 percent in the elderly and those with health complications, I am not so impressed. If it is 90 percent effective across all populations tested, then I am truly excited.

I am also curious about how long they think this 90 percent protective number holds following vaccination. If protection against infection holds for a year, then this is super exciting. If protection against infection lasts for six weeks or three months, much less exciting.

Douam: I think it is definitely good news, but I would not declare victory yet. The announcement was made on the news, and we have yet to see the actual data in scientific journals. Especially, I would want to see how racially/ethnically/socially diverse is the vaccinated population that shows [the vaccine has] 90 percent effective protection. Additionally, we have to be aware that 90 percent figure could still change, as the trial is not over.

So, I am optimistic but I still remain cautious. Another point is that although 90 percent is definitely a great start to bend the pandemic, we will need to refine this vaccine over time to increase effectiveness, ideally up to 95 percent. For a pandemic of this scale, where hundreds of millions will have to be vaccinated, leaving 10 percent of people unprotected is a lot.

Is it responsible for Pfizer to come out with this finding before the trial is finished and their data have been peer reviewed?

Connor: I am constantly uncomfortable with the direct-to-press reporting of results, especially with the small amount of information that is released. I understand that these are unprecedented times, and everyone is very interested in the development and approval of a vaccine that protects against COVID-19. I would like to see that if they are going to release top-line numbers like this that they release all of the data.

Douam: It is a bit premature in my opinion, but I also understand the need for the country to hear that things are moving toward the right direction. So, I can also understand why they made the announcement. There is also a big vaccine race ongoing, especially with Moderna, so their announcement is also a signal to the other biopharma [companies developing vaccines] that Pfizer is taking the lead.

By the end of the year, Pfizer expects to make enough doses to vaccinate 15 million to 20 million people. What impact could this have on the spread of coronavirus here in the United States?

Connor: I can't tell whether Pfizer expects to have these made (e.g., sitting in a freezer at Pfizer) or made, delivered, and administered. Regardless, having any progress on a vaccine and its initial rollout will be great. I do not think that it will mean that the disease stops circulating in the United States immediately, but it could be an important start in protecting our most vulnerable populations from this disease.

Douam: It really depends where the vaccination campaign will be conducted, and which population(s) will be targeted. If the targeted populations are low-risk populations, like persons who have been very careful since the beginning of the pandemic in maintaining distancing and wearing masks, then vaccinating 15 million of those people will not have a significant impact. However, if we aim to target areas and populations that, by their behavior, facilitate spread of [COVID-19], then this can have a more dramatic impact.

My concern, however, is that there is still a lot of vaccine hesitancy out there, and it seems that the people who do not practice physical distancing and do not wear masks are also the most likely to reject vaccination, unfortunately. Therefore, I really think that these first set of doses could have the most impact if they were distributed to very specific workers that are on the front line of this pandemic, that is: the healthcare workers, childcare workers, elderly care workers, and social workers.

Does the good news about the Pfizer vaccine bode well for other similar vaccines in development?

Connor: I think so, but we are in uncharted territory on much of this vaccine development.

Douam: Yes, definitely, but we have to wait to see what the definitive effectiveness of this vaccine will be, and how the effectiveness of other vaccines will compare. If the Moderna vaccine (or other vaccines) have an effectiveness of 95 percent, this is huge, as 5 percent can represent several million people. I am curious to see how other biotech/pharma [companies] are going to react to the Pfizer announcement. Are they also going to communicate their non-definitive percentages of [vaccine] effectiveness as fast as they can? Or are they going to wait a bit longer to provide the public with a definitive/final percentage of effectiveness, [which could be] as good or even better than [Pfizer's] 90 percent?

We also have to keep in mind, as I mentioned before, that this is just version 1.0 of a vaccine, and we still don't know how protective it is over months and years—and we will not know that before months and years have passed—which is why I think that the vaccine is going to be a constant work in progress over the next few years. I would not be surprised if we were to be given vaccine shots on a yearly basis with a new version of the vaccine every year. [This would] avoid taking the chance of the overall immunization going down, because this virus is going to stick around no matter what.

Will the vaccine's design—needing two doses, requiring cold storage—hamper its ability to be quickly and broadly distributed?

Connor: Indeed, it will.

Douam: This is why I was talking [about this being] vaccine version 1.0. Right now, we need something quick and that works. We would take anything that works. But the vaccine race will not stop after that, as there are still challenges associated with these [initial] vaccines. The first one is the percentage of effectiveness that I was talking about before. The second is the vaccine's stability and transportation; mRNA vaccines [like Pfizer's] are easy to make and [can provoke a good immune response], but they are less stable than other vaccines. They require dry ice for transportation, which would suggest that we might face a shortage of dry ice soon. If a company can make something as easy to produce, but easier to transport, the Pfizer vaccine will become obsolete.

The third [factor here] is the [Pfizer vaccine's] booster requirement. It is complicated enough to vaccinate enough people once, so [having to vaccinate everyone] two times makes it harder. Getting rid of a booster shot is, to me, the most pressing thing that will need to be fixed by the next versions of the vaccine.

People

Scientific Leadership

Ronald B. Corley, PhD
Professor and Chair, Department of Microbiology
Director, NEIDL
Director, Immunology Core

Dr. Corley's Research interests:

- Innate and adaptive immunity

Gerald T. Keusch, MD
Professor of Medicine & International Health
Associate Director, NEIDL
Director, Collaborative Research

Dr. Keusch's research interests:

- Global impact of infectious diseases on economic development and public health

Faculty

Nahid Bhadelia, MD, MA
Associate Professor, Medicine / ID
Center for Emerging Infectious Diseases Policy and Research (CEID)

Dr. Bhadelia' s research interests:

- International pandemics strategy & policy
- Disaster preparedness training for healthcare workers

Tonya Colpitts, PhD *
Adjunct Faculty, Microbiology

Dr. Colpitts' research interests:

- Virus/Flavivirus pathogenesis
- Virus-host-vector interactions
- Transmission-blocking vaccines

Nicholas Crossland, DVM ACVP
Assistant Professor, Pathology
Director, NEIDL Comparative Pathology Laboratory

Dr. Crossland's research interests:

- Borrelia burgdoferi and mechanisms of persistence
  Comparative pathology using animal models

Markus Bosmann, MD
Associate Professor of Medicine, Pathology & Laboratory Medicine

Dr. Bosmann' s research interests:

- Acute respiratory distress syndrome
- Infection-associated inflammation
- Macrophages, neutrophils, T cells, lung epithelial cells

John H. Connor, PhD
Associate Professor, Microbiology
Lead, Viral Genomic Tracking &Single Cell Omics Resource

Dr. Connor's research interests:

- Virus-host interaction
- Viral domination of protein synthesis
- Novel approaches to virus detection

Robert Davey, PhD
Professor, Microbiology
Lead, High Throughput Screening Service Unit, NEIDL

Dr. Davey's research interests:

- Host factor-based therapy development
- Infection mechanism for filoviruses and other high containment viruses

Florian Douam, PhD
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Dr. Douam's research interests:

- Viral immunogenicity and pathogenicity mechanisms in vivo
- Advanced humanized mouse systems

Rahm Gummuluru, PhD
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Dr. Gummuluru's research interests:

- Multiple aspects of filovirus biology Development of vaccines and therapeutics

Thomas B Kepler, PhD
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Dr. Kepler's research interests:

- Quantitative Systems Immunology Vaccine Development

Rachel Fearns, PhD
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Dr. Fearns' research Interests:

- Negative strand RNA virus polymerase activities
- Control of respiratory syncytial virus RNA synthesis

Davidson Hamer, MD
Professor, Global Health & Medicine

Dr. Hamer's research interests:

- Tropical Infectious diseases
- Multi-site disease surveillance
- Molecular epidemiological studies to predict outbreaks

Bang-Bon Koo, PhD*
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Dr. Koo's research interests:

- Biomedical in-vivo imaging

Multimodal magnetic resonance imaging and analysis

Anthony Griffiths, PhD
Associate Professor, Microbiology
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- Multiple aspects of filovirus biology
- Development of vaccines and therapeutics

Anna Honko, PhD
Research Assoc Professor, Microbiology
Assoc Director, Nonclinical Studies Unit

Dr. Honkos research interests:

- Immunology and vaccine development
- Caracterization infectious disease animal models using implantable radiotelemetry

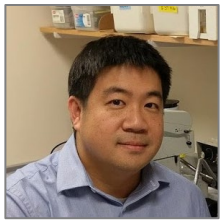
Igor Kramnik, MD, PhD
Associate Professor, Medicine and Microbiology

Dr. Kramnik's research interests:

- Genes controlling host resistance and susceptibility to TB
- Mechanisms of macrophage activation and differentiation

Core Faculty (blue font)
Affiliate Faculty (black font)

Joined during FY201 (green *)
Left during FY21 (red *)



Nelson Lau, PhD (A)
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Dr. Lau's research interests:

- Transposable element regulation
- RNAi
- Regulatory RNAs
- Gene silencing

Mohsan Saeed, PhD
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Role of viral proteases in shaping virus-host interactions

Joseph Mizgerd, PhD
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Director, Pulmonary Center

Dr. Mizgerd' s research interests:

- Pulmonary immunity
- Cell biology of the lung
- Mechanismms of inflammation

John C. Samuelson, MD, PhD
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- Pathogenesis of protozoan parasites
- Structures of parasite walls & glycoprotein

Elke Mühlberger, PhD
Professor, Microbiology
Director, NEIDL Virology Services

Dr. Mühlberger's research interests:

- Host response to filovirus infection
- Molecular mechanisms of filovirus replication and transcription

Core Faculty (blue font)
Affiliate Faculty (black font)

Joined during FY201 (green *)
Left during FY21 (red *)

Laboratory Staff and Trainees

Connor Lab

Devaux, Alexander *
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Lab Operations Staff

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Yen, Judy
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Executive Leadership

Ronald B. Corley, PhD
Director, NEIDL

Thomas Daley
Director of Operations

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Chief Safety Officer

Administration

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Spell, Virginia
Research Contracts Manager

Trevino, Richard , MPH
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Executive Director, Community Relations

Idiokitas, Chimel
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Facilities Maintenance & Operations

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Facilities Engineering Operations Manager

Ananian, David
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Control Technician I

Corbett, Joseph
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Cyr, Brandon
Control Technician II

Fahey, Shaun *
General Mechanic

Fonseca, Paulo *
Control Technician II

Galvao, Joao
Control Technician II

Gendron, Jonathan *
General Mechanic

Kjersgard, Eric J
Control Technician II

Madden, Lance
General Mechanic

Minacapilli, Salvatore
General Mechanic

Mosca, Derek
Maintenance Mechanic

Murphy, James
General Mechanic

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Rodriguez, Mario
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Director, NEIDL Facilities

Sousa, Daniel
NEIDL Shipper & Receiver

Tucker, Daniel
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Tupe, Michael T
Maintenance Mechanic

Wynne, Paul M *
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IT Operations Administrator

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Carvalho, Mariah *
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Diaz-Perez, Yulianela
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Gross, Sarah *
Consulting Vet Research Tech

Grosz, Kyle
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Hardcastle, Kath DVM, DACLAM*
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Harrington, Patrice
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Kurnick, Susanna *
Research Clinical Veterinarian

Laprise, Ambre *
Veterinary Research Technician

Lemoine, Kyle *
Veterinary Research Technician

Nickel, Ashley *
Veterinary Research Technician

Nunes, Corey
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Varada, Rao DVM PhD *
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NEIDL Core Director

"*" Joined during FY201

"*" Left during FY21

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Flynn, Nick
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Gilmartin, John *
Sr. Research Safety Specialist

Madico, Guillermo, MD PhD
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Olinger, Gene G, PhD
Assoc. Director, Training in High Containment

Tuohey, Kevin M
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Chief Safety Officer

Wallenstein, Adam
Senior Specialist, High Containment

Wold, Reed
Senior Specialist, High Containment

Yun, Nadezhda, MD
Assoc Director, Research Safety for High Containment

Public Safety

Management & Staff

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Systems Integrator

Taranto, Stephen
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Taverna, Michelle
Access Control Officer

Tracy, Harris
Systems Integrator

Public Safety Officers

Annese, Rae

Barros, Christopher L

Barros, Jeffrey P

Duffy, Joseph M

Estrella, David *

Estrella, Jesse

Gallivan, John

Maldonis, Joseph

Phelps, Justin

Saad, Jacob

Salhi, Adil

Santos, Rayshawn *

Souza, Joshua

Wynne, Paul M *

Wynne, Sean C

"*" Joined during FY201
"*" Left during FY21

NEIDL Organizational Chart

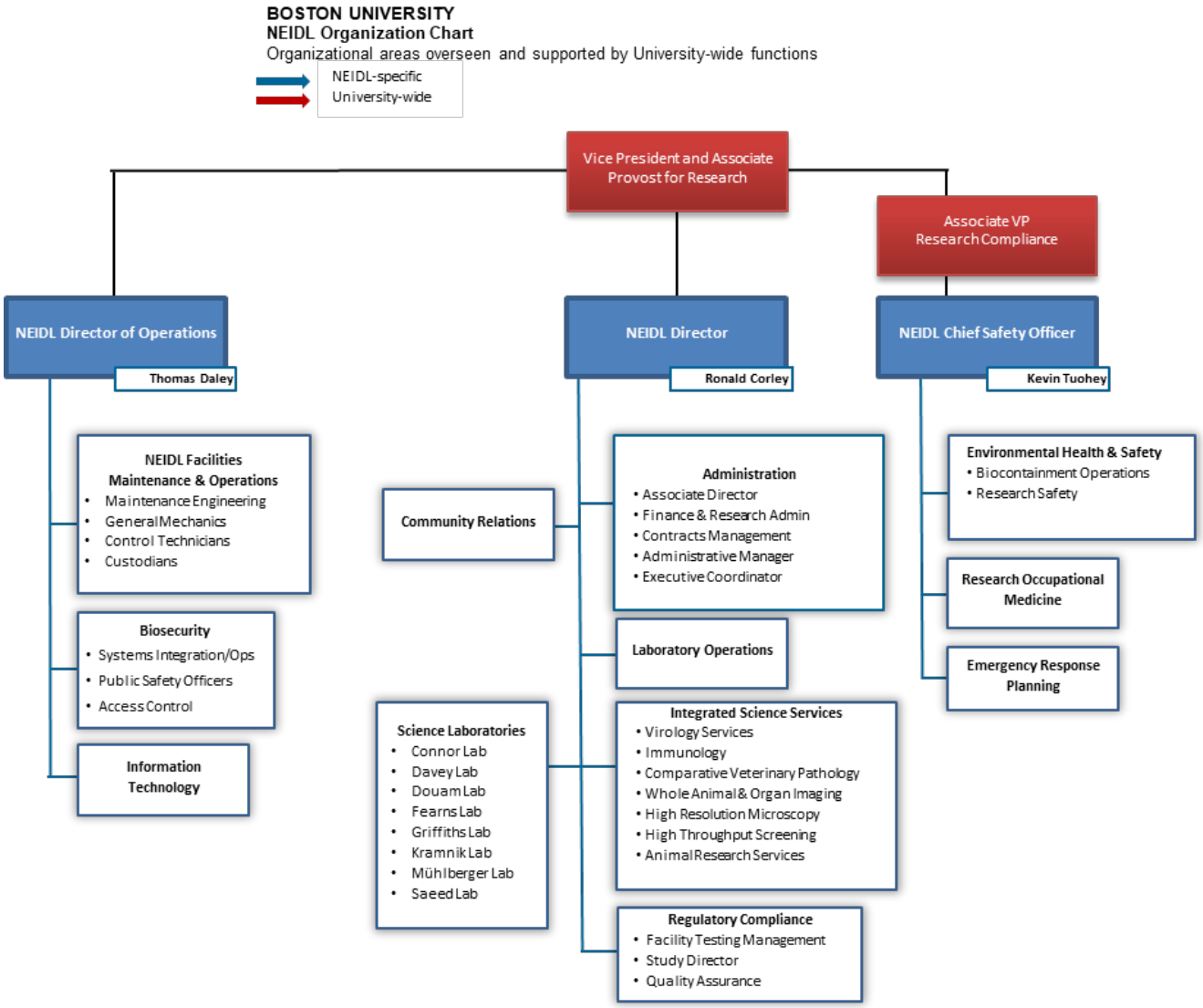
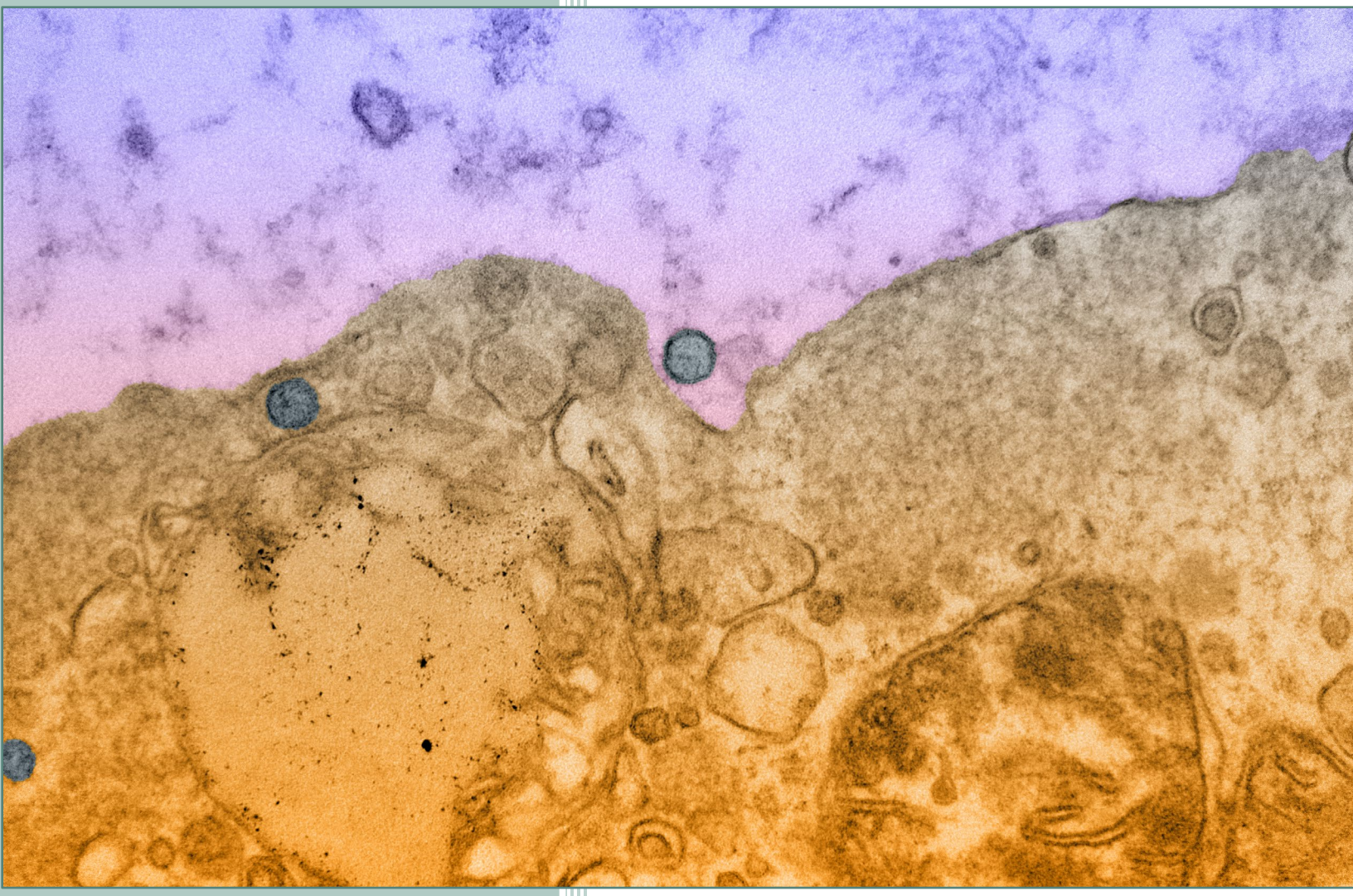


Photo on back cover: SARS-CoV-2 particle uptake into a human pneumocyte. Douam Lab



BOSTON UNIVERSITY

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