


The COVID-19 Pandemic: Reflections of Science, Person, and Challenge in Academic Research Settings

Jean M. Bidlack¹ · Sulie L. Chang² · Sylvia Fitting³ · Howard E. Gendelman⁴ · Santhi Gorantla⁴ · Santosh Kumar⁵ · Maria Cecilia Garibaldi Marcondes⁶ · Douglas D. Meigs⁴  · Loyda M. Melendez⁷ · Ilker K. Sariyer⁸ · Sowmya Yelamanchili⁹

Received: 4 November 2021 / Accepted: 11 November 2021 / Published online: 26 November 2021

Abstract

In spring of 2021, the Society on NeuroImmune Pharmacology (SNIP) organized a virtual workshop on the coronavirus disease 2019 (COVID-19). The daylong event's fourth and final symposium, "Well-being and reflections," offered a glimpse at the pandemic's impact on the lives of our scientists and educators. This manuscript includes a brief summary of the symposium, a transcription of our incoming president Dr. Santosh Kumar's lecture, titled "Intervention and improved well-being of basic science researchers during the COVID-19 era: a case study," and the panel discussion that followed, "Reflection and sharing," featuring Drs. Jean M. Bidlack, Sylvia Fitting, Santhi Gorantla, Maria Cecilia G. Marcondes, Loyda M. Melendez, and Ilker K. Sariyer. The conclusion of this manuscript includes comments from SNIP's president Dr. Sulie L. Chang and our Chief Editor, Dr. Howard E. Gendelman. Drs. Sowmya Yelamanchili and Jeymohan Joseph co-chaired the symposium.

Keywords COVID-19 · SARS-CoV-2 · Oral history · Diversity, equity, and inclusion · Early-career investigators · Well-being · Neuroimmune pharmacology · Therapeutics · Vaccines

Introduction

Since the onset of the global coronavirus disease 2019 (COVID-19) pandemic, society has struggled to regain normalcy in adapting to a new order. Scientists and physicians share these societal concerns. Certainly, clinics and laboratories were not sheltered from the lockdowns and various public health measures that have disrupted businesses. How has the challenging year affected research scientists,

laboratory technicians, instructors, students, fellows, and others engaged in basic and translational scientific pursuits? The question has received a paucity of attention. At the individual level, experiences of disruption caused by the pandemic have varied enormously from person to person and place to place. However, an arguably more resilient wheel of science has continued to roll onward through discovery, publications, and scientific exchanges. Reflections on how the pandemic affected the lives and the work of individual

Douglas D. Meigs
doug.meigs@unmc.edu

¹ Department of Pharmacology and Physiology, School of Medicine and Dentistry, University of Rochester Medical Center, Rochester, NY, USA

² Department of Biological Sciences, Institute of Neuroimmune Pharmacology, Seton Hall University, South Orange, NJ, USA

³ Department of Psychology and Neuroscience, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA

⁴ Department of Pharmacology and Experimental Neuroscience, College of Medicine, University of Nebraska Medical Center, Omaha, NE, USA

⁵ Department of Pharmaceutical Sciences, College of Pharmacy, University of Tennessee Health Science Center, Memphis, TN, USA

⁶ San Diego Biomedical Research Institute (Neuroimmunology Program), CA, San Diego, USA

⁷ Department of Microbiology and Medical Zoology, University of Puerto Rico-Medical Sciences Campus, San Juan, Puerto Rico, USA

⁸ Department of Neuroscience and Center for Neurovirology, Lewis Katz School of Medicine, Temple University, PA, Philadelphia, USA

⁹ Department of Anesthesiology, College of Medicine, University of Nebraska Medical Center, Omaha, NE, USA

scientists and colleagues offer an important historical documentation of the COVID-19 pandemic and the response by our segment of society, represented by the Society on NeuroImmune Pharmacology (SNIP). To such ends, this manuscript serves to provide a historical perspective on the experiences of a group of scientists who have endured work through the pandemic. Relevant back-to-back lectures and panel discussions are excerpted from the SNIP COVID-19 Virtual Workshop's "Well-being and reflections" symposium on April 9, 2021, hosted through a webinar from the University of Nebraska Medical Center's Department of Pharmacology and Experimental Neuroscience (Kumar et al. 2021).

Summary

"Well-being and reflections"

The 2021 SNIP COVID-19 Virtual Workshop's fourth and final symposium was led by officers of the Society on Neuroimmune Pharmacology from the Diversity and Inclusion Committee. It started with a talk by Dr. Jeymohan Joseph of the National Institute of Mental Health (NIMH), describing the known neurological manifestations of SARS-CoV-2 infection with an overview of investigations completed in China, Italy, Germany, and the United States. Immune response observed from patients with neurological manifestations of COVID-19 were reviewed along with the pathophysiology and neurological disease clinical manifestations, including but not limited to brain fog, insomnia, and mood swings. Taken together, studies show a clear effect of SARS-CoV-2 infection on the nervous system (Acharya et al. 2020; Berlin et al. 2020; Brann et al. 2020; Coolen et al. 2020; Costello and Dalakas 2020; Couzin-Frankel 2020; Frank 2020; Liotta et al. 2020; Mao et al. 2020; Matschke et al. 2020; Oxley et al. 2020; Radmanesh et al. 2020; Rogers et al. 2020; Song et al. 2020; Zubair et al. 2020; Eden et al. 2021; Frontera et al. 2021; Lee et al. 2021; Meinhardt et al. 2021; Rifino et al. 2021; Taquet et al. 2021). To this end, a better understanding of the mechanisms involved is needed to ensure preventative and therapeutic approaches. The NIH/NIMH promptly responded, as Dr. Joseph highlighted, with interest in such research, as well as with the acknowledgement that scientific activities have been significantly impacted by COVID-19 (NIH, 2020; 2021a; 2021b). For instance, K99/R00 research deadlines were extended by 8 months, and F- and K-awards now allow for no-cost and funded extensions in current research activities.

Dr. Thirumala-Devi Kanneganti, from St. Jude Children's Research Hospital, presented findings on immunity and pathways towards cell death that included pyroptosis, apoptosis, and necroptosis (PANoptosis) in SARS-CoV-2 infection and

cytokine shock, with data showing that the blockage of signaling cascades regulating the PANoptosome complex and inflammatory cell death may serve as a therapeutic path during COVID-19 as well as other infectious and inflammatory diseases (Karki and Kanneganti 2021; Karki et al. 2021; Zheng et al. 2021).

Next, the impact on research during the COVID-19 era was discussed by Dr. Santosh Kumar, from the Department of Pharmaceutical Sciences of the University of Tennessee Health Science Center. Generally, the mental health of researchers was greatly impacted, and research productivity was negatively affected. Dr. Kumar presented work resulting from a mitigation strategy involving positive enforcement, well-being, and fun activities. These mitigation activities were followed by assessment of well-being using longitudinal perceived stress tests and COVID-19 stress tests. Interestingly, stress measurements decreased in an intervention group compared to the control group, demonstrating the value of mitigation strategies.

Lastly, the symposium concluded with a panel discussion on personal reflections and sharing during the COVID-19 era. Drs. Jean M. Bidlack, Sylvia Fitting, Santhi Gorantla, Maria Cecilia G. Marcondes, Loyda M. Melendez, and Ilker K. Sariyer shared their personal and professional experiences during the pandemic in the panel chaired by Dr. Sowmya Yelamanchili. Their experiences included adjustments of teaching and research discussions suddenly shifted to Zoom, professional impact to young investigators and their productivity, and the lag or complete loss of research activities due to the shutdowns. The shutdowns curtailed animal welfare and planned experiments, including a block in the creation of humanized mice, as well as the interruption in reagents and lab material by supplier companies. These issues and others deeply affected experiments down the road. More personal experiences included the burden of dealing with COVID-19 in the family, and especially how women scientists with younger children were more significantly impacted. On the other hand, panelists also discussed how they tried and managed to make the best out of the situation, as much as possible. For instance, Dr. Melendez contributed to the establishment of a diagnostic lab as a new resource for SARS-CoV-2 testing in patients and employees. Dr. Marcondes mentioned how the conference room in her institute was converted into a space for children with scheduled times to give parent researchers the opportunity to continue their work. While being locked out of the lab, several investigators worked on data analysis and manuscript writing, and involved students and postdocs in writing reviews, which led to a number of publications. The final remarks of this overview of scientific and personal experience were given by the SNIP President Dr. Sulie L. Chang, who thanked all the NIH officials, presenters, SNIP Executive Committee, and all the SNIP members for a successful virtual meeting on COVID-19.

Edited lecture transcription

“Intervention and improved well-being of basic science researchers during the COVID-19 era: a case study” (Kumar et al. 2020b)

Presented by Dr. Santosh Kumar

Dr. Jeymohan Joseph (chair): It's a pleasure to introduce Dr. Santosh Kumar, who needs no introduction, from the Department of Pharmaceutical Sciences, College of Pharmacy, University of Tennessee Health Science Center (UTHSC), Memphis. He's going to tell us about interventions and improved well-being of basic science researchers during COVID-19 case study. Dr. Kumar...

Dr. Santosh Kumar: Thank you very much, Dr. Joseph. Thank you, everyone. We have had fantastic science presentations. I thought that maybe we should have some change and talk about well-being — what we have done and what we could do with the challenges of a pandemic. Discussions on well-being and reflections of others' experiences in the panel will follow my talk. My lab has done some work related to COVID-19. Our group published a review paper on repurposing antiviral drugs for COVID-19 (Kumar et al. 2020a), and I've written some newspaper columns in the local newspaper (Kumar, 2020a; 2020b). But this talk today will be on intervention and improved well-being of basic science researchers during the COVID-19 era. There were nine individuals in my laboratory working through the pandemic. We were doing Zoom meetings all the time with no live work at all. So, I really appreciate all our members and all the participants in this study, and funding support from multiple sources — NIH grant DA047178 and UTHSC's Plough Center for Sterile Drug Delivery Solutions.

We all know that in addition to the well-being of the general public affected by COVID-19 and healthcare professionals, college students were also affected with several psychological and psychiatric issues. If you look at the available data, all the data show increased levels for health concerns or suicidal thoughts compared to the pre-COVID era, and they all increased either mildly, moderately, or severely (Son et al. 2020). Similarly, a news article from *Nature* also discussed about soaring depression and anxiety among U.S. graduate students during the pandemic (Woolston 2020). So, we have to be careful about how we deal with not just ourselves, but also our students and postdocs. The other thing that was affected during the COVID-19 was researchers' productivity. This was addressed in many published papers, but I'm referencing one *Nature* paper (Myers et al. 2020). It shows, during the pandemic, compared to pre-COVID, the total work hours decreased. There was a negative shift in the total work hours among all the activities. If you look at

research, you see steeper declines in share of time devoted to research, fundraising, and other tasks compared to teaching, because we have to do teaching anyway, even if it was all Zoom at the time. And today, we are still doing Zoom teaching.

Some studies also showed how this pandemic environment affected gender inequality, and clearly there was some differential effect on male and female productivity (Squazzoni et al. 2020). For example, the overall number of submissions for publication went up during the COVID time for both men and women. However, for men it went up a little bit more than women. The overall acceptance rates were very similar. Another study, done by a colleague at UTHSC, talks about how this pandemic affected the productivity of U.S. faculty with very young children (Krukowski et al. 2021). That makes sense because those taking care of young children at the home, who are engaged in Zoom school at the home, are affected in their own productivity.

In our case study (Kumar et al. 2020b), the first thing we said was, “Okay, let's prepare ourselves and our activities before the crisis,” which was January to March. We knew that the crisis was coming, based on news coverage and the CDC reports. So, we said, “Okay, let's postpone all kinds of writing stuff and just focus on all the live experiments. Do whatever experiments we can until we have lockdown,” which eventually happened in March. That's exactly what we did for 2 to 2.5 months. And then, during lockdown we said, “Okay, let's do a lab meeting.” We spent one hour extra for the lab meeting. The reason we did a longer lab meeting was because we wanted to listen to everyone's concerns, celebrate any good news, talk about some COVID-related facts, empower one another, and play some fun and engaging games. So, that kept us kind of engaged in a more fun way. We also talked about exercising, reflections, and gratitude. During the lockdown, we focused more on productivity in terms of data analysis, manuscript writing, and conceiving new ideas, etc. That's exactly what we did during the lockdown period of 3–4 months, while the university was pretty much closed without any real experiments being done.

In our group, we assessed the COVID differentiator. The idea was that in any kind of challenge we always have three categories: individuals who were negatively impacted, individuals who stayed the course, and individuals who found new opportunities and improved performance. We said, “Don't let the crisis go to waste,” and this comes from a quote from a Stanford economist, Paul Romer, who said, “A crisis is a terrible thing to waste.” I'm not saying this in a mean way; if something has happened, which we cannot change, then our attitude is how can we take advantage from our circumstance. So, the No. 1 thing is mindset. What kind of mindset should we have? Consider the contrasts of positive mindset induced by positive emotion vs. negative

mindset induced by negative emotions: faith/staying strong vs. panic/fear; facts/reality vs. stupidity/hype; safety vs. carelessness; managing the crisis vs. getting under the crisis; victor vs. victim mentality; and thriving vs. surviving attitude. The bottom line is, if you can't change something, why worry about it? If you can, why worry about? Just do it! We strived for this mentality during the COVID-19 era. But we knew that it's not easy to do. We had to work on a daily basis to do better and be more mindful. Then we talked about, "What are the advantages of the COVID-19 era?" There have been a lot of disadvantages. We all acknowledge that. Our question is, what are some of the positives? For example: 1. We have more freedom. 2. The boss is not looking over our shoulder and micromanaging. 3. We have family togetherness. 4. We have more time to think and be creative. Sometimes we are so busy working that we hardly find time to think creatively. 5. We have time for yoga, meditation, and exercise — things we usually don't get to do when we are working 12- to-14-hour days as a scientist. 6. We have time to think about new opportunities, new research projects, etc. 7. And, we have time to help other people.

Then we said, "Okay, let's play a game." The idea was that we have some random questions inspired by multiple sources, and if lab members answer "yes," then they get one point. We accumulate points together. Questions included statements like: "Have you seen someone washing their hands for 20 seconds?" "Took a nap in the afternoon?" "Donated for a COVID-19 cause?" etc. If somebody admits to taking a nap in the afternoon or waking up later in the day, we are not judging them, we're just having fun with this game. That's all our goal was. Reflection was the next step, and the reflection was all about how did I contribute positively to the society or to other people? Is it positive or is it negative? If it is negative, can we make it to a neutral? If it is neutral, can we make it to a positive? So, we devised many questions for reflections. We did multiple reflections and tried to figure out how our reflections were improving in terms of positive thinking. We cultivated mindfulness. When we talk to someone, do we make them feel better or worse? That's very important. Whenever somebody interacts with you, are they feeling better or worse after the interaction? That's something we all need to work on daily.

After doing this maybe a month or two, we thought, "Looks like we are doing good, so let's test our stress scores." We tested our general stress score called "perceived stress score" (PSS) as described (New Hampshire Department of Administrative Services 2021). The idea is that we answer these PSS questions, get a point if we answer the questions. If the total point tally is 0-to-13, we have low stress; if it is 14-to-26, we have moderate stress; and 27-to-40, high stress. So, we all volunteered to test ourselves after getting IRB approval, and then we compared with a control group. We also asked questions that are directly related

to stress due to COVID-19, or stress that was induced by the pandemic. We found literature to inspire questions to ask to measure COVID-19 stress score (Winston & Strawn LLP 2020). We divided these questions into three columns: fear zone, knowledge zone, and growth zone. The idea was to ask these questions for each zone, answer, and give points to ourselves. Then, based on the point tallies, we determined if our fear zone was going down over time; if the knowledge zone was going up over the time; and if the growth zone was also going up over time. Those were the goals over a period of five months.

Of course, we all knew our study population within our intervention group. We did not want to have a control group because we did not want to compare ourselves with anyone else. But we were asked by the reviewers to include a control group — people who were not involved in our mitigation strategies. After those tests, the PSS scores showed a decreasing trend in our intervention group over previous months, and overall, the scores significantly decreased in five months. However, the PSS scores stayed the same in the control group over the five-month period. When we looked at the COVID-19 fear zone, we found that the scores in the control group remained constant, while our intervention group showed a significant decrease in COVID-19 fear zone scores from month to month, and overall, in five months. This was our goal. In the case of knowledge zone, clearly the scores in the intervention group increased from month to month, likewise in comparison to the control group. However, in the case of control group, the COVID-19 knowledge zone scores did not change significantly. We also looked at our COVID-19 growth zone scores, and we saw a similar positive change in the intervention group compared to the control group. So, clearly these intervention strategies did work in reducing COVID-19-induced stress. We also looked at our own productivity in those 5–6 months. Our idea was to write and submit as many articles, as many reviews and editorials as possible. We were able to track all those publications during that time period, and we were happy with the productivity. We exceeded our own productivity during the COVID-19 era compared to the previous years. Our conclusion was that the development of our mitigation strategies during the COVID-19 era improved the well-being of the intervention group compared to the control group, and the intervention group also improved productivity.

The take home message: if you anticipate a problem, develop an appropriate mitigation strategy, assess the progress of the mitigation strategy, and have an optimistic outlook throughout the mitigation plan. We have the potential for success amid any challenge. I'm not saying it's going to be easy because we all are different people, but we can always get better if we work daily with intention. This strategy, with appropriate changes, could be implemented by any other group or organization when facing similar or different

challenges — including new, emerging, reemerging, or any other kind of pandemic or natural disaster or financial crisis. With that, I am done and will entertain any questions you might have. Thank you very much.

Edited panel discussion transcription

“Reflection and sharing”

Panelists: Drs. Jean M. Bidlack, Sylvia Fitting, Santhi Gorantla, Maria Cecilia G. Marcondes, Loyda M. Melendez, and Ilker K. Sariyer. Panel chair: Dr. Sowmya Yelamanchili

Dr. Sowmya Yelamanchili (chair): Santosh, it was a really nice talk about your reflections and sharing. Now, we will move on to the panel discussion, which is basically an extension Santosh’s talk on reflections and sharing. We have six panelists today who have agreed to comment on how they managed to find a balance during the pandemic. It’s really amazing to hear today that some of these wonderful works were performed despite of the pandemic. And so, we feel that, as a scientific community, it’s not only important for us to acknowledge all the hard work, but also learn from our community how they managed to balance it all. With that in mind, the SNIP council thought that a panel discussion would be ideal. So, I will go ahead and start the panel discussion with a very broad question for all the panelists. I hope you are ready. What is the biggest personal or professional challenge you have faced because of the COVID-19 pandemic? And I will start with Dr. Jean Bidlack. As you all know, she’s a one of the founding members of SNIP, professor and associate chair of the Department of Pharmacology and Physiology at the University of Rochester. Dr. Bidlack...

Dr. Jean M. Bidlack: Okay, well, thank you very much, and thank you Santosh for the excellent introduction because we really have found everything that you were saying to be very true. I’d say, initially, the biggest situation I noticed was teaching — because at that time, in the spring as I’m doing now, I teach the principles of pharmacology course, which is a team-taught course, and all of a sudden, it really came down very fast. You gotta go to Zoom. I gotta go to what? And then, remember we thought it was only going to last two or three weeks. Okay, I’m lecturing. I can handle this, except for the fact I didn’t have a webcam at that time. I’m sitting in my office right now at my desk. I’ve been in all along. It’s at the med center and all faculty are essential personnel, and so I’ve been able to go into my office the whole time. But you couldn’t find a webcam to save your life at the very beginning of all of this. And then, learning to lecture with Zoom, and then teaching other faculty to lecture, too, because it is a team-taught course. That was one of the early

challenges. Then, not having a lab going, and then having the grad students come back and the general slowness of getting back up. Our animals were okay. My technician did come in to take care of our animals and things like that. We didn’t lose animals, which I’ve heard some people did. And then, beyond that, just getting up to the general productivity again. I’m involved as chair of the university committee on tenure and privileges and on the faculty senate, and we are dealing with other younger faculty and graduate student problems that are arising, and it is a very personalized time. I think it’s not going to be one-size-fits-all at all. We have to stop and listen to each individual person and how this COVID pandemic has affected their lives. Going forward, we have to have a memory, too. Three years from now we might say, “What pandemic?” And yet, at the same time it’s affected people’s careers very much, and particularly women with children I have heard from. For example, from a faculty member with three school-aged kids at home during the pandemic: “I’m a seventh-grade teacher, I’m an eighth-grade teacher, and a second-grade teacher, and I’m doing all these other things for people in my lab, and I have my own grad students. I don’t have time to think to write a paper or submit grants.” I think that we really have to learn to deal with it. At the same time, I’ve gotten really good at Zoom and we’re teaching this semester, too, but it’s what you would expect to do. So again, we adapt to the situation.

Dr. Yelamanchili: Yes, cannot agree more, especially with Zoom, and now we figured out all the cool backgrounds we can make with Zoom. And I agree 100% with the kids. I have two boys myself, and it’s been quite a challenge with them at home and doing the work together. Well, our next panelist is going to share some thoughts. Dr. Sylvia Fitting, she’s an associate professor in the Department of Psychology and Neuroscience, University of North Carolina, Chapel Hill. Sylvia...

Dr. Sylvia Fitting: For me, it was actually a very unique time because I just submitted my tenure promotion documents in November 2019. Additionally, I had a daughter who was three months old when the first cases of COVID were reported, so I was actually on maternity leave in spring 2020. Thus, whereas for a lot of people the COVID pandemic started a struggle of isolation and loneliness, I was actually pretty busy with our daughter. Further, the change that people started to work remotely from home helped me to receive more support from my partner and family members living in the same household. As we live in a community that is very much spread out, I was also able to go outside and continue a somewhat normal life, for example: daily walks with our daughter. Being able to go outside during the pandemic helped me tremendously to maintain a healthy mindset. So personally, I was in a pretty good place, but professionally, I was very much struggling, especially being separated from my students and not being physically

present to help them manage their lives in this new situation. I started my own lab at UNC in 2015, so I was just at the beginning of my independent career. Two of my students defended their Ph.D. dissertation and master's thesis work in May 2020, which all had to take place remotely. Campus operations at UNC had to be reduced in March 2020, so my lab shut down and we had to cut down our animal colonies to 20%. Two of my current students had to completely stop their ongoing experiments. So, in addition to not only dealing with my own productivity problems, I was also trying to give emotional support to my students. I was trying to be a motivator, problem solver, and making clear to my students that as of now, the No. 1 priority was to stay healthy, safe, and sane. In addition, I was trying to deal with the lab shut down and later worked together with faculty members of our program to set plans into place for reopening our labs in the future. So, all of this — getting a handle on my own professional life but also my students' well-being — was a really tough time.

Dr. Yelamanchili: Yeah, I agree 100% with what you said. It was important for the students and the postdocs also to have that support, and for us to give them the support is one of the major issues here. So, we'll go to our next panelist, Dr. Santhi Gorantla. She's a professor in the Department of Pharmacology and Experimental Neuroscience at UNMC. Santhi...

Dr. Santhi Gorantla: Hi, thanks for allowing me to be the panelist. I really enjoyed the symposium so far. About how we suffered during COVID, with the lockdowns, we had to shut down our labs. But we did not completely shut down because we had some ongoing animal experiments, and I'm very thankful to all the lab members who didn't complain about coming and finishing all those — because they had to be finished, and they were definitely responsible. They took the responsibility to finish those works and take safety precautions, because safety is a major thing that we considered. We did work in shifts. They came to the lab, maybe an hour at a time, to finish their work as needed. But we had major setbacks because we work with humanized mice, and we developed recently a human microbial mouse model for HIV brain infection. This is a transgenic mouse line, which can support human microbial development. And this is a new strain of mice that we have. Our animal facility, they asked us to stop the breeding and to maintain only a very minimal colony, and that was a major setback. To get the colony back, to expand the colony and make humanized mice, it took almost one year after the shutdown was lifted. And we also had a block on umbilical cord blood collection; that is our source of stem cells, so we could not collect those samples. We had a lot of setbacks, but I'm very thankful to the lab members who always were eager to work. We put safety as our primary concern, and we figured out that the labs are safer than grocery stores because we maintain social

distancing and use masking. So, that's what we followed. We followed all the guidelines. We had those setbacks, and we concentrated on data analysis and tissue analysis and all those things, and now we are writing papers. Thankfully, we survived but still we learned a lot during the pandemic.

Dr. Yelamanchili: Yeah, we survived. That's great. Our next panelist is Dr. Cecilia Marcondes, she's an associate professor at the San Diego Biomedical Institute, and she is going to share some thoughts.

Dr. Maria Cecilia G. Marcondes: Thank you so much, Sowmya, for inviting me and all the other panelists. It's a great moment to share with you and all the other listeners. I would just tell you more or less what we did in our institute. Our institute is relatively small. We are about 11 principal investigators, so it's relatively easy to handle. We were all about three months in lockdown, but of course soon realized this is not sustainable. As soon as we were considered essential workers, our CEO, Dr. Joanna Davies, reopened and we established some very strict rules. We performed a couple of structural and organizational changes. For instance, we placed plastic curtains between all the benches so that people in different slots did not share spills with the neighbor slots. We put all these curtains all over to minimize air movement and established a shift system (morning/afternoon). We have two doors going into the lab, so we established a system that some people would enter through one door, some people through the other door so that everybody could have a relatively low-density circulation per shift, and the capability of going to the lab. This has been working. Also, no sharing food, kitchen is closed, all these things allowed people to keep going. But of course, we have people that have kids — myself and including Dr. Liana Basova, who gave a talk today. We were lucky that she could keep her kids at school. Her school district remained open, but sometimes it was complicated, so we transformed our conference/meeting room into a children space, so the moms in different shifts could work, just taking care that we wouldn't mix different families at the same time. So, many female scientists were able to bring their kids to the lab and leave them in that meeting room doing their homework or Zoom school with the teacher, or just playing, and then clean up everything so the next family would be able to take advantage of that space. And so, this is still ongoing, actually, for many of us. Myself, because a lot of what I do is writing, I saw a lot of freedom on not having to commute because I drive about one hour and a half per day to get to the lab and back. Even though I don't know anymore all the songs on the radio, I had time to write a record number of papers, put out a couple of grants, and think about things that were in the drawer. So, there is a lot of positive on the experience, in addition to being able to bond with my family and know more about my kids, right? Sometimes we outsource them, and we don't learn very much about their personalities. And

so, it has been very rich so far in that sense. I'm not the kind of person that will shut down and say, "Oh my God," I'm more of the kind that handles in a positive manner. And so far, we balance and we keep going. That's the deal. But there are issues. For instance, if I have to buy a reagent to keep going in the lab, the companies are back ordered in a lot of things, right? I had to buy methamphetamine, and it was back ordered from Sigma for eight months. Plus, we didn't have students, which decreased slightly the productivity. Of course, when we have students, we have to stop and teach the students, which takes time but pays off.

Dr. Yelamanchili: That was pretty easy. I mean, I would love to hear you talk more. Your students have really handled so well. I think having that access for having your children come in, and they can do the Zoom meetings there. I think that's a very good support from the institute. And I know that you've looked at COVID-19 really closely, right? Your kids got COVID-19, right? And I really want to hear, how did you manage?

Dr. Marcondes: Yeah, both my kids.

Dr. Yelamanchili: I mean, it must have been so difficult to manage.

Dr. Marcondes: Yes, but I'm very thankful for my training in biosafety level 3. And I transformed my house into a BSL3 facility with clean things going through one door, dirty things going through another door, and my little monkeys were in the containment with a separate bathroom right away, and everybody wearing mask inside of the house, N-95s inside of the house, everybody with designated areas in the house. My husband was sleeping downstairs in the laundry room, my kids, each one of them, until we were sure that both of them were not positive, staying in different areas of the house. Nobody was allowed in the kitchen but me. Clothes in bags. In 12 days, I went through 2 gallons of bleach to sanitize bathrooms and kitchen. So, I transformed my house into a BSL2/3 facility. And I have to tell you that science works, because neither myself or my husband got infected, and this sounds like a miracle but it's just a matter of being very rigorous, and I'm very thankful for my training. That's what it was.

Dr. Yelamanchili: Yes, we are all thankful for being in the scientist community and to have learned about viruses, and to know how to actually control infections in controlled settings. So thankful. Our next panelist is Dr. Loyda Melendez. She is a professor at the Department of Microbiology and Zoology at the University of Puerto Rico School of Medicine. Loyda...

Dr. Loyda M. Melendez: I want to congratulate this group for the excellent workshop, all the people that participated and presented such a good science in this time that has been so difficult for everybody to do research. At the beginning of the pandemic, the island immediately shut down. Our governor wanted to close everything, and it was very

strict, even more strict than in the U.S. Thus, the university did not allow anybody to go to the laboratory or do anything in the building. So, it was very hard to plan to do science. And then, suddenly, like most of universities, we have to teach with technology we didn't use before. Thus, it was very hectic for me and for most faculty to do online teaching. It was kind of hard, but I did participate and recorded the classes, and then sent it to the coordinator for uploading into Blackboard. But teaching online to a big group is more impersonal. You are not interacting with the student. As for the graduate students, the way we motivated each other was by learning how to do Google Meet. And so, by Google Meet, we saw each other, and started talking about things that we could do for work. We decided to write a manuscript review on SARS-CoV-2. I assigned a subtopic to each of the undergraduates and graduates to write and therefore distract them from the situation. They started reading the literature and writing science. After several revisions, we submitted the review, and it was published in the *Virology & Immunology Journal* by May 2020, entitled "SARS-CoV-2: Biology, Detection, Macrophage-Mediated Pathogenesis and Potential Treatments" (Borges-Velez et al. 2020). During that time, my university wanted to develop COVID-19 testing because it was limited, and we did not get the reagents for testing in Puerto Rico from the mainland because it was scarce. Thus, Dr. Carmen Cadilla, a molecular biologist, and I put some money from research to start buying the agents to do COVID-19 testing. We contacted the people in the Department of Pathology that had set the instrumentation included in the EUA, for development of testing and implementation by July 2020. All the employees from the medical campus, about 5,000, have already been tested or get tested upon possible exposure. Recently they also implemented COVID-19 vaccination. It was a shift from our work with HIV to start investigating about COVID and how it was affecting our society. In the middle of July 2020, I had a very bad experience. My son died in motorcycle accident, and it was very stressful for me. It was something that I thought I would not overcome, but I decided that God wants me to be here to do something good. Thus, I continued doing research on how this new virus was affecting our population, and developed a project on examining differences between genetic factors and the degree of COVID-19 severity applying genomics and proteomics approaches to the patients' peripheral blood mononuclear cells. We are still collecting patient samples from the hospital. It has not been easy because the strict regulations with patient isolation at the hospital beds. To get clinicians to collaborate for patient consents and obtaining samples was unbelievably difficult. Losing a son is something I would never think that I could survive to. I still have a wonderful daughter that has been affected, but we are learning to cope. And so we have developed more bonding and this is positive. We will continue

working to see what the future brings. But really, I was very impressed with all the science that most of you guys have done during this hectic time. Congratulations.

Dr. Yelamanchili: Thank you, Loyda. I'm really sorry for your loss, but just listening to you — how much science you have done, in spite of all this, it's really motivating and inspiring. We'll move on to our last panelist of the session. We haven't really balanced the genders in the session so he's the only male scientist we're going to have here. Dr. Ilker Sariyer is associate professor in the Department of Neuroscience and Neurovirology at the Temple University. Ilker...

Dr. Ilker K. Sariyer: Hello, everyone. Thank you for this opportunity. I agree with all the challenges my colleagues had during the pandemic. In the beginning of the pandemic when we shut down the labs, I was really worried because I was in the middle of so many studies. I had plans for grants and manuscripts. I had a couple of graduate students; they had to graduate this year, and that really gave me a lot of worry. Another challenge was reopening the labs. We had a gradual reopening, and that was really successful. I can say that our group did really good job on reopening plans and everything. But for me, it was very difficult to stay home for those 6–8 weeks. We are scientists. We live in the lab. I do a lot of research activities on the bench with my students and postdocs. Having all the Zoom meetings was quite stressful, but then we learned how to manage it. Meanwhile, I had a chance to revisit all the research data gathered throughout the years. I realized that I had a lot of data that could be published, or written as a review paper. I ended up publishing more manuscripts than ever and submitted more grants. That was positive, one of the positive outcomes for me. Also, as a part of reopening plans, I got into a little bit of SARS research, and I was able to get permission to be one of the earliest to reopen my lab at Temple. And that really helped a lot for my research handling in my laboratory. With respect to personal matters, I realized that I was not really spending enough time with my daughter before the pandemic. Being at home due to the pandemic led us spending more time together. I think it helped a lot to improve our relations within the family. I think we got even much closer and stronger during the pandemic because we had a chance to spend more time together, share more things together. On the other hand, I'm sure some of you already had someone in your family with COVID. My mom and dad got COVID, they survived fortunately, but it was tough time. All the unknowns with the disease in the beginning and in the middle of the pandemic brought some stress to all of us. We know as scientists how to deal with things in the lab and workplace, but when it happens to our family, it's tough. So, I'm going to stop here. I agree all the other concerns and comments that my colleagues had, and I again, I appreciate this opportunity. Thank you.

Dr. Yelamanchili: Thank you, Ilker. I 100% agree with what you said. It was a good time to spend with family, and especially the kids and connect back with each other. Many of us dealt with the fear of parents getting infected, especially when the parents are far away from here, for those of us who have parents in other countries. That was pretty scary for us. So, thank you to all panelists for sharing your thoughts, and I think this has been great. I don't have any further questions. We have heard from all of the panelists, so I will just give this over to Sulie, who will take it from here and conclude the session.

Dr. Sulie L. Chang (SNIP President, workshop organizing committee): We have time for questions.

Dr. Sowmya Yelamanchili: The floor is open for questions, so if there are any questions for the panelists, please ask them.

Dr. Bidlack: I can talk more about what we're doing at Rochester.

Dr. Chang: Yes, please.

Dr. Bidlack: We have given all of our junior faculty and untenured faculty an extra year before they have to come up for promotion. That is blanket completely. Yet there is also the concern — as actually Santosh showed — some people, particularly the males with an extra year, they've published more papers, whereas females that have been home taking care of children — and there's some reversal to this. I'm not saying it's all one sex — but people who have been taking care of children aren't able to publish a paper a month, and that has been difficult and something that we have to remember downstream when we're looking to hire people. Normally, you might say, "Well, what happened there? Why was this big year or two-year gap in your publications?" Remembering what happened along the way, our concern is the one-year extension isn't equal. It influences some people more than others, and we don't want to be raising the bar, like saying, "Okay, well, this person published 12 papers in the last year, now the bar for associate professor has gone up that much more." No, it shouldn't be that way, but it's something to keep an eye on for the future, and I think, at least here, the administrators are very concerned.

Dr. Howard E. Gendelman (Journal of Neuroimmune Pharmacology, Editor-in-Chief): I have a quick question for Jeymohan. He's still with us, I hope.

Dr. Joseph: Yes. I am here.

Dr. Gendelman: I think a lot of us are curious about what the National Institutes of Health (NIH), National Institute of Mental Health (NIMH), National Institute of Neurological Disorders and Stroke (NINDS), and National Institute on Drug Abuse (NIDA) are thinking about the next phase of variant viruses, the metabolic problems and the post-syndromes, the neurological syndromes, that are being seen in nearly half of these cases. There are persistent neurological

abnormalities and dysfunctions. What do the institutes think about getting involved or not getting involved? What will the future look like in terms of preclinical and clinical studies that involve the brain and mental health?

Dr. Joseph: There is a lot of interest in looking at this, and this is being allocated to different institutes based on their areas. So, the National Heart, Lung, and Blood Institute (NHLBI) is really taking a big lead in this effort for cardiovascular things, and the National Institute of Allergy and Infectious Diseases (NIAD) is also involved, and NINDS will probably take a bigger lead in the more basic neuroscience-type research relating to the neurologic issues. We are doing a big meeting in July involving NINDS and NIMH and National Institute on Aging where we're going to look at this post-acute sequelae of COVID (NIH 2021c), and really look at some of the priorities for research in the neuroscience-neuropsychiatry area. At that time we may have a better sense of where things are going. I can't tell you about NIMH allocation in this area or interest in this area, but at least the division of AIDS research is trying to promote it as best as we can. Our funding stream is coming from AIDS dollars, so we're not able to focus exclusively on COVID. It has to be in the context of coinfection. So, if there's any events that happen in the set of HIV-SARS coinfection, that's something we may be able to support with AIDS dollars. But that's roughly where we are with that. I hope that's answered your question. But I did want to say to this panel it's great to hear how you have dealt with this epidemic and managed to still be really successful in doing as much as you can. That's pretty remarkable. As you know, NIH has been incredibly busy thinking about some of these things, and they have been issuing notices after notices since all of this started back in May. Even we have a hard time keeping up with all the new announcements that come out to help with these COVID-related issues. And the three of the announcements that I presented in my talk are an example of trying to help with this situation, for example, extending the eligibility period for K-99 people, especially the early-career folks, and really paying more attention to the trainees, the K and the F awardees, giving them opportunities to request supplemental funding to their awards and all of that. So, I think NIH is trying to help as much as possible with the funding aspects of it.

Dr. Gendelman: That's very helpful. One more word if I can, Sulie, and I'll turn it back to you.

Dr. Chang: Go ahead.

Dr. Gendelman: This was very impressive. I mean, I had no idea of the scope of work that was being done in multiple aspects. The *Journal of Neuroimmune Pharmacology* (JNIP) will be hosting a theme issue, "The Neuroimmune Pharmacology of SARS-CoV-2," in conjunction with this workshop. I'd love to have these manuscripts as soon as possible, and I promise to you, I will expedite them in review

with acceptance if they're as good as these presentations. They will be published pronto. It's great for the Society to have been a lead in all of this. It's really a big kick in the right direction, don't you think Jeymohan? It was quite an impressive day.

Dr. Joseph: Yeah. I wasn't aware that there is so much basic science work going on in the year of COVID. This is the first time I've heard it all in one place.

Conclusion

The following text from SNIP President Dr. Sulie L. Chang was edited to combine her "Welcome Message," where she shared reflections on the pandemic's disruption to her personal and professional life, and excerpts from her concluding remarks to close out the SNIP COVID-19 Virtual Workshop.

Dr. Chang: All members of our Society have been impacted by COVID-19 both personally and professionally. Following the sharing and reflection of SNIP colleagues, I would like to briefly share my own experiences. First, personally, I am now wearing long hair for the first time since many years ago, which attendees can see in this Zoom video call. Professionally, the pandemic lockdowns led my laboratory into the realm of network meta-analysis, whereby we gradually came to realize and appreciate the powerful, necessary integration of our in vivo, in vitro, and in silico studies. We were locked down seven months because the regulation in New Jersey was very strict, as we were the pandemic's early epicenter on the east coast of the U.S. Without access to our lab to conduct our studies in vivo and in vitro, we worked from home to complete our in silico studies of various projects using bioinformatics tools. Using QIAGEN Ingenuity Pathways Analysis (IPA) tools and QIAGEN Knowledge Base (QKB) as research resource, we first conducted meta-analysis on the mechanisms underlying the involvement of neuroinflammation signaling pathway in alcohol modulation of amyloid precursor protein (APP) as a potential causal factor in Alzheimer's disease (AD) (Masi et al. 2020).

We soon shifted the focus of our meta-analysis to the pandemic. A significant increase in alcohol consumption corresponded with the COVID-19 pandemic, with U.S. sales of alcoholic beverages increasing by 55% compared to the same time in previous years (Bremner 2020). Because using alcohol suppresses immunity, we hypothesized that alcohol consumption may augment the inflammatory response to SARS-CoV-2 infection and that ethanol (EtOH) may worsen the severity of COVID-19 outcomes through modulation of the inflammatory response in COVID-19 patients. To substantiate this hypothesis, we examined the possible relationships between alcohol exposure and COVID-19 pathologies

by performing a network meta-analysis of gene expression changes reported in patients with COVID-19 derived from three resources: 1. literature searches in MEDLINE, bioRxiv, and medRxiv; 2. GEO database of RNA-sequencing data from autopsied lungs of COVID-19 patients; and 3. QIAGEN Coronavirus Network Explorer (QCNE). Our analysis indicated that alcohol-augmented effects of SARS-CoV-2 on various conical pathways including neuroinflammation signal pathways. We also identified the following 11 common key inflammatory mediators between alcohol exposure and COVID-19: IL-1 β , IL-6, JUN, NR3C1 (GR), TNF, IFNG, PPARG, PPARG-RXT, STAT, NF κ B, and HIF1A. These 11 mediators were mapped to the pathways predicated to associate with SARS-CoV-2 infection. In summary, despite medical records of COVID-19 patients being sparse for drinking history, our meta-analyses demonstrated that alcohol exposure could augment COVID-19 pathologies (Huang et al. 2021).

To address if there will be issues with neurodegenerative diseases in the post-COVID-19 era, by applying both IPA networking and Molecule Activation Predictor (MAP) tools on each of these 11 mediators between alcohol and COVID-19, we found that IL-1 β , IL-6, JUN, NR3C1 (GR), TNF, and IFNG would activate, PPARG and PPARG-RXT would inhibit, while STAT, NF κ B, and HIF1A would have no effect on APP expression. However, the overall effects of concurrent activation of these 11 mediators would result in strong activation of APP expression holistically. Subsequently, we used the MAP tool to simulate increased EtOH exposure on expression of the 11 mediators, which jointly led to further activation of APP expression (Alabed et al. 2021). By showing EtOH augmentation on COVID-19 pathologies and APP expression upon SARS-CoV-2 infection, our studies call attention to the long-term complications of alcohol and COVID-19 on Alzheimer disease and other possible neurodegenerative complications.

I'll also share briefly about the pandemic's impact on our Society. When we started to plan this virtual workshop two-to-three months ago, Dr. Santosh Kumar and I were a little worried, "What if we only have three abstracts?" Well, maybe I can ask my collaborator friends to attend and present, I thought. Then, as it turned out, in early March we had the good headache of an overwhelming response. Now, how do we handle that? We originally planned to have one COVID symposium. Suddenly, we had four showcasing research on molecular approaches, therapeutic/vaccine approaches, work by early-career investigators, and this final symposium from the SNIP committee on diversity and inclusion. We had more than 200 in attendance with roughly 30 presentations today.

I would like to thank all the attendees for coming to this very unique virtual workshop, and I would like to thank all the speakers and participants. I would like to thank the

organizing committee. They worked so hard to make this possible — particularly to Dr. Kumar for his leadership in chairing this virtual workshop. I would like to thank again Dr. Gendelman as our *Journal's* editor-in-chief. I really appreciate him reminding me and others to submit papers. I also need to thank Doug Meigs, *JNIP's* managing editor, who has served as a virtual master of ceremonies and stayed with us all day, along with the University of Nebraska Medical Center for its IT support of our Zoom livestream. Thanks also to Dr. Changhai Cui for presenting on National Institute on Alcohol Abuse and Alcoholism funding for COVID-19 research. Thanks to Dr. Woody Lin for presenting on HIV, COVID-19, and substance abuse. Actually, right before this meeting, I heard NIDA's director, Dr. Nora D. Volkow, talking about COVID-19 and drug abuse. That reminded me how 18 years ago, Dr. Volkow was able to convince the NIH that controlling substance abuse could help to control HIV infection. And thanks to Dr. Jeymohan Joseph, HIV Neuropathogenesis, Genetics, and Therapeutics Branch Chief of the NIMH Division of AIDS Research, for sharing how COVID-19 is a psychological issue. My daughter is a clinical psychology Ph.D. student, and she has already been informed that they need to be prepared to address the overwhelming psychological issues stemming from the pandemic.

Now, our members keep asking: "Are we allowed to have our next meeting?" Yes, we will. As you know, COVID-19 disrupted our 2020 SNIP conference that had been booked in New Delhi, India. When two cases of COVID-19 in New Delhi were reported on March 1, 2020, it was originally postponed to fall 2020. And it was postponed again in 2021. Our SNIP bylaws require leadership transition at the annual conference, which meant I had to stay as president for more than one year. Presently, our Society's 26th Scientific Conference is scheduled for February/March of 2022, at the same venue in New Delhi as planned prior to disruption by the pandemic (SNIP 2021). At our next conference, I can finally conclude my presidency. As you can already see from this excellent virtual workshop, Dr. Kumar will be a wonderful president.

Finally, as expressed in our sharing and reflection, this pandemic period is very unfortunate, but it is also a very interesting and challenging period for us as scientists. We can all contribute a lot. Thank you.

Acknowledgements The University of Nebraska Medical Center hosted the Zoom webinar for the virtual workshop. Transcription support was provided by the Bureau of Sociological Research at the University of Nebraska at Lincoln.

Funding The virtual workshop, in part, was supported by the National Institute on Drug Abuse (DA047178 to S Kumar and DA046258 to SL Chang). HE Gendelman and the University of Nebraska Medical Center's Department of Pharmacology and Experimental Neuroscience provided funding for transcriptions from the Bureau of Sociological Research and transcript editing by DD Meigs.

Declarations

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

References

- Acharya A, Kevadiya BD, Gendelman HE, Byrareddy SN (2020) SARS-CoV-2 Infection Leads to Neurological Dysfunction. *J Neuroimmune Pharmacol* 15:167–173. <https://doi.org/10.1007/s11481-020-09924-9>
- Alabed S, Huang W, Zhou H, Camacho R, Ali SF, Chang SL (2021) Meta-analysis of the mechanisms underlying alcohol elevation of amyloid precursor protein expression upon SARS-CoV-2 infection. Abstract for the 2021 Annual conference of Society for Neuroscience in Chicago, USA
- Berlin DA, Gulick RM, Martinez FJ (2020) Severe Covid-19. *N Engl J Med* 383:2451–2460. <https://doi.org/10.1056/NEJMcp2009575>
- Borges-Velez G, Rosario-Rodriguez LJ, Rosado-Philippi JE, Cartagena LJ, Garcia-Requena L, Gonzalez A, Perez J, Melendez LM (2020) SARS-Cov-2: Biology, Detection, Macrophage Mediated Pathogenesis and Potential Treatments. *Virol Immunol J* 4. <https://doi.org/10.23880/vij-16000242>
- Brann DH et al (2020) Non-neuronal expression of SARS-CoV-2 entry genes in the olfactory system suggests mechanisms underlying COVID-19-associated anosmia. *Sci Adv*. <https://doi.org/10.1126/sciadv.abc5801>
- Bremner J (2020) U.S. Alcohol Sales Increase 55 Percent in One Week Amid Coronavirus Pandemic. *Newsweek*. <https://www.newsweek.com/us-alcohol-sales-increase-55-percent-one-week-amid-coronavirus-pandemic-1495510>. (Accessed 2021, October 6)
- Coolen T, Lolli V, Sadeghi N, Rovai A, Trotta N, Taccone FS, Creteur J, Henrard S, Goffard JC, Dewitte O, Naeije G, Goldman S, De Tiege X (2020) Early postmortem brain MRI findings in COVID-19 non-survivors. *Neurology* 95:e2016–e2027. <https://doi.org/10.1212/WNL.0000000000001116>
- Costello F, Dalakas MC (2020) Cranial neuropathies and COVID-19: Neurotropism and autoimmunity. *Neurology* 95:195–196. <https://doi.org/10.1212/WNL.00000000000009921>
- Couzín-Frankel J (2020) The long haul. *Science* 369:614–617. <https://doi.org/10.1126/science.369.6504.614>
- Eden A, Kanberg N, Gostner J, Fuchs D, Hagberg L, Andersson LM, Lindh M, Price RW, Zetterberg H, Gisslen M (2021) CSF Biomarkers in Patients With COVID-19 and Neurologic Symptoms: A Case Series. *Neurology* 96:e294–e300. <https://doi.org/10.1212/WNL.00000000000010977>
- Frank S (2020) Catch me if you can: SARS-CoV-2 detection in brains of deceased patients with COVID-19. *Lancet Neurol* 19:883–884. [https://doi.org/10.1016/S1474-4422\(20\)30371-9](https://doi.org/10.1016/S1474-4422(20)30371-9)
- Frontera JA et al (2021) A Prospective Study of Neurologic Disorders in Hospitalized Patients With COVID-19 in New York City. *Neurology* 96:e575–e586. <https://doi.org/10.1212/WNL.00000000000010979>
- Huang W, Zhou H, Hodgkinson C, Montero A, Goldman D, Chang SL (2021) Network Meta-Analysis of the Mechanisms Underlying Alcohol Augmentation of COVID-19 Pathologies. *Alcohol Clin Exp Res* 45:675–688. <https://doi.org/10.1111/acer.14573>
- Karki R, Kanneganti TD (2021) The “cytokine storm”: molecular mechanisms and therapeutic prospects. *Trends Immunol* 42:681–705. <https://doi.org/10.1016/j.it.2021.06.001>
- Karki R, Sharma BR, Tuladhar S, Williams EP, Zalduondo L, Samir P, Zheng M, Sundaram B, Banoth B, Malireddi RKS, Schreiner P, Neale G, Vogel P, Webby R, Jonsson CB, Kanneganti TD (2021) Synergism of TNF-alpha and IFN-gamma Triggers Inflammatory Cell Death, Tissue Damage, and Mortality in SARS-CoV-2 Infection and Cytokine Shock Syndromes. *Cell* 184(149–168):e117. <https://doi.org/10.1016/j.cell.2020.11.025>
- Krukowski RA, Jagsi R, Cardel MI (2021) Academic Productivity Differences by Gender and Child Age in Science, Technology, Engineering, Mathematics, and Medicine Faculty During the COVID-19 Pandemic. *J Womens Health (larchmt)* 30:341–347. <https://doi.org/10.1089/jwh.2020.8710>
- Kumar S (2020a) University of Tennessee Health Sciences Center making strides in treating COVID-19. *The Commercial Appeal*. Memphis, TN, USA. <https://www.commercialappeal.com/story/opinion/2020/04/13/progress-made-finding-covid-19-vaccine/2985371001/>. (Accessed 2021, October 6)
- Kumar S (2020b) Challenges with COVID-19 could bring transformational change, improve human health. *The Commercial Appeal*. Memphis, TN, USA. <https://www.commercialappeal.com/story/opinion/2020/04/13/progress-made-finding-covid-19-vaccine/2985371001/>. (Accessed 2021, October 6)
- Kumar S, Zhi K, Mukherji A, Gerth K (2020a) Repurposing Antiviral Protease Inhibitors Using Extracellular Vesicles for Potential Therapy of COVID-19. *Viruses*. <https://doi.org/10.3390/v12050486>
- Kumar S, Kodidela S, Kumar A, Gerth K, Zhi K (2020b) Intervention and Improved Well-Being of Basic Science Researchers During the COVID 19 Era: A Case Study. *Front Psychol* 11:574712. <https://doi.org/10.3389/fpsyg.2020.574712>
- Kumar S, Pendyala G, Yelamanchili SV, Seth P, Maggirwar S, Bidlack JM, Chang SL (2021) Society on NeuroImmune Pharmacology COVID-19 Virtual Workshop. *J Neuroimmune Pharmacol* 16:519–530. <https://doi.org/10.1007/s11481-021-10001-y>
- Lee MH, Perl DP, Nair G, Li W, Maric D, Murray H, Dodd SJ, Koretsky AP, Watts JA, Cheung V, Masliah E, Horkayne-Szakaly I, Jones R, Stram MN, Moncur J, Hefti M, Folkerth RD, Nath A (2021) Microvascular Injury in the Brains of Patients with Covid-19. *N Engl J Med* 384:481–483. <https://doi.org/10.1056/NEJMc2033369>
- Liotta EM, Batra A, Clark JR, Shlobin NA, Hoffman SC, Orban ZS, Korolnik IJ (2020) Frequent neurologic manifestations and encephalopathy-associated morbidity in Covid-19 patients. *Ann Clin Transl Neurol* 7:2221–2230. <https://doi.org/10.1002/acn3.51210>
- Mao L, Jin H, Wang M, Hu Y, Chen S, He Q, Chang J, Hong C, Zhou Y, Wang D, Miao X, Li Y, Hu B (2020) Neurologic Manifestations of Hospitalized Patients With Coronavirus Disease 2019 in Wuhan, China. *JAMA Neurol* 77:683–690. <https://doi.org/10.1001/jamaneurol.2020.1127>
- Masi SA, Vigorito M, Chu TC, Chang SL (2020) Alcohol Modulation of Amyloid Precursor Protein in Alzheimer's Disease. *Journal of Drug and Alcohol Research* 9:1–12. Available at: <https://www.ashdin.com/articles/alcohol-modulation-of-amyloid-precursor-protein-in-alzheimers-disease.pdf> or http://works.bepress.com/tin-chun_chu/48/. <https://doi.org/10.4303/jdar/236094>
- Matschke J et al (2020) Neuropathology of patients with COVID-19 in Germany: a post-mortem case series. *Lancet Neurol* 19:919–929. [https://doi.org/10.1016/S1474-4422\(20\)30308-2](https://doi.org/10.1016/S1474-4422(20)30308-2)
- Meinhardt J et al (2021) Olfactory transmucosal SARS-CoV-2 invasion as a port of central nervous system entry in individuals with COVID-19. *Nat Neurosci* 24:168–175. <https://doi.org/10.1038/s41593-020-00758-5>
- Myers KR, Tham WY, Yin Y, Cohodes N, Thursby JG, Thursby MC, Schiffer P, Walsh JT, Lakhani KR, Wang D (2020) Unequal

- effects of the COVID-19 pandemic on scientists. *Nat Hum Behav* 4:880–883. <https://doi.org/10.1038/s41562-020-0921-y>
- New Hampshire Department of Administrative Services (2021) Perceived Stress Scale. New Hampshire Employee Assistance Program. <https://das.nh.gov/wellness/Docs%5CPerceived%20Stress%20Scale.pdf>. (Accessed 2021, October 6)
- NIH (2020) Temporary Extension of Eligibility for the NIH K99/R00 Pathway to Independence Award During the COVID-19 Pandemic. <https://grants.nih.gov/grants/guide/notice-files/not-od-20-158.html>. (Accessed 2021, October 6).
- NIH (2021a) Reminder – Requesting Extensions for Early Career Scientists Whose Career Trajectories Have Been Significantly Impacted by COVID-19. <https://grants.nih.gov/grants/guide/notice-files/NOT-OD-21-052.html>. (Accessed 2021, October 6)
- NIH (2021b) Notice of Special Interest: Administrative Supplements for COVID-19 Impacted NIMH Research. <https://grants.nih.gov/grants/guide/notice-files/NOT-MH-21-120.html>. (Accessed 2021, October 6)
- NIH (2021c) Neurologic and Psychiatric Effects of SARS-CoV-2 Meeting. Virtual: 2021, July 14–15. <https://www.nimh.nih.gov/news/events/2021/neurologic-and-psychiatric-effects-of-sars-cov-2-meeting>. (Accessed 2021, October 6)
- Oxley TJ, Mocco J, Majidi S, Kellner CP, Shoirah H, Singh IP, De Leacy RA, Shigematsu T, Ladner TR, Yaeger KA, Skliut M, Weinberger J, Dangayach NS, Bederson JB, Tuhim S, Fifi JT (2020) Large-Vessel Stroke as a Presenting Feature of Covid-19 in the Young. *N Engl J Med* 382:e60. <https://doi.org/10.1056/NEJMc2009787>
- Radmanesh A, Derman A, Lui YW, Raz E, Loh JP, Hagiwara M, Borja MJ, Zan E, Fatterpekar GM (2020) COVID-19-associated Diffuse Leukoencephalopathy and Microhemorrhages. *Radiology* 297:E223–E227. <https://doi.org/10.1148/radiol.2020202040>
- Rifino N et al (2021) Neurologic manifestations in 1760 COVID-19 patients admitted to Papa Giovanni XXIII Hospital, Bergamo, Italy. *J Neurol* 268:2331–2338. <https://doi.org/10.1007/s00415-020-10251-5>
- Rogers JP, Chesney E, Oliver D, Pollak TA, McGuire P, Fusar-Poli P, Zandi MS, Lewis G, David AS (2020) Psychiatric and neuropsychiatric presentations associated with severe coronavirus infections: a systematic review and meta-analysis with comparison to the COVID-19 pandemic. *Lancet Psychiatry* 7:611–627. [https://doi.org/10.1016/S2215-0366\(20\)30203-0](https://doi.org/10.1016/S2215-0366(20)30203-0)
- SNIP (2021) Upcoming Conference: 26th Scientific Conference — February/March, 2022. <https://s-nip.org/conferences>. (Accessed 2021, October 6)
- Son C, Hegde S, Smith A, Wang X, Sasangohar F (2020) Effects of COVID-19 on College Students' Mental Health in the United States: Interview Survey Study. *J Med Internet Res* 22:e21279. <https://doi.org/10.2196/21279>
- Song E et al. (2020) Exploratory neuroimmune profiling identifies CNS-specific alterations in COVID-19 patients with neurological involvement. *bioRxiv*. <https://doi.org/10.1101/2020.09.11.293464>
- Squazzoni F, Bravo G, Grimaldo F, Garcia-Costa D, Farjam M, Mehmani B (2020) Only Second-Class Tickets for Women in the COVID-19 Race. A Study on Manuscript Submissions and Reviews in 2329 Elsevier Journals (October 16, 2020). Available at SSRN: <https://ssrn.com/abstract=3712813> or <https://doi.org/10.1371/journal.pone.0257919>
- Taquet M, Luciano S, Geddes JR, Harrison PJ (2021) Bidirectional associations between COVID-19 and psychiatric disorder: retrospective cohort studies of 62 354 COVID-19 cases in the USA. *Lancet Psychiatry* 8:130–140. [https://doi.org/10.1016/S2215-0366\(20\)30462-4](https://doi.org/10.1016/S2215-0366(20)30462-4)
- Winston & Strawn LLP (2020) Focusing on Resilience. <https://www.winston.com/en/thought-leadership/focusing-on-resilience.html>. (Accessed 2021, October 6)
- Woolston C (2020) Signs of depression and anxiety soar among US graduate students during pandemic. *Nature* 585:147–148. <https://doi.org/10.1038/d41586-020-02439-6>
- Zheng M, Karki R, Williams EP, Yang D, Fitzpatrick E, Vogel P, Jonsson CB, Kanneganti TD (2021) TLR2 senses the SARS-CoV-2 envelope protein to produce inflammatory cytokines. *Nat Immunol* 22:829–838. <https://doi.org/10.1038/s41590-021-00937-x>
- Zubair AS, McAlpine LS, Gardin T, Farhadian S, Kuruvilla DE, Spudich S (2020) Neuropathogenesis and Neurologic Manifestations of the Coronaviruses in the Age of Coronavirus Disease 2019: A Review. *JAMA Neurol* 77:1018–1027. <https://doi.org/10.1001/jamaneurol.2020.2065>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.