

# Muniyappa, Ranganath and Gubbi, Sriram 2021

## Drs. Ranganath Muniyappa and Sriram Gubbi Oral History

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Read the papers:

"Catecholamine physiology and its implications in patients with COVID-19," Sriram Gubbi, Matthew A. Nazari, David Taieb, Joanna Klubo-Gwiezdzinska, and Karel Pacak, *Lancet Diabetes Endocrinol.* 2020 Dec; 8(12): 978–986. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7598304/>

"COVID-19 pandemic, coronaviruses, and diabetes mellitus," Ranganath Muniyappa and Sriram Gubbi, *Am J Physiol Endocrinol Metab.* 2020 May 1; 318(5): E736–E741. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7191633/>

"Metabolic Syndrome and COVID 19: Endocrine-Immune-Vascular Interactions Shapes Clinical Course," Rashika Bansal, Sriram Gubbi, and Ranganath Muniyappa, *Endocrinology.* 2020 Oct; 161(10): bqaa112. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7337756/>

"Diabetes, Obesity, and Risk Prediction of Severe COVID-19," Ranganath Muniyappa and Kenneth J Wilkins, *J Clin Endocrinol Metab.* 2020 Oct; 105(10): dgaa442. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7454695/>

"A Pragmatic Approach to Inpatient Diabetes Management during the COVID-19 Pandemic," Mary Korytkowski, Kellie Antinori-Lent, Andjela Drincic, Irl B Hirsch, Marie E McDonnell, Robert Rushakoff, and Ranganath Muniyappa, *J Clin Endocrinol Metab.* 2020 Jun 4 : dgaa342. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7313952/>

Dr. Ranganath Muniyappa and Dr. Sriram Gubbi

Behind the Mask

March 9, 2021

GB: Good morning. Today is March 9, 2021, and I have the pleasure of speaking to Dr. Ranganath Muniyappa, who is a senior research physician for the Clinical Endocrinology Section of the Diabetes, Endocrinology, and Obesity Branch. He's also the director of the Inter-Institute Endocrinology Fellowship Program. And Dr. Sriram Gubbi is a staff clinician in the Metabolic Diseases Branch. Both Dr. Muniyappa and Dr. Gubbi are in NIDDK. Thank you very much for speaking with me today about your research.

RM: Thank you Gabrielle. Good morning.

GB: So to get started why do patients with diabetes have a higher risk of dying from SARS-CoV-2? What studies have been done within the spectrum of those with diabetes, so pre-diabetes to those with very bad diabetes that are not being monitored, about how they fare, and how do patients with type 1 diabetes compare to those with type 2 diabetes? I know that's a lot of questions.

RM: Gabrielle, ever since the early studies from China were reported, I think it's well-established now that those people with diabetes fare poorly in terms of hospitalization, in terms of being on a mechanical ventilator (meaning needing assistance), and death. In the last 12 months or so, we have gotten a lot more data and it seems to confirm across all countries whether it be China, Italy, the U.K., and in the U.S. now that's very clear. In regard to your question, I will answer the type 2 and the type 1 comparison because that's important.

All these studies are retrospective and case-based studies. Both here in the U.S. and in the U.K. there are large sample size studies that we have in terms of patient populations, and it's not a surprise—there are a lot more people with type 2 diabetes than type 1 diabetes—and people with type 2 diabetes constitute the larger number of people who have higher mortality. However, if you account for age, sex, and where they live, or socioeconomic status—if you account for all of that—it looks like patients with type 1 are actually at more risk for developing severe COVID-19 than with type 2.

Now this is from studies in France and in the U.S., but the key distinction is I think people tend to worry too much because most of the type 1 patients, they're younger, but if you actually look at the data, it is type 1 patients who are greater than 65 years old who are most affected in terms of mortality. If you're younger than 50 yr, there is really not an increased risk. So if you are greater than 65 yr, if your blood glucoses are uncontrolled, and you have other complications because of type 1 or type 2, like eye disease, microvascular disease, kidney disease, you have a higher degree of mortality.

The last part that you asked, why do people with diabetes succumb more to this particular virus, and I mean this is just based on observational studies. It's just that people with diabetes are obese, also have hypertension, and the complications that I talked to you about. When you have diabetes, it comes in clusters in terms of other metabolic disorders, and therefore they are at a higher risk because each condition increases your risk for death and hospitalization. So that is one of the reasons why we see a lot more death in patients with diabetes. One last thing I would like to say: if you are younger, say, if you are in the 40s and 50s and have diabetes, you have a higher risk of hospitalization and severe COVID compared to somebody who is of the same age, but who doesn't have diabetes. So, if you're younger and have diabetes, it increases your risk; otherwise, age is the primary risk factor. The older you are, the higher the risk for severe COVID.

GB: Were you all surprised—or maybe you all weren't surprised were you—that people with diabetes would maybe have a harder time with COVID?

RM: We weren't surprised at all, partly because we know from experience, you know, other disorders that affect the lung, initially as a primarily respiratory disease, people with diabetes usually have poorer outcomes. It was not surprising. What was surprising was this disease, in addition to affecting the lungs, causes blood clots and loss of vascular function both in the arterial and the venous side and that was surprising to us. So, there you go.

GB: That is interesting. So, since your article came out in June, "Metabolic Syndrome and COVID-19: Endocrine Immune Vascular Interactions Shaped Clinical Course," have there been any conclusive studies throughout the world linking unfavorable outcomes with COVID to those with hypertension? In your article, you said that it was still speculation at the time because it was very early in the pandemic.

SG: Right, so I'd be happy to answer that question. If I could I'd like to share a slide. So, here's a pretty simplistic slide. "Conclusive" evidence, it's a tricky word to say the least, but there have been several studies—it's too many to count—that have tried to associate hypertension with adverse COVID outcomes. So, hypertension has been shown in several studies to be an independent predictor of mortality, and severe COVID-19 has also been associated with increased risk for blood inflammatory markers, and also multi-organ injury. And poor blood pressure control has been shown to be associated with increased risk of COVID-19 related adverse effects, also the higher the blood pressure, the higher the risk for longer duration of disease and symptom duration from COVID-19.

Anti-hypertensive medicines, of course, if there's blood pressure as a risk factor, you might want to mitigate the high blood pressure. A lot of studies have also evaluated the effects of antihypertensive therapy on COVID-19 outcomes in general, and antihypertensive therapy has not really shown any adverse association. And data on racial differences and also socioeconomic strata, they're as of now, a bit limited. There are so many studies out there. A lot of studies have also found conflicting results. Some studies have not found hypertension to be a predictor, and some studies have found some forms of antihypertensive therapies to be more associated with mortality while others have shown them to be protective or less risk of mortality.

So, there's lots of conflicting data as well, Gabrielle, but the reason is because a lot of these are observational and retrospective studies. They're not the gold standard studies per se. What they show is a mere association, which means there is hypertension, and there is increased COVID death, and they both are occurring together, but that does not necessarily mean that hypertension is causing the deaths, and again as Dr. Muniyappa mentioned, there are many confounding factors here because those people are likely to be more obese. They're more likely to be diabetic, and they are more likely to be having other illnesses or comorbidities, as we call it, that might make them more susceptible to severe disease. Again, the exact pathophysiologic mechanism is yet to be entirely elucidated.

I'd like to bring your attention about one particular class of drugs which are called ACE inhibitors (angiotensin converting enzyme inhibitors) and ARBS (that is angiotensin receptor blockers). Now these cause upregulation which means they increase the amount of a protein called ACE2, which is the protein that has been shown to allow the entry of the SARS-CoV-2 virus into the human cells. So, there was a speculation initially when we had discussed about this that these drugs may potentially increase viral entry, but we don't know what its effect could be. And a lot of studies have shown that these drugs do not necessarily increase any adverse COVID-related outcomes. Actually, in fact, some of the studies have also shown that they are associated with reduced mortality. So, a lot of data has come in, but conclusive evidence, that's actually a tricky terminology, but if you ask me is hypertension something that would increase your chances of having severe disease, then yes, there is an association I would say. The bottom line is we as physicians should help patients control their blood pressure.

GB: Where did a lot of this data come from for some of these studies like observations in hospitals like electronic record systems?

SG: A lot of them are from hospital data. They are from electronic medical records, and a lot of them have gathered data from publicly available databases, and they have also performed some machine learning techniques on these. A lot of countries have published. Of course, the bulk of the data you're getting is primarily from China, United States, the United Kingdom, and a lot of studies from Italy as well. And all the data has been pretty consistent. There are several studies that have compiled the studies that are systematic reviews and meta-analyses. There have been several that have been published—it's too huge to list—and all of them have in fact shown that hypertension more often than not has been associated with worse COVID-19 related outcomes, which could mean death or admission to ICU.

GB: Can you talk more in detail about why those with obesity have a higher chance of having a more negative outcome if they contract COVID-19?

RM: So that's a good question, and once again I think the association between obesity and severe COVID, earlier on when the studies came from China, was not that strong; however I think data from both the U.K. and in the U.S. now has clearly shown that there is an effect. Now when you look at associations, the CDC just published a report yesterday. It's a large number of patients in that particular report. You can see a dose response; that is, if you go from lean to overweight to obese, based on BMI [body mass index] categories, your risk of contracting severe COVID whether it's hospitalization, mechanical ventilation, mortality actually goes up. It looks like there is a dose response that you see. Not only that, if you are below 19 [BMI], then you are also at a higher risk, so it's like a J-shaped curve.

Now the question that you asked is an important one, and we really don't know. Is it causal? So, in all of this, the question is if you are obese, does it cause you to have severe COVID? There is a technique called mendelian randomization where you look if gene variants that predispose you to develop obesity is causally associated with severe COVID. There is a study from the U.K. from the UK Biobank, which basically showed that in fact it does. If you do a mendelian randomization study, it shows that increased BMI could be causing severe complications, but this appears to be mediated through type 2 diabetes. The other things that people have proposed is lower cardiovascular fitness, and then previously we have known that if your immunity, like innate immunity that's important to fight off viral infections, are actually diminished in people who were obese; however, having said that if you actually look at the response to the vaccine, there is no difference between obese and non-obese individuals. However, that doesn't mean that the dynamics that happen in obese and non-obese individuals are similar upon acquiring SARS-CoV-2 viral infection.

Other things that people have talked about is obesity is itself an inflammatory state. Obesity itself has endothelial inflammation and endothelial dysfunction, so following viral infection, people who are obese actually are more prone for microvascular and macrovascular dysfunction and more coagulation and so those are the proposed hypotheses. I mean it's very hard to tease that out, but more and more studies are being published so we can better understand why people with obesity develop severe COVID.

GB: Are there cases of other metabolic diseases that were not brought up in the initial review that you think would be important to mention now in terms of how individuals fare with COVID-19?

SG: So, there are others, but mainly the metabolic diseases that have been consistently studied include diabetes, hypertension, obesity... those are classically described as the components of what we call "metabolic syndrome." There have been certain chemicals that have been proposed to be causing or at least associated with worse outcomes. I can actually show you one of the slides from one of my publications later in 2020.

Now this demonstrates the potential role of catecholamines. Those are chemicals produced in our adrenal glands and our nervous system, the most famous one being adrenaline. So, we proposed that these hormones could potentially cause a lot of adverse effects especially on the heart. They can cause heart rhythm issues; they can cause increased cardiac muscle thickness, unhealthy thickness; they could also cause impaired pancreatic beta-cell function that could lead to increased glucose levels; and also increased risk for hypertension by contracting kidney vessels. It could also impair coagulation pathway and immune dysregulation through complex mechanisms. This is something that we had proposed to be associated with potential worse COVID-19 outcomes.

Now one of the ways to study this is to evaluate drugs that target catecholamine function. They are called alpha blockers and beta blockers. They're basically blood pressure medicines. Until now, the data on them have been pretty conflicting or neutral to say the least. Mainly the data is from meta-analyses, but a specific evaluation of alpha blockers and beta blockers, there are a couple of trials that as of now are still recruiting, and we don't have data on those yet. There're also ongoing studies, or at least small size studies from the U.S. and Italy and even China that are evaluating thyroid function association with COVID. We don't have large scale data on that yet. But thyroid function and also steroid function is something that we are evaluating.

GB: You might have already spoken about this, but in your article, you explain how various reactions to the SARS-CoV-2 pathogen can lead to people being in a hyper-coagulative state. What effect does being in a hyper-coagulative state have on those with metabolic disorders, and why is it especially dangerous for them?

RM: Like I previously mentioned to you, I think what we see in this particular viral infection is formation of microclots both on the venous side and arterial side, and that causes a lot of havoc from the central nervous system symptoms to cardiac systems, to pulmonary embolism, to acute kidney injury. It's actually the reverse. For example, if you are having all these metabolic disorders that Dr. Gubbi mentioned, then you are at a higher risk for developing clots, right. But once you develop the clots, then the reverse happens, for example, it's now very well known that people in the ICU who have high blood sugars, uncontrolled blood sugars, they have a higher risk for mortality, and people who have well-controlled blood sugars when they are in the hospital in the ICU or in the hospital, they have better outcomes in terms of death and mechanical ventilation. So, I think once you get to that stage where you develop clots and you have hyperglycemia because of all the stress of the infection, then they compound each other so you'll have to address both of them adequately to get better outcomes for the patient.

GB: Okay, well thank you for clarifying that. What efforts have been made or what efforts do you think should be made to address hypertension and diabetes as a preventative measure against COVID? In some states, those with underlying conditions are able to get vaccinated before others in their age bracket, but it's not uniform, and it seems like it's not enough.

SG: Right, definitely. It has been an ongoing challenge, and it's also especially, I think in the more developed nations, it could be a double-edged sword where, you know, people's freedom to choose what they want to do sometimes kills; they might end up making the wrong choice. And also, it's understandable some people tend to be skeptical especially with the upcoming vaccines because of the rapid development of these vaccines. They're skeptical as to whether these vaccines are well-tested. But the truth seems to be that it's just that the science and technology has been so advanced that you don't need years to develop, and I don't know if a lot of people get that. So that's one of the reasons why I think the vaccine administration could be slow—and also the production, you know, mass production in a short amount of time, is always a challenge. And of course, we would definitely advocate for patients who are at higher risk, which are the elderly population and those with metabolic syndrome. These are the two high-risk populations that need to be preferred over the general population to be vaccinated, but that hasn't been the case. I mean you probably know people, I know people, who are still waiting in line. They're about 70, and vaccines are running out.

So, I think there should be better policies implemented that would help with better distribution of vaccines and campaigns to educate people regardless of their ethnicity or socio-economic strata. I think there should be strong impetus to educate people on why getting the vaccine, especially timely vaccination, is important, and to constantly bring up data on how effective the vaccines have been and how safe they have been to the people who have already received it. The people who have received it can educate their friends and family and encourage them to take the vaccine. These are some of the ways with which we could expedite and get mass vaccination and hopefully protect people with metabolic syndrome during these trying times.

GB: You think there are other public health measures that could be done particularly targeted to those with metabolic disorders?

SG: Yes.

GB: Are endocrinologists reaching out to them, or you had mentioned in China, they had videos and things?

SG: Exactly. I'd be happy to share my slides. These are some of the general outpatient management that we recommend for managing patients with metabolic syndrome, especially, if you notice, optimal access to healthcare is of prime importance and so is effective utilization of telemedicine. This has been a boon for a lot of us and even for the patients. Telemedicine has been used pretty effectively. I mean, it's a new tool so we're still learning how to make better utility of it, but we are pretty happy with how it has been able to provide healthcare access to a lot of people. And it's also very important to keep encouraging people to eat healthy foods, perform regular physical activity, and continue taking their medications. A lot of people develop some misconceptions that taking certain medicines might increase risk; either it's in their mind or they hear their relatives saying [that]. Breaking those misconceptions is pivotal from the physicians and healthcare workers' standpoint.

Also, support from higher-ups, changes in policy measures, and of course, prioritization of COVID-19 vaccination to the vulnerable population, that is those with metabolic syndrome, is really important. Provide good quality food. It's like if there's cheap-priced food, it's likely the food quality itself is cheap. You need to make cheap food that is good quality. It's always been an issue. Funding metabolic syndrome research and COVID-19 is also important I think, including NIDDK. They are supporting research on this, which is good. And also identifying disparities especially socioeconomic and racial disparities. All humans are not genetically identical. Some people are more at risk for severe complications of COVID-19 compared to others. A lot of these policies are being put forth, but they need to be improved as more data come in.

GB: Yeah.

RM: One more thing just to add. As endocrinologists, we take care of people with diabetes, and one of the things that we do really well is make sure that they get their flu shot, make sure that they get their pneumonia shot. These are the standards of care for people taking care of diabetes. The question that you asked was very astute in terms of involving endocrinologists in making sure that folks get the vaccine because they have a good relationship with their endocrinologist or their diabetologist, and that might actually help.

GB: Yeah. Absolutely. Good. How are you guys currently engaged in research that's going to build on your initial findings, and what other aspects of metabolic disorders and COVID would you like to delve deeper into?

SG: I guess I'll start my answer. As discussed initially, there are a lot of questions about the potential interaction of other endocrine systems with COVID in SARS-CoV-2 infection. I am currently working with my supervisor, Dr. Joanna Klubo, and evaluating thyroid function and adrenal function and SARS-CoV2 because these tissues also express the protein ACE2, which might potentially allow the viral entry and could cause infection in these organs, causing thyroid and adrenal disorders, particularly adrenal disorders if they go undiagnosed. This can lead to a condition called adrenal insufficiency, which could potentially be fatal. So, we are evaluating thyroid hormones and various steroid hormones using a high-quality test called mass spectrometry which allows for accurate measurement of these hormones, and we are evaluating their association with severity of COVID-19 and mortality in COVID-19.

GB: What phase of your study are you in currently?

SG: We have done a pilot study with patients where we have performed the analysis, but the study is not complete yet. Some of our preliminary findings have in fact shown that there is remarkable suppression in all the thyroid hormones among patients who are particularly sick. There is a hormone that is inactive. It's called Reverse T3. It's a thyroid hormone metabolite. It's typically high in patients who are sick. Surprisingly we have found very low levels of this hormone in COVID patients who are sick, and we have also found some interesting steroid patterns where certain glucocorticoid, that is cortisol, that's the main steroid hormone, one of its metabolites have been surprisingly high, and we don't know why exactly, and we are trying to further evaluate that.

RM: Gabrielle, what we are doing is, like I mentioned to you, there are some ethnic and socioeconomic differences in terms of those who get severe COVID, and this is mainly because those ethnic populations' social economic status and the type of work that they do, they're essential workers, and they have metabolic syndrome features, including obesity, hypertension, and diabetes. So, that is why those individuals are at a higher risk. What we are trying to do is study these ethnic differences say in African-Americans and Hispanics and in South Asians for that matter, say in the New York/ New Jersey area. We are collecting blood samples and trying to look at the metabolic pattern to identify markers that might help in the future to better understand why we have severe COVID-19-related complications in certain ethnicities.

GB: That's really interesting. We're going to transition from your roles as scientists to your roles as individuals living through the pandemic. So, what has been some of the personal opportunities and challenges that you both have faced during COVID?

RM: So, let me talk about the opportunities first because that's the positive side of it. The opportunities: it's a new infection, it's a new disease, and being at NIH is such a privilege that it gives us opportunities to make a difference in a small way or in a big way in terms of coming out with the vaccine. So the opportunity—when they closed us down almost a year ago, everybody started to focus on this particular disease, and us being endocrinologists, we looked at that particular angle. So, it has given opportunity for us to now understand a little bit of how innate immunity interacts with metabolism and put our collective heads together and try to understand this disease as much as possible. That is the opportunity. And it has made scientific collaboration much more essential. Like previously, we used to just stay within our own groups, but now this (pandemic) has forced us to go collaborate with everybody else so it's a great opportunity there. The challenge, of course, is like you probably know is we have [a fewer] number of patients coming to the Clinical Center because we have to control the disease, and the infection, that has been challenging because you can't go to the lab and do the stuff that Dr. Gubbi was mentioning. It's very hard to do, and therefore those are the challenges. In personal life, obviously you want to go meet your kids and family just like everybody else. I mean that's a huge challenge, but hopefully it'll all end soon. Hopefully.

GB: So it's been a combination of working from home and working at NIH for both?

RM: Exactly. Yes. Since we both are clinicians, we are required to be in the hospital because we take care of patients. You have to be there. When you're not, you're at home. It's much easier to now really work on the deep stuff that you want to write and whatnot. That's been good.

SG: I mean the opportunities again for me particularly, and for a lot of researchers, they could catch up on a lot of research that had experienced backlog so that was kind of good in a way I guess. But of course the challenge is more so that a lot of collaborations that existed before the pandemic could not be pursued further because research was centered on patient care, which was disrupted because of the pandemic. We are sadder about the fact that the patients are not able to get the care that they were able to get before. On the other hand, we're also happy that technologies like telemedicine are available, and that has made some healthcare a bit more affordable than, say, in 2010 when we didn't have iPads or Microsoft Teams and whatnot. In that way, it has been challenging, and of course my wife works in Wisconsin and it's been hard for us to not meet each other. So, definitely I think the isolation for certain people who live apart, it can affect some people more than others. I think not maybe for me, but I've known people or friends who have been significantly psychologically impacted by this pandemic, but I guess humanity has now accepted this new environment. Hopefully we'll get out of it soon.

GB: Yes. I actually had a question about routine diabetic patients. Did you see a huge spike or worsening because you know for a long time you weren't able to get routine checkups, things like that. In the beginning of the pandemic, people were scared to go to the hospital or the doctor's office or canceled appointments, things like that. So, was there a rise in untreated diabetes or it wasn't that significant?

RM: That's a very good question, but I don't think the data is in yet, right. Okay, so anecdotes. Anecdotally we hear a lot of our own patients losing control of their blood glucoses, but I think the data is still not there to see what percent of our population that we were actually taking care of now have uncontrolled diabetes. And Gabrielle, the other thing is the problem with all of these data sets, they're biased, right. They're self-selected, but there's a whole lot of people who don't have access to telehealth, right now. So if you only look at people who have access to telehealth, the people who have broadband internet and whatnot, but if you look at rural communities who have substantial amount of diabetes or you look at urban areas in certain zip codes, there are a lot of [people with] obesity and diabetes who don't have access. Not only access to telehealth, let alone they don't have access to health insurance. So, I think whatever data that we get might not be as accurate, but we will have to wait and see and keep our fingers crossed.

SG: I mean the only thing I am aware of, it's just that one study in the U.K. from mid-2020. They showed that in certain counties in the U.K. there was marked increase in both type 1 and type 2 diabetes immediately following the pandemic for about four months, and then gradually it subsided. Maybe the reduction in cases has to do with better telehealth measures and better access, but then again these are complex issues. We can't really pinpoint as to COVID caused this or caused that. So, I think as Dr. Muniyappa mentioned, we need more time and more data to more confidently say that such effects have occurred.

GB: Lastly can you just talk a little bit about some hobbies that you all have had during COVID? I know Dr. Gubbi has done a lot of really great art, and we want to hear more about that as well.

RM: Exactly, I agree.

SG: Thank you. My main hobby is: I do artwork. Mainly colored pencil artwork and markers on paper. I was able to do a few COVID-19-related artworks for one of mine and Dr. Muniyappa's papers. And I also made another artwork; it's based off of a computer game called Doom. Kids of my generation would be able to recognize that game. So, it was the poster of that game where I modified the demons to coronavirus demons and the main protagonist to be a healthcare worker. A lot of my New York friends who are ER doctors especially liked it, and I actually shipped copies of that to my colleagues. Otherwise other hobbies I do [are] play violin and guitar. We do not have a lot of downtime, of course, being busy with research and the clinic, but during downtime I have been brushing up on my skills on guitar and violin. [I] also do some astronomy. I do own a telescope, and I do like watching, looking at the sky and bring some glimmer of hope to humanity.

GB: Do you do a lot of the illustrations for your non-COVID work as well like, have you always done the graphs and the illustrations? I mean I was very impressed by what you did for your COVID paper.

SG: Yes. Yes. I have done it for a lot of other papers as well as my papers on pituitary and hypertension. I have made a lot of artwork, but now because of increasing responsibilities, I have stuck to software to make the artwork, but otherwise I do mainly wildlife and astronomy-related art.

GB: Dr. Muniyappa, have you done any hobbies during this time that have helped you get through the pandemic?

RM: I've taken up gardening. I never wanted to do it, but now since we are locked up and my wife keeps insisting on it so that's the only hobby that I have picked up. But Gabrielle, isn't it impressive the art that Sriram does!

GB: It's so impressive!

RM: Exactly. So, you know when you asked the question about non-COVID artwork, in fact, he's the go-to guy for us. If you come with a scheme or an imagination about how things are, you just give that to Sriram, and then he has this beautiful, imaginative brain and the skill to make it appear in front of you. So, in that sense he is a very talented guy.

GB: Very, very talented. Yeah, do you always just do marker and color pencil, or do you use other mediums as well?

SG: I do use other mediums too.

RM: Can you share some of the non-scientific stuff that you have done?

SG: I'm actually trying to, but it's on social media. I typically don't access social media through my work laptop... if you don't mind giving me one moment. Okay, I got access. I have uploaded some photos on Facebook. So, let me just share the screen.

RM: It's incredible.

GB: It is really, really incredible.

RM: Look at that. You should look. This is all artwork that he has done.

GB: Oh my gosh.

SG: So, this is mainly the type of artwork that I do. It is astronomy related.

RM: So Sriram so you literally you did this by hand didn't you?

SG: Yes. So, this is made of pastel pencil. It's a bit of a chalky texture, and for this I used paint and airbrush. So, a lot of different modalities again. This is pastel artwork, and this is purely colored pencil.

GB: Oh my goodness!

SG: This is again colored pencil. So, these are some of the artworks that I have done in the recent past, and of course, this is the COVID one.

GB: Oh my G-d. You're very talented! Did you have training as a child?

SG: No, it was a metabolic defect. [Laughter.] So, no training.

GB: It is very impressive! A multi-talented person for sure. Is there anything else that either of you would like to add about your research as NIH clinicians but also as people who are living through the pandemic?

SG: From my side, I think I'm incredibly grateful to the National Institutes of Health and NIDDK and especially Dr. Muniyappa, who was my program director when I was a fellow because we have such great mentors and faculty here. It really opens up your mind and broadens your horizons. I think it's a fantastic place for research, and I'm incredibly grateful for this opportunity that I have had being at the NIH. And definitely from being a clinician, I would like to provide increasing and better health care to my patients now that the pandemic is sort of calming down. So, I hope to bring in more patients, of course following COVID precautions, and give them the right amount and the ideal care that they deserve.

RM: For me I have been here 17 years now almost, and it's an incredible privilege to be here at NIH to do the kinds of things that we do. The leadership all the way down NIDDK has been incredibly supportive in terms of urging us to do stuff. What I want to do is two things. We will have a lot of long COVID-19 patients, meaning people who recover [who] have a lot of symptoms. So, we will have to put our heads together to figure out why that is and study that a little bit more with a lot more objective data so that we can really understand it. Number 2, ethnic disparities in terms of the mortality that this disease is affected is just heartbreaking, and that is because there are always ethnic disparities in terms of how we take care of people with diabetes in this country. My interest remains and was before to study ethnic differences in people with obesity and diabetes. That's what I study. Now it's a very important burning issue. If we have another virus that does the same thing, there is no excuse. I mean there was never an excuse to have unequal outcomes in terms of diabetes, but this one should spur all of us to focus on the disparities that we see so that we can really decrease it, it's a tragedy to lose more than half a million and many of them people of color, underserved, lower economic status, and essential workers. I think we will have to really put our efforts going forward to reduce that disparity. So as long as I'm here at the NIH, those two will be the focus as we go forward.

GB: That sounds good. Well thank you very much. I wish you both the best on your continued research and that you all continue to stay healthy as well as your families stay healthy.

RM: Gabrielle, thank you so much for giving us this opportunity to share our research and our thoughts and have the rest of a wonderful safe year, and now that we have vaccines, we will be able to do all sorts of things hopefully in the next couple of months. By summer, I think we'll be in a better place than where we are now.

SG: Thank you so much, Gabrielle for your time and for interviewing us, and I wish the best of luck to you and your family as well. Thank you.