COVID Information Commons (CIC) Research Lightning Talk

Transcript of a Presentation by Helena Solo-Gabriele (University of Miami), November 15, 2021

Title: Wastewater-Based Monitoring of COVID-19

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YouTube Recording with Slides

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Transcript:

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Okay thank you. Can you see my screen? Hey, thanks to the moderators. Thank you so much for hosting this event. I'm here to speak about our group research called South Florida RAD. It's focused on a wastewater-based monitoring program for COVID-19. Our project is a joint project between University of Miami and Weill Cornell Medicine. We are funded through NIH. There are three PIs on the project. Chris Mason of Weill Cornell Medicine and from the University of Miami, Stephan Schurer and myself. I am Helena Solo-Gabriele and for more information about our project you can visit covidsfrad.org.

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I wanted to begin by describing the goals of our project. We have three specific aims. They focus on data standardization in developing and informatics infrastructure, characterizing the wastewater, and then integrating that information with human health surveillance. So essentially, we are pairing or coupling human information, human COVID-19 cases with wastewater information. We're integrating that in a data platform that then we use to develop models to predict outbreaks. Our intent is that these models will be used by decision makers to develop policies that will minimize the transmission of disease. A big portion of our research is in data standardization. We're working with three laboratories and integrating all of the information from all the laboratories coupled with the human health surveillance is a challenge. And we do- a lot of our work is focused on developing that data platform, but in this talk I'm going to present mostly on the outbreak characterization portion of the work. So, our ultimate objective is to relate wastewater measurements to predict COVID-19 cases.

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This involves pairing the human health surveillance with wastewater SARS-CoV-2 levels. As we know, in addition to transmission through aerosolized droplets from respiratory systems, humans that are ill with COVID-19 will also excrete the virus through their feces and urine, and as a result it is found in the sanitary sewer system. We can then collect the sample from the sanitary sewer system and then analyze it for the RNA of the virus called SARS-CoV-2.

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In order to do this work, every one of our sample collection plans are paired, again, with a human surveillance system. We have a student residential monitoring program that is led through our University of Miami which has a very extensive testing, tracking, and tracing system led by our provost for research and also the president of the university who are experts in public health. And on campus, our main academic campus is the Gables Campus, and you can see our monitoring stations given by the blue balloons there. In terms of student surveillance during the fall and spring of ‘21, the students were tested weekly by nasal swab qPCR augmented with breath tests. And then we were able to get those results by total test and by positive patients, but on the level of both the building and building scale. In addition, during the fall and summer of ‘21, students that were unvaccinated were tested weekly, and then when we got a spike at one of the dorms, the sewage from the dorms- all this residential students were tested at that time, providing us with additional information about the occurrence of COVID-19 within the building.

In addition to our student residential monitoring, we also have the university hospital that treats known numbers of COVID patients and we have access to electronic medical records that provide us with information about the severity of the disease of the patients within the hospital and we couple that with the wastewater data. And then at the county level, we also have samples that we collect from a major wastewater treatment plant called the Central District Wastewater Treatment Plant which services about 800,000 people in Miami-Dade county, and we pair that up with the data that's available on the county basis through the Department of Health.

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One of the main innovations that we have developed through our study is a new technology for measuring SARS-CoV-2 in wastewater. We call it the volcano second generation or V2G qPCR. This technology was developed through the University of Miami Center for AIDS Research CFAR under the direction of Dr. Mark Sharkey. Mark Sharkey was developing sample methods or analysis methods for saliva, and as you can see in the upper right graphic, the negative versus the positive results are very distinct in terms of their fluorescence. This technology uses a novel polymerase that is capable of using either DNA and RNA and therefore avoids a cDNA synthesis step, simplifying the process making the process less expensive, and also faster. We have a turnaround time once it gets to Mark Sharkey's lab of about two and a half hours. This technology was adjusted for measurements in wastewater, and as you can see comparison with the more traditional arctic PCR versus the V2G qPCR provides comparable results between the two technologies.

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In terms of our university surveillance, this is the documentation of student and faculty positives at the University of Miami over time as given by our dashboard. On the left we have the number of people testing positive. The gray bars correspond to the students and the gold correspond to faculty and staff. On the right we can put the wastewater levels in a logarithmic scale where wastewater is expressed in genomic copies per liter. We have our detection limit for our SARS-CoV-2 which is on the order of about a hundred genomic copies per liter. And then superimposing on that we have our weekly wastewater data given by the yellow squares as shown here. And then we can start taking moving averages, moving averages of the human health, seven day moving average, and a three-sample moving average for the wastewater. And what we can see from our on-campus surveillance is- early during the fall semester there was a wave that was observed before we collected our wastewater samples. Then there was a second wave during the fall semester that was captured by the wastewater. There was a large larger wave during the January time period, again, which was captured by the wastewater. Then the fourth wave, during the spring semester, again, observed both in the wastewater and in the human cases. Interestingly once the vaccine was available for the community and the students, the values in the wastewater and also amongst the human population decreased significantly. And then we had the last wave, the fifth wave associated- towards the end of the summer associated with the delta variant. This data was analyzed by epidemiologists on our project, Naresh Kumar and Alejandro Montero. They found through this analysis that SARS-CoV-2 and wastewater was a four-day lead indicator of cases on campus. They developed a model based on the wastewater data where the concentration of RNA genomic copies per liter given by the C, take the natural logarithm of that will give us a relationship- an estimate of the positivity. So, for example, if we have 10 to the sixth or a million genomic copies per liter in the sewage, we can estimate that the individuals that are contributing to that sewage have about a 12- there's a 12 percent positivity. 12 percent of the population is likely positive within that group.

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This is our weekly sampling program and in addition to weekly, right now actually we're sampling twice a week, but in addition to our weekly sampling we also have hourly and daily sampling that we also do to answer specific questions. And but our sampling is pretty similar in terms of how we process them, but the way we process our sample is we take our raw wastewater and we concentrate it using electronegative filtration. We produce three filters, and each of those filters are then sent to one of the three laboratories, either Mark Sharkey's lab at Center for AIDS Research, Sean Williams laboratory at the Oncogenomic Shared Resource at the Sylvester Comprehensive Cancer Center at the University of Miami, or Chris Mason's lab at the Integrated Genomics laboratory at Weill Cornell Medicine. Two of those filters undergo rapid detection by both V2G with checking by RT-qPCR, and that is what we use on a weekly basis for real-time forecasting of COVID cases on campus. Additional filters also go to Chris Mason plus Sean Williams' lab. Those filters also undergo a deep sequencing process using RT-q, and in Chris Mason's lab that data is then processed through a bioinformatic pipeline that then gives information about variants.

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In terms of the results, the top results here are the qPCR by V2G giving us the values over time, and then on the bottom graph we have the variation of the variance. As you can see these are the dates of the sample collection on the bottom, and we can see from the March to early June time frame, the dominance of the variants within the wastewater was the alpha and beta variants, but as we proceed into June through July, and then ultimately into August and September we get a dominance of the delta variant as observed in the wastewater and this was reflected within the patient samples as well such that the wastewater is able to also not only detect the COVID-19 cases but also can provide information about the variants among the community.

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So, this is a presentation of some of the work that we're doing. Before I end, I wanted to again acknowledge the National Institute of Health for the provision of funding also the collaboration through the University of Miami and Weill Cornell Medicine. This collaboration would not have been possible without the support that we see through the University through the upper leadership, through facilities, through environmental health and safety, our laboratory team students, and field sampling teams. Very much appreciated. And I will end by providing my email address and then also our webpage for more information at covidsfrad.org. Thank you.