Delphine Dean, PhD, is the Ron and Jane Lindsay Family Innovation Professor in the Department of Bioengineering, Clemson University
For the last 15 years, Dr. Dean's lab has worked to develop medical devices and sensors for low-resource settings here and abroad in Tanzania and India. Since March, she has been serving as the Clemson lead on the Clemson-UofSC-MUSC-Prisma COVID-19 Diagnostics and Serological Testing Taskforce. Through this collaborative effort, she has been helping to develop diagnostic screening and environmental COVID tests. She is working with colleagues to create rapid point of care COVID-19 saliva tests and validating those against the standard nasal tests from Clemson employee and athletics department screenings. Dr. Dean is also the Chief Science Officer for Accessible Diagnostics LLC which develops smartphone based at home health tests for diabetes and recently COVID-19

Mark Blenner, PhD is the McQueen Quattlebaum Associate Professor in the Department of Chemical & Biomolecular Engineering, Clemson University
Dr. Blenner is an expert in biomolecular engineering and molecular biotechnology. He has been a part of the Clemson-UofSC-MUSC-Prisma COVID-19 diagnostics and serological testing taskforce since it formed in early April. He has developed serology testing and has with colleagues moved to saliva-based testing. He has validating the saliva PCR protocol against nasal swab samples from Clemson employee screening and Clemson athletics, as well as performed screening for Pickens County community members. He is currently working with others at Clemson to develop point-of-care saliva solutions so individuals can do the screening on their own. His focus is on antigen tests, which are less sensitive, but much cheaper and easier to scale – making them ideal for frequent and widespread surveillance.

Phillip Buckhaults, PhD is an Associate Professor & the Director of the Cancer Genetics Lab at the School of Pharmacy, UofSC
Dr. Buckhaults has extensive experience in the molecular genetics of cancer and is a well published expert in cancer genomics with a history of developing molecular genetic methods of cancer detection assays. He has used his skill set for investigating and improving novel high-throughput methods of detecting trace quantities of SARS CoV2 in complex biological samples.

Helmut Albrecht, MD is the Heyward Gibbes Distinguished Professor of Internal Medicine in the School of Medicine at the UofSC
D. Albrecht is an Infectious Diseases specialists who has published over 300 articles and over 50 book chapters on a variety of infections. He has previously served as Chief of Staff at Prisma Health Richland, and as division chief for infectious diseases and as chair of the department of internal medicine.
At Emory University he helped write the grant that created the first civilian biocontainment unit, which became known as the Ebola unit during the outbreak in 2014. Dr. Albrecht has been involved in coordinating the response to multiple outbreaks including anthrax, 2019 H1N1, and now COVID-19. Governor Haley, for instance, asked him to help lead her Ebola Response Team. Dr. Albrecht has helped organize the convalescent plasma program at Prisma Health Midlands for COVID-19 patients and with Drs. Buckhaults and Dr. Shtutman he has initiated a study of asymptomatic health care workers and community testing activities.

Testing Primer

1. Available tests

- **Viral culture**: Detects live virus and is therefore likely a marker of infectivity/infectiousness. This is not done in routine screening and requires high level laboratories that cannot be scaled to be useful for clinical testing

- **PCR**: Detection of genetic material, i.e. RNA obtained from secretions/tissues where the virus lives. It requires amplification which multiplies the RNA to an amount to make it detectable

- **LAMP**: Typically detects RNA (or another antigen) allowing for smaller machines, more rapid

- **Antigen testing**: Detects virus protein particles without amplification. Fast, less sensitive.

- **Antibody testing**: Human response to a virus. There are acute phase antibodies (IgM) that could have a limited role in diagnosing infection (usually too late) but the main use in the later antibodies (IgG) that indicate exposure to the virus

2. Turn around time (TAT): critical for containment

TAT is composite of the **time it takes to run the assay plus backlog plus time for notification**

Time of assay depends on test (Antigen, antibody, LAMP, PCR) and on degree of automation (automated systems are faster but often require proprietary components such as cartridges which are in limited supply and are less flexible in material requirements with multiple entities competing for the same swabs, transport media etcetera).

Typical assay times

- PCR (2.5 to 4 hours depending on degree of automation).
- Antigen, LAMP (5 minutes in proprietory to 20 minutes in homegrown testing systems)
- Antibody (minutes in point of care testing using lateral flow tests (think pregnancy test) to an hour in automated machine)

Given above the main reason for TAT is not the time to run the test but that the numbers a laboratory is asked to run exceeds the daily slots and the tests back up.

Definitions

Case: Confirmed by licensed test

Person under investigation: Symptomatic or exposed person awaiting test result (should be in quarantine)

Quarantine: Close contact (<6 feet, > 15 minutes, no masks) to a case or person under investigation. Duration 14 days. If the TAT for the test of a PUI is long, for instance 7 days, all contacts will have to quarantine at least that time. Example: Center on the OL.

Isolation: For confirmed cases, 10d and 20d depending on patient/clinical criteria versus test based algorithm. The latter, we feel, is not a good use of scarce resources (adds on average 3 additional tests).

Testing: a) the act of obtaining a test or b) the running of a test

3. Reason for testing: dictates which material (swab, saliva) and what tests to use

- **Diagnostic testing** (1st step testing) is to diagnose someone suspected of having the disease (symptomatic, high risk exposure). Tests should be sensitive ("a negative result means you can trust the patient is not infected", i.e. it is not missing positives but it is usually set up to overdiagnose, which then can be fixed with confirmatory testing). Does not target asymptomatic patients therefore may miss a majority of such cases.

- **Confirmatory testing** (2nd step testing). Confirms positive screening tests to rule out false positives. Needs to be specific ("a positive result truly indicates a positive case")

It is important to understand that we are using tests that are specific and therefore would work well as confirmatory tests for diagnostic testing even though they are not very good for that purpose (but are the best we have).

- **Surveillance testing**

This implies screening a relevant portion of the community (symptoms or not) to understand where the cases are and how many you have to identify and isolate the infected (so you do not have to lock away the uninfected aka stay at home). For tests for this strategy is more important that they are easy to manage and uncomplicated, less expensive and quick

4. Personal take home

Mass testing will require protocols for obtaining specimens but also for notification of negative tests and notification and counseling of positive tests, which, if not done, will affect turnaround times

Testing is important but is only part of the mix of six mitigating factors. Impact of testing is enhanced by public health interventions (isolation, tracing, contact testing) and educational (hand hygiene, cough etiquette) and social measures (distancing, masking) as well as immunity (vaccine, previous exposure to SARS CoV2 but also other coronaviruses). These measures are synergistic. If you want to drop one, the others need to be so much more complete to compensate, which is difficult.

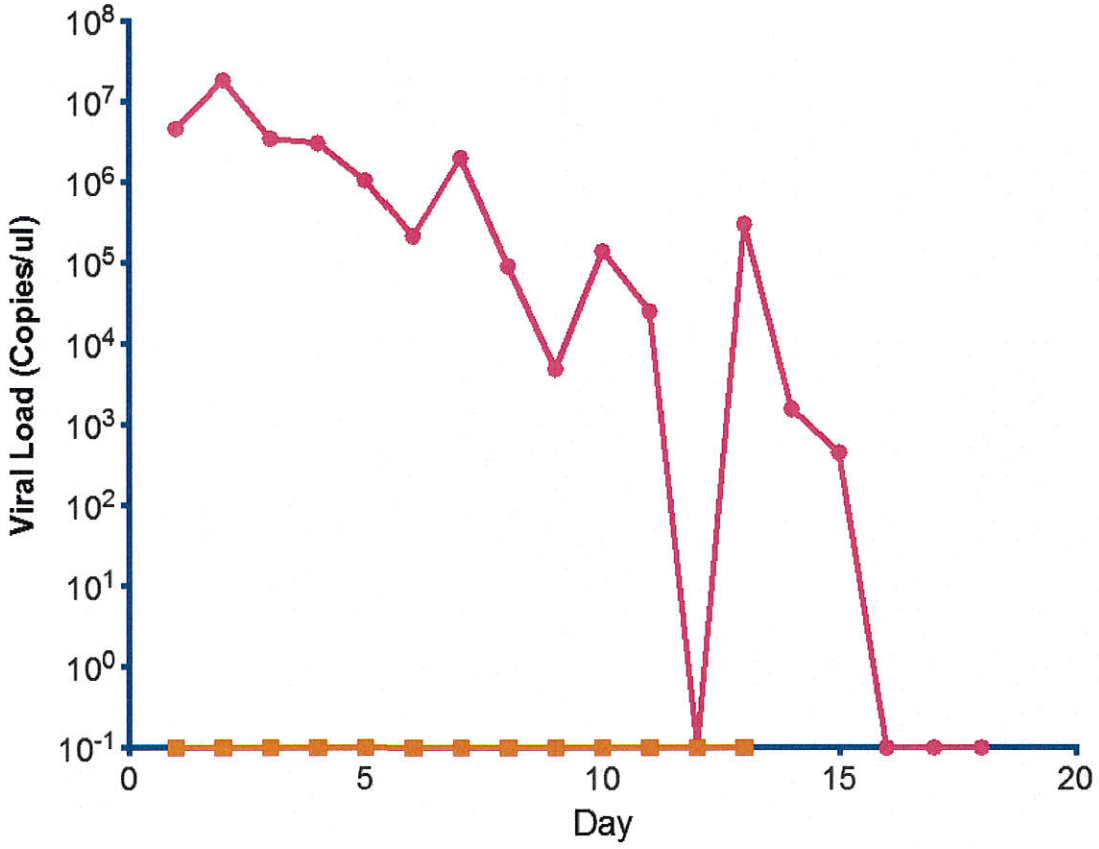
We need to get back to containment (currently in mitigation) and testing is the main tool for that. Containment is based on the ability to successfully identify cases, isolate them and inform patients. In a disease with a high rate of asymptomatic disease spreaders identification of cases can only be done with testing. Without identification, no isolation, no informing

We cannot test ourselves out of this crisis, but without testing we are not going anywhere

Testing leads to more cases today, but much fewer cases in the future

Treat the patient not the test results (SC is better in infectious diseases than many other states)

Testing 2020: Self administered tests, home testing, population/community testing, pooling, testing apps


Viral Load (Copies/ul)
10^8
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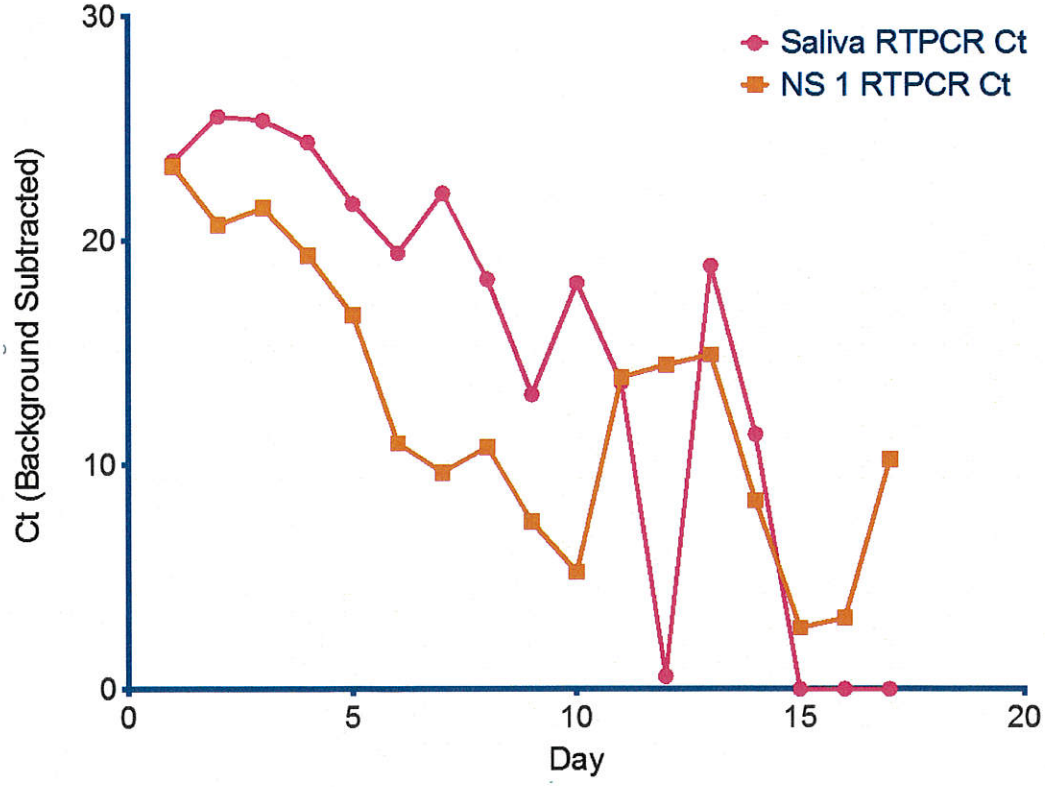
Day


Saliva RTPCR Ct
NS 1 RTPCR Ct
Ct (Background Subtracted)
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