Tracking SARS-CoV-2 in the Wastewater Across a Range of North Carolina Municipalities

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BACKGROUND

This study was an early responder to the COVID-19 pandemic producing ground-breaking research in terms of wastewater data collection and analysis in addition to unprecedented collaboration among research universities, local, state and national agencies, industry and various other relevant stakeholders. It contained five objectives, listed below with summaries of progress and results.

Highlights:
- Wastewater research proved to be highly effective in understanding the pandemic in a non-invasive way.
- Wastewater-based epidemiology research existed previously, but this project greatly expanded the breadth and capacity of the research.
- An emphasis on collaboration helped make this project as strong as it was, combining a variety of institutions and organizations and communicating to ensure high level research was produced in a short amount of time. In doing this, the project built out capacity in the state for similar research to be conducted in the future.
- This project instigated two additional projects being funded by federal agencies.

PROJECT

Goal
To develop capacity and contribute valuable information to the state of North Carolina in the presence and persistence of Sars-CoV-2 like viruses in complex wastewater infrastructure and environmental systems as a metric of community COVID-19 prevalence.
This graphic indicates the different sewersheds being studied by different university-led subgroups.

Objectives and Results

Objective #1: Develop cross-state collaborative project team to conduct Wastewater Treatment Plant (WWTP) collection, sampling and analysis relying on a framework of existing collaborative academic-state-industry relationships.

- Collaboration with North Carolina Department of Health and Human Services (NC DHHS), North Carolina Department of Environmental Quality (NC DEQ), UNC system, 20 municipal wastewater treatment plants and more.
- Project team development:
  - Large amount of sharing resources, protocol, hard and software and general expertise.
- Data generated from this objective was used for other objectives.

Objective #2: Ensure that collaborating labs are making progress toward fully quantitative, validated wastewater analyses for SC2 and variants.

- Heavy emphasis on the partnerships created in Objective #1 and building more:
  - Collaborated with outside industry partners to improve the outcome of Objective 2.
  - Three cross-state collaborative relationships built with the Southern California Coastal Water Research Project, Hampton Roads Sanitation District and the State of Wisconsin.

Objective #3: Initiate collaborative framework of municipal, county, stakeholder interaction, through collaboration with NC DEQ, UNC system researchers, NC DHHS, county health departments utilizing existing GIS mapping, epidemiological and modeling expertise.
• NCSU held stakeholder workshop with interested parties to discuss communication strategies for work with public officials on how best to disseminate this information.
• Working with another researcher to provide wastewater sampling and concentration data that has been incorporated into a susceptible-exposed-infected-recovered epidemiological model. This is being used to trigger hospital management decisions, including elective procedure cancellations and admission triage under many outbreak scenarios.

Objective #4: Continue to develop and optimize molecular diagnostic tools to build surveillance capabilities for the next decade, and for future pandemics.
• Build and expand collaborative relationships with industry partners that are playing a prominent role in the expansion of COVID-19 related molecular applications.

Objective #5: Interact with a team of epidemiologists and spatial and GIS modelling researching to understand the impact of social distancing and mitigation measures to place the data into a useful context for future surveillance system development.
• This objective was broken down into three parts: Geospatial Analysis, Epidemiologic Analysis, and Disease Mapping.
• Geospatial Analysis
  o Developed a GIS-based workflow to delineate sewershed boundaries for each of the individual WWTPs.
  o Generated and automated GIS based methods to store in a code sharing repository but found that sewershed boundaries often didn’t align with zip codes or county boundaries. To combat this, the team developed a technique to modify publicly available case data to more accurately reflect the number of cases in the samples.
• Epidemiologic Analysis
  o In the process of combining data from three sources to better estimate the true prevalence of COVID-19 infection in each of the study sewersheds, ultimately estimating asymptomatic cases based on how many individuals are likely to be shedding Sars-CoV-2 in feces.
• Disease Mapping
  o Counts of confirmed cases of COVID-19 that were obtained for all counties and zip codes across the state of North Carolina were input for geostatistical analysis in order to estimate the cross-state incidence.

FUTURE ACTIONS
• North Carolina will continue to participate in the CDC funded project to surveil wastewater nationwide. This will serve as an early warning sign to public officials about COVID numbers without relying on individuals’ testing results.
• This study will be expanded with funding from NIH so that a surveillance system for a range of pathogens can be studied in the same way. This will be expanded to the entire nation.
• This study could only be conducted near areas with labs to analyze the wastewater data and did not reach septic systems, which in the future could lead to additional studies.

Read the entire final report. To find more information about other Collaboratory projects visit: https://collaboratory.unc.edu/.