South African experiences with wastewater based epidemiology for SARS-CoV-2

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For the

SOUTH AFRICAN COLLABORATIVE COVID-19 ENVIRONMENTAL SURVEILLANCE SYSTEM (SACCESS)
• Acknowledgements
  – NICD team
  – Funders
South African experiences with wastewater-based epidemiology for SARS-CoV-2

1. The beginnings of the SACCESS network – from polio environmental surveillance to SARS-CoV-2
2. SARS-CoV-2 quantitative and sequencing results in wastewater – results
3. Sequencing SARS-CoV-2 in wastewater – successes
4. Challenges for wastewater based epidemiology
5. What is the future of wastewater based epidemiology in South Africa?
The beginnings – from polio to SARS-CoV-2 environmental surveillance

• WHO recommends environmental surveillance for polio to
  – Monitoring enteric virus circulation
  – Detecting wild-type poliovirus
  – Monitoring circulating vaccine-derived poliovirus
• The NICD is a WHO Polio Collaborating Centre and was appointed as a regional reference laboratory prior to 2010
• NICD Centre for Vaccines and Immunology commenced with polio environmental surveillance in 2018, in line with WHO suggestions.
• These data inform RSA on presence of
  – wild polio virus (last detected in clinical cases in 1989),
  – sabin-like virus (oral polio vaccine) and
  – non-polio enterovirus
  in the national sewer system and hence in patients
The beginnings – from polio to SARS-CoV-2 environmental surveillance

- Successes of polio ES in RSA
  - Regular sampling from 18 sites in all Metros across RSA
  - Detection of Sabin strain
  - Detection of Sabin-like virus with 7 mutations
  - No cVDPV (despite 2 clinical cases of immunodeficient VDPV detected in 2017 and 2019)
• Emerging interest in use of SARS-CoV-2 in wastewater to monitor epidemiological patterns as early as April/May 2020

• First published results appeared in August 2020 from a number of countries including Australia, Italy, USA

• Melinda Suchard from NICD Centre for Vaccines and Immunology initiated SARS-CoV-2 testing using polio wastewater samples

The beginnings – from polio to SARS-CoV-2 environmental surveillance
The SACCESS network comprises 8 laboratories which test 87 wastewater treatment plants every week across South Africa:

- Free State: 9
- Eastern Cape: 10
- Gauteng: 40
- Mpumalanga: 3
- Northern Cape: 2
- Kwazulu-Natal: 12
- Western Cape: 5
- Limpopo: 2
- North West: 3

The network is funded by the NICD and the Water Research Commission (WRC).

The beginnings – from polio to SARS-CoV-2 environmental surveillance
Quantitative SARS-CoV-2 in wastewater – results

- Current trends in SARS-CoV-2 levels and variants present across Gauteng

City of Tshwane, Gauteng Province
Levels of SARS-CoV-2 present in wastewater from wastewater plants, City of Tshwane

SARS-CoV-2 variants present in wastewater from Daspoort, City of Tshwane
Quantitative SARS-CoV-2 in wastewater – results

- Current trends in SARS-CoV-2 levels across Gauteng

Levels of SARS-CoV-2 present in wastewater from wastewater plants, City of Johannesburg

SARS-CoV-2 variants present in wastewater from Goudkoppies, City of Johannesburg
Quantitative SARS-CoV-2 in wastewater – results

Gauteng wastewater treatment plants

- Current trends in SARS-CoV-2 levels across Gauteng

Levels of SARS-CoV-2 present in wastewater from wastewater plants, City of Ekurhuleni

SARS-CoV-2 variants present in wastewater from Hartbeesfontein, City of Ekurhuleni
Quantitative SARS-CoV-2 in wastewater – results

• Current trends in SARS-CoV-2 levels across eThekwini wastewater plants

South Africa
KwaZulu-Natal Province

SARS-CoV-2 variants present in wastewater from Central WWTP, eThekwini

Beta
Delta
C1.1
Omicron
Quantitative SARS-CoV-2 in wastewater – results

Mangaung waste water treatment plants

Levels of SARS-CoV-2 present in wastewater from wastewater plants, Mangaung

- Current trends in SARS-CoV-2 levels across Mangaung wastewater plants

SARS-CoV-2 variants present in wastewater from Bloemspruit WWTP, Mangaung
Quantitative SARS-CoV-2 in wastewater – results

• Current trends in SARS-CoV-2 levels across NMMB wastewater plants

**Eastern Cape wastewater treatment plants**

Levels of SARS-CoV-2 present in wastewater from wastewater plants, Mangaung

SARS-CoV-2 variants present in wastewater from Bloemspruit WWTP, Mangaung

- Beta
- Delta
- C1.1
- Omicron
Quantitative SARS-CoV-2 in wastewater – results

City of Cape Town wastewater treatment plants

- Current trends in SARS-CoV-2 levels across City of Cape Town wastewater plants

Levels of SARS-CoV-2 present in wastewater from wastewater plants, Mangaung

SARS-CoV-2 variants present in wastewater from Bloemspruit WWTP, Mangaung

City of Cape Town
Quantitative SARS-CoV-2 in wastewater – successes

- Convincing public health managers that wastewater is a useful surveillance tool
  - Good correlations between cases and admissions with SARS-CoV-2 levels in wastewater

<table>
<thead>
<tr>
<th>Wastewater plants</th>
<th>Correlation coefficient (Spearman’s)</th>
<th>p-value</th>
<th>Regression coefficient</th>
<th>p-value</th>
<th>R squared (Coefficient of determination)</th>
<th>Correlation coefficient (Spearman’s)</th>
<th>p-value</th>
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<th>Regression coefficient</th>
<th>p-value</th>
<th>R squared (Coefficient of determination)</th>
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Quantitative SARS-CoV-2 in wastewater – successes

- Convincing public health managers that wastewater is a useful surveillance tool
  - Many epidemiologists were sceptical about the value of wastewater
  - Early in the 4th wave, we started picking up increases in levels in Tshwane plants

% of PCR test which were positive, clinical samples patients, week 43, 2021

Cases of SARS-CoV-2 (bars) and levels of SARS-CoV-2 in wastewater, week 43, 2021

Wastewater levels (lines) at selected treatment plants, by total Gauteng cases, epi weeks 36-47, 2021
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% of PCR test which were positive, clinical samples patients, week 45, 2021

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% of PCR test which were positive, clinical samples patients, **week 46, 2021**

Cases of SARS-CoV-2 (bars) and levels of SARS-CoV-2 in wastewater, **week 46, 2021**

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Wastewater levels (lines) at selected treatment plants, by total Gauteng cases, epi weeks 36-47, 2021
Sequencing SARS-CoV-2 in wastewater – successes

- Convincing public health managers that wastewater is a useful surveillance tool

- Wastewater sequence findings correspond with clinical SARS-CoV-2 sequences both by time and location

- Read frequency of SNPs corresponds with proportion of isolates in population

SNP mutations corresponding with specific variants identified in wastewater samples

SARS-CoV-2 variants from clinical isolates obtained from Free State province (n=c.1300)
Challenges for wastewater based epidemiology

• Quantification
  – Methodology
    • Standardising methods
    • Eliminating variation where possible (e.g. due to rainfall)
    • Turn-around-time
  – Interpretation of results
    • When is an increase something to worry about?
– Utilisation and confidence in results
  • Getting policy makers to use results
– Uptake of results by public
  • Getting the public to trust and use results
Challenges for wastewater based epidemiology

- **Quantification**
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- **Genomics**
  - Methodology
    - Reliable amplification of RNA, especially when SARS-Cov-2 is present at low levels
    - Methods only work for known VOC/variants identified by clinical samples
      - Need to develop methods to detect signals when new variants are present
    - Turn around time
What is the future of wastewater based epidemiology in South Africa?

FOCUS AREAS for 2022

• Strengthening communication tools
• Advocating public and policy-maker use of data
• Formulating interpretive thresholds and models
• Strengthening interpretation of results in relation to population health of persons contributing to sewer network
• Widening scope of network to include other communicable diseases
  – Hepatitis A, measles, influenza, tuberculosis, antimicrobial resistance

Soon to come – wastewater dashboard
THANK YOU

Weekly wastewater surveillance reports are published on the NICD website.

https://www.nicd.ac.za/diseases-a-z-index/disease-index-covid-19/surveillance-reports/