STATE OF KNOWLEDGE ON SARS-CoV-2 AND IMPLICATIONS FOR THE SOUTH AFRICAN WATER/WASTEWATER SERVICES

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INTRODUCTION

UNKNOWNS

- Concentration of viable virus in wastewater (and its variability)
- Is SARS-CoV-2 dose response relationship applicable?
- We believe WWTP's can adequately control, but needs confirmation – Fate & Transport in biosolids
- Faecal-oral transmission route ?

KNOWNS

- No live (infective) SARS-CoV-2 detected in raw wastewater, only RNA fragments
- RNA fragments partition to sludge (biosolids)
- Framework for risk to sewer collection workers has been established

SARS-CoV-2 SHEDDING INTO WASTEWATER

- **Patients shed virus into the wastewater environment**:
  - Primarily from respiratory and GI tract
  - SARS-CoV-2 genomic RNA detected in faeces, but no infective strain confirmed yet
  - Studies suggest that Coronaviruses may survive in stool samples for 3-4 days
  - Interconnectedness of the wastewater plumbing network can facilitate exposure e.g. Hong Kong Case, 2003 & 2020
  - High risk transmission settings such as hospitals and health-care buildings a significant source

The COVID-19 virus may be present in Wastewaters, but many other infectious viruses are commonly present!

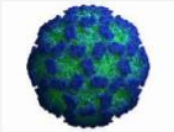
Norovirus 1

Highly contagious

Vomiting and diarrhea

Transfer from contaminated surfaces

High concentrations in wastewater

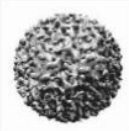


HEP A 2

Highly contagious

Nausea, vomiting
Abdominal pain
fever
Dark urine
Joint pain
Yellowing of the skin and eyes

Infects liver cells



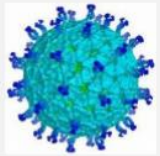
Rotavirus 3

Highly contagious

Affects Infants and young children

Severe watery diarrhea, vomiting, fever, abdominal pain

Severe dehydration

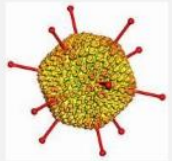


Adenovirus 4

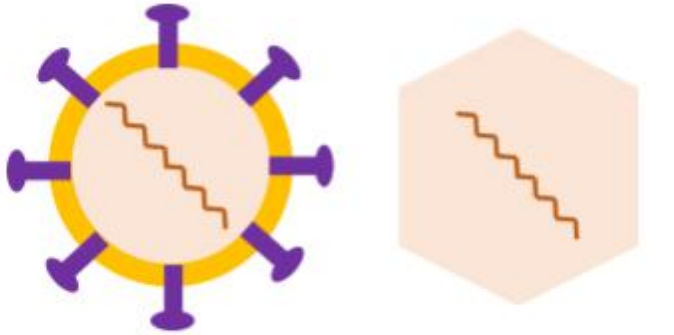
Common in wastewater

Causes a range of illnesses

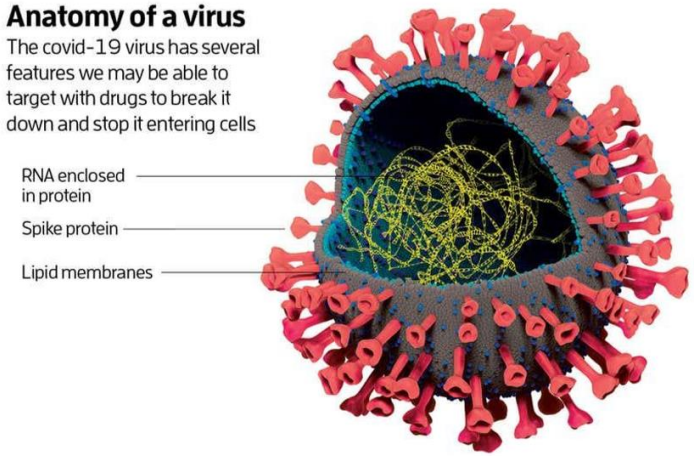
cold-like symptoms, sore throat, bronchitis, pneumonia, diarrhea conjunctivitis



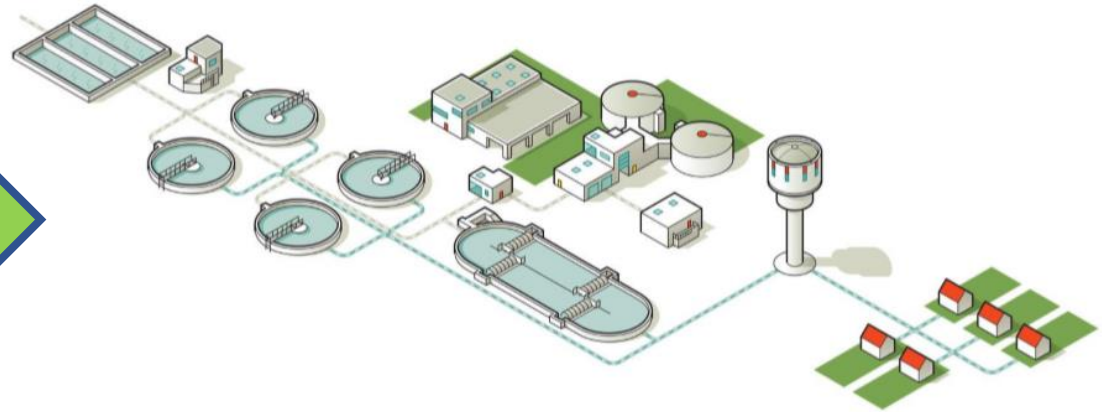
SARS-CoV-2 IN RAW SEWAGE



Example of Genes, RNA, and Remnants of Inactive Virus



RAW SEWAGE

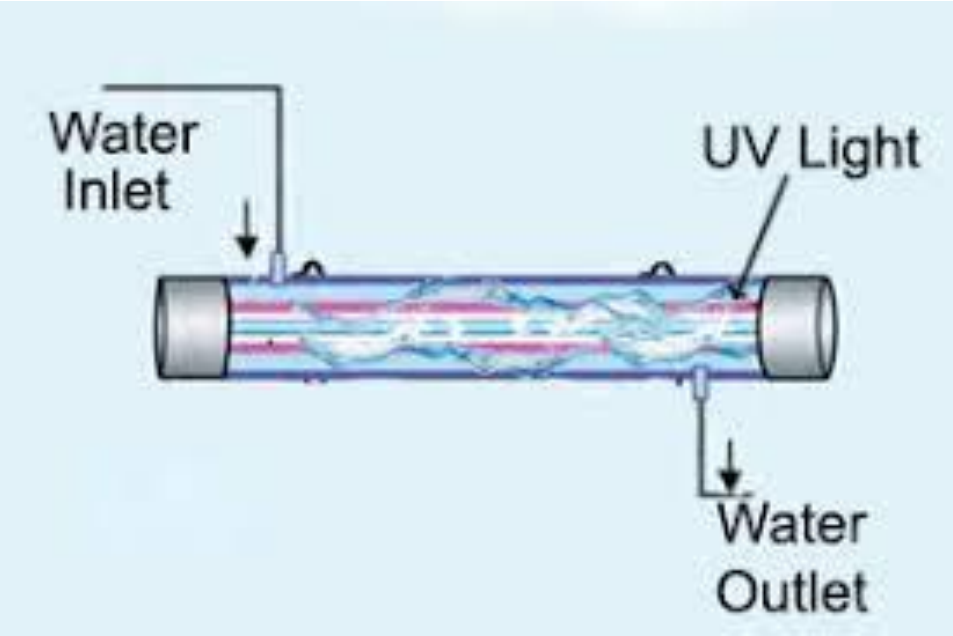


RISK OF TRANSMISSION VIA WASTEWATER

- Is wastewater a **POTENTIAL** transmission route through generation of virus-laden aerosols during wastewater treatment ?
  - Surface waters used for recreation, agriculture irrigation, or serving as drinking water sources in SA – a concern
  - Potential role of aerosol from contaminated sewage in the transmission of SARS-CoV-2 (**Upstream vs Downstream**)
  - RNA fragments detected in raw wastewater (Netherlands, Australia, France & USA)
  - No RNA fragments detected in treated effluent – **NEED CONFIRMATION IN SA**

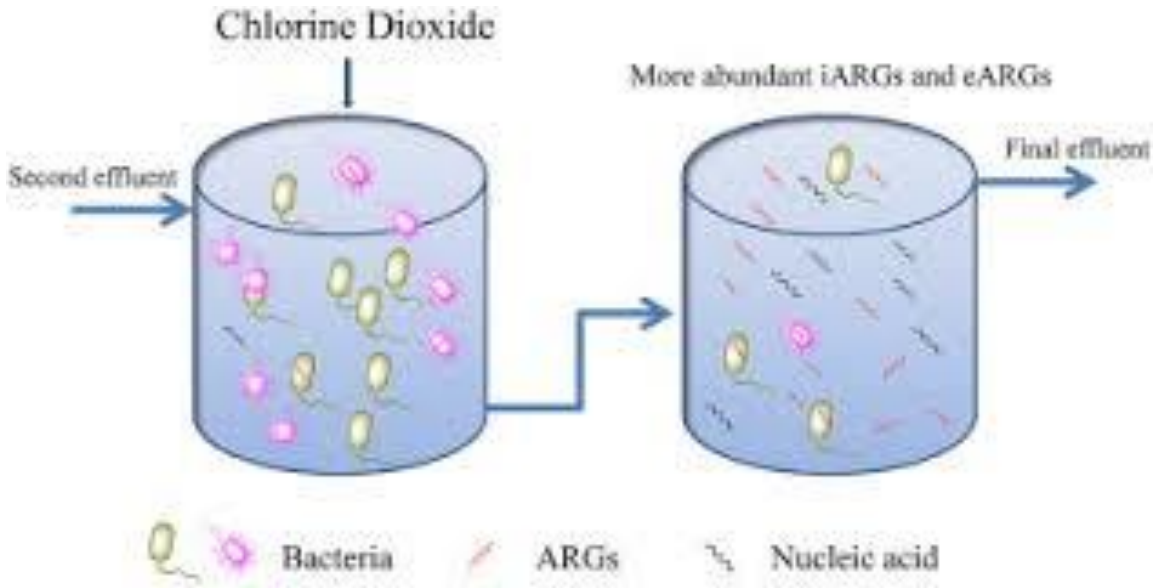
VIRUS INACTIVATION

UV Disinfection



CHALLENGE: UV light Attenuation

Chlorine Disinfection



CHALLENGE: Chlorine Consuming Components, e.g. Ammonia

SARS-CoV-2 AND WWTPs COMPLIANCE

- Not surprising for RNA of SARS-CoV-2 to be detected in wastewater – **WASTE SINK**
- Creates additional uncertainty for the wastewater reuse industries;

  - SARS-CoV-2 - sensitive to disinfectants and high temperatures;
  - SARS-CoV-2 less abundant as an infectious virus in sewage than other viruses - less stable in currently applied WASTEWATER TREATMENT;
  - Drinking water systems are safe, based on years of research and knowledge on other viruses that are more robust than SARS-CoV-2;
  - SARS-CoV-2 is not an important waterborne pathogen - **primary route of transmission being droplets from coughing and sneezing and contact with contaminated surfaces**;
  - With no epidemiological signals that sewage workers are at risk, the risk of SARS-CoV-2 transmission via sewage is considered low and current protective measures considered adequate **???**
  - Monitoring the virus in sewage very sensitive and critical - serves as early warning system

OUTBREAK RESPONSE

- Effective screening of suspected infectious cases from individual households - logistical challenge for medical professionals
  - time-consuming
  - labour intensive
  - availability of testing technologies – constraint
- **Alternative Method** – Wastewater-Based Epidemiology or Wastewater Surveillance

GENERAL USES OF WASTEWATER SURVEILLANCE DATA?

- **Measure the scope of the outbreak**
  - independent from patient testing or hospital reporting, including data on asymptomatic individuals
- **Provide decision support**
  - determine the timing & severity of public health interventions to mitigate spread of the disease
- **Better anticipate likely impact**
  - on hospital capacity in order to inform hospital readiness and the necessity of public health interventions
- **Track the effectiveness of interventions**
  - measure the wind-down period of the outbreak
- **Provide an early warning for re-emergence**
  - in case this has a seasonal cycle
- **CHALLENGE:** rapid analytical method for on-site detection at the wastewater collection point required.

RESEARCH NEEDS

- **Move towards a Mechanistic Model of Viral Inactivation**
  - Specific mechanisms to include the role of pH, ammonia, biological activity, temperature, and solids found in wastewater matrices
  - Challenging task when working with BSL 3 and 4 microorganisms

- **Better Characterization of Exposure and Transmission Pathways in the Wastewater Environment**
  - Exposure pathways for both wastewater workers and the general public poorly characterized
  - Need to define specific exposure scenarios, potential exposure - unintended releases
  - Potential for aerosolization & fate in existing sewage treatment infrastructure
  - Persistence and viability of the SARS-CoV-2 virus in wastewater

RESEARCH NEEDS – CONT'D

- **Appropriate Disinfection Approaches of High Strength Waste**
  - Evaluation of alternative disinfection methods, such as pH adjustment or heat
  - Disinfection efficacy of the SARS-CoV-2 virus
    - ❖ more mechanistic understanding of chlorine and UV action in high strength waste required
- **Understanding spread of COVID-19 through use of ES of wastewater**
  - National Sampling Protocol – Sample Design
  - National Virus Analysis Protocol
  - National Data Analysis and Integration Plan
  - National Communication
- **Communication Requirements**
  - Need Communication Strategy
    - ➢ Using Graphics Illustrations, Factsheets and Media

NATIONAL WASTEWATER SURVEILLANCE

- tracking and monitoring the presence of the SARS-CoV-2 virus in sewage to provide information on prevalence and burden of COVID-19 in the communities and health delivery.

P1

SAMPLING AND ANALYSIS

Establishment of national sampling protocols, sample collection and analysis

P2

DATA ANALYSIS

National data analysis & integration into national COVID-19 data

P3

GIS MAPPING

Overlay of sewer networks map with areas of reported high or low cases – Heat Map

P4

COMMUNICATION

Communication strategies for implications of ES results with public health community, elected officials, wastewater professionals & the public

OUTCOMES & IMPACTS

(i) Early warning system for re-emergence of COVID-19; (ii) Measure of the prevalence of the outbreak; (iii) Provide decision support and extent of impact; (iv) Tracking effectiveness of the interventions

FUNDING SOURCES

❖WRC to provide bulk of funding supported by relevant partners

WATER QUALITY SANITATION AND HEALTH PROGRAMME

LABORATORY SERVICES

CLUSTER 1: WBE

NATIONAL WASTEWATER SURVEILLANCE

- tracking and monitoring the presence of the SARS-CoV-2 virus in sewage to provide information on prevalence and burden of COVID-19 in the communities and health delivery.

P1 — SAMPLING AND ANALYSIS

Establishment of national sampling protocols, sample collection and analysis

P2 — DATA ANALYSIS

National data analysis & integration into national COVID-19 data

P3 — GIS MAPPING

Overlay of sewer networks map with areas of reported high or low cases

P4 — COMMUNICATION

Dev. of strategies for communicating implications of ES results with PH community, elected officials, wastewater professionals & the public

CLUSTER 2: TIER 1

TIER 1 RESEARCH

- presence and persistence of SARS-CoV-2 in water and sanitation environments.

P1 — ADVANCED CHARACTERIZATION TECHNIQUES

Development of novel methods for detecting of SARS-CoV-2 in different water and sanitation environments

P2 — FATE, BEHAVIOUR AND HUMAN RISKS ASSESSMENT

Persistence of SARS-CoV-2 in water and sludge, and human health risks assessments and mitigation

P3 — ONE-HEALTH APPROACH

Determination of the role of water in the transport and transmission of diseases (including COVID-19) between humans, the environment, and food production

CLUSTER 3: TIER 2

TIER 2 RESEARCH

- Transmission and preparedness

P1 — ECOSYSTEM RESPONSE

Ecosystem Responses to The Large Scale Use of SARS-CoV-2 Disinfectants

P2 — TRANSMISSION THROUGH WATER AND FOOD

Presence of SAR-CoV-2 in food products and water

P3 — PREPAREDNESS AND READINESS

Nexus planning transformative approaches and the Epidemic Preparedness Index for South Africa

OUTCOMES & IMPACTS

- ❖ Early warning system for re-emergence of COVID-19
- ❖ Measure of the prevalence of the outbreak
- ❖ Provide decision support and extent of impact
- ❖ Tracking effectiveness of the interventions
- ❖ small, portable device for detecting SARS-CoV-2 in wastewater
- ❖ Scientific evidence on SARS-CoV-2 survival, risks and its attenuation
- ❖ Preparedness and readiness for novel pathogens
- ❖ Improved sanitation and hygiene in the food value chain
- ❖ Risk reduction from novel pathogens

FUNDING SOURCES

- ❖ WRC to provide bulk of funding supported by relevant partners
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INDEPENDENT ADVISORY PANEL

THANK YOU

Science Brief

State of knowledge on SARS-Cov-2 and wastewater