WASTEWATER & ENVIRONMENTAL SURVEILLANCE (WES) CASE STUDY

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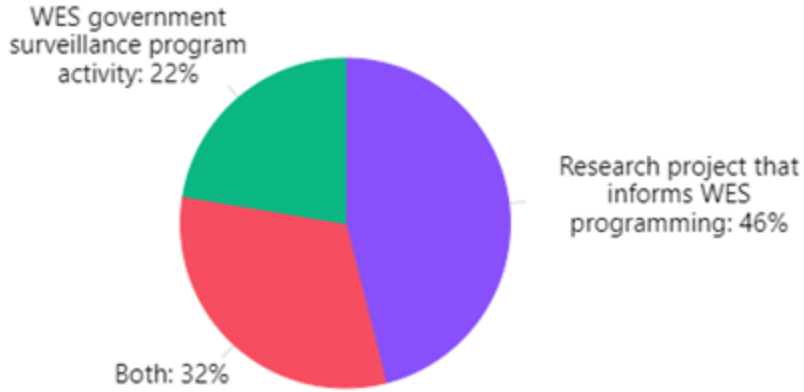
THE UNIVERSITY OF SYDNEY
Sydney Infectious Diseases Institute

CIDM centre for infectious diseases & microbiology Public Health

WES projects in Asia



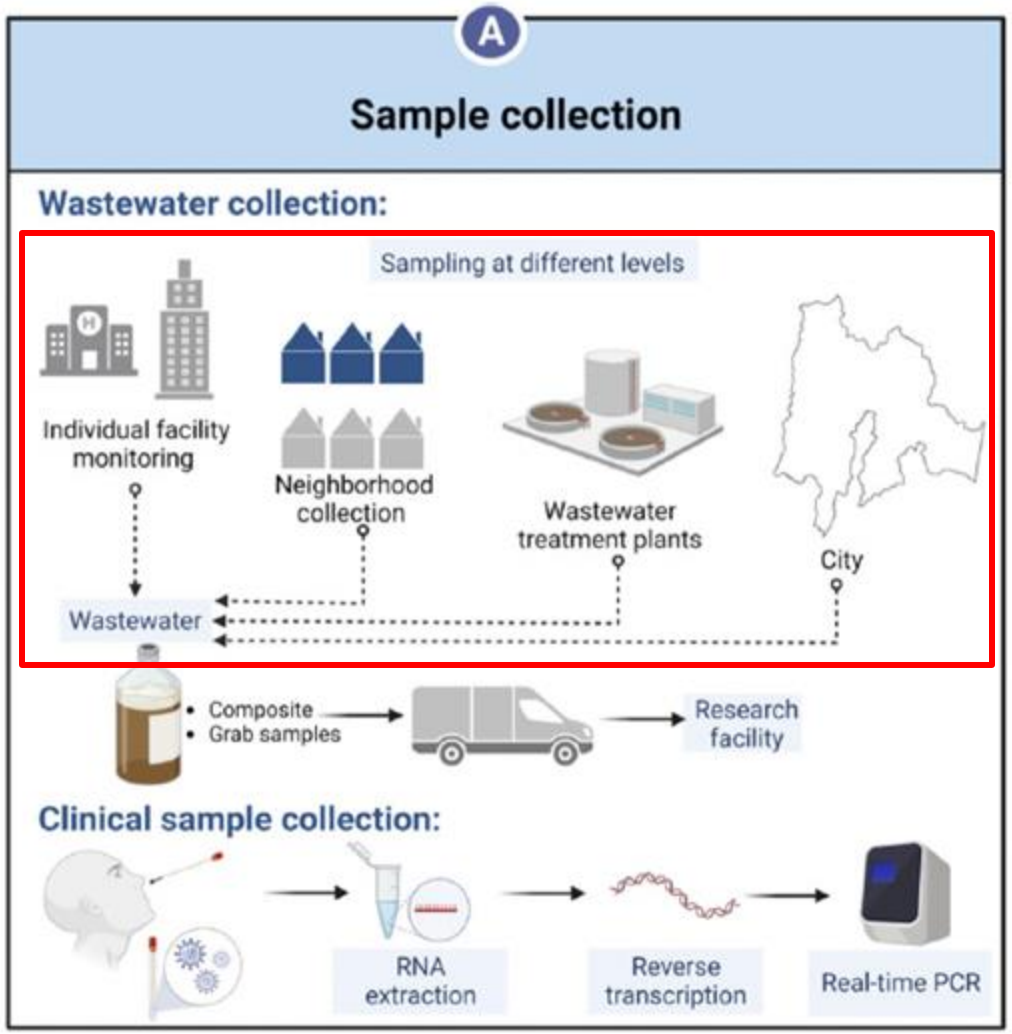
https://wes.asiapgi.net/

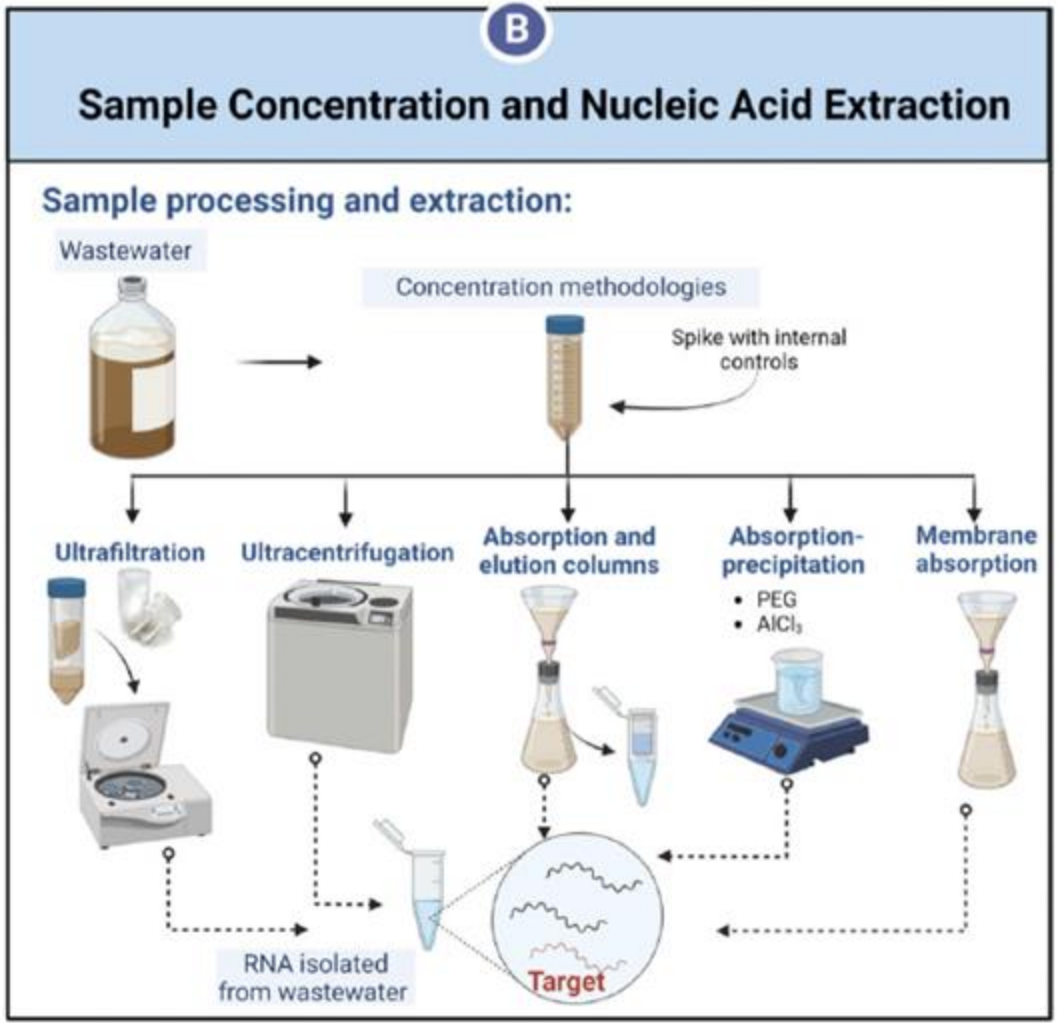
WES as an early warning tool

- WES have become an increasingly important tool for early warning detection of known and unknown pathogens
- COVID-19 pandemic showed the value of WES, complementing clinical surveillance to monitor and track variants
- WES can expand its scope beyond SARS-CoV-2 and poliovirus to become a cost-effective, objective and real time tool for public health infectious disease surveillance
- Enables serial monitoring with minimal interruption to daily life but generate population level data

But is there any other utility?

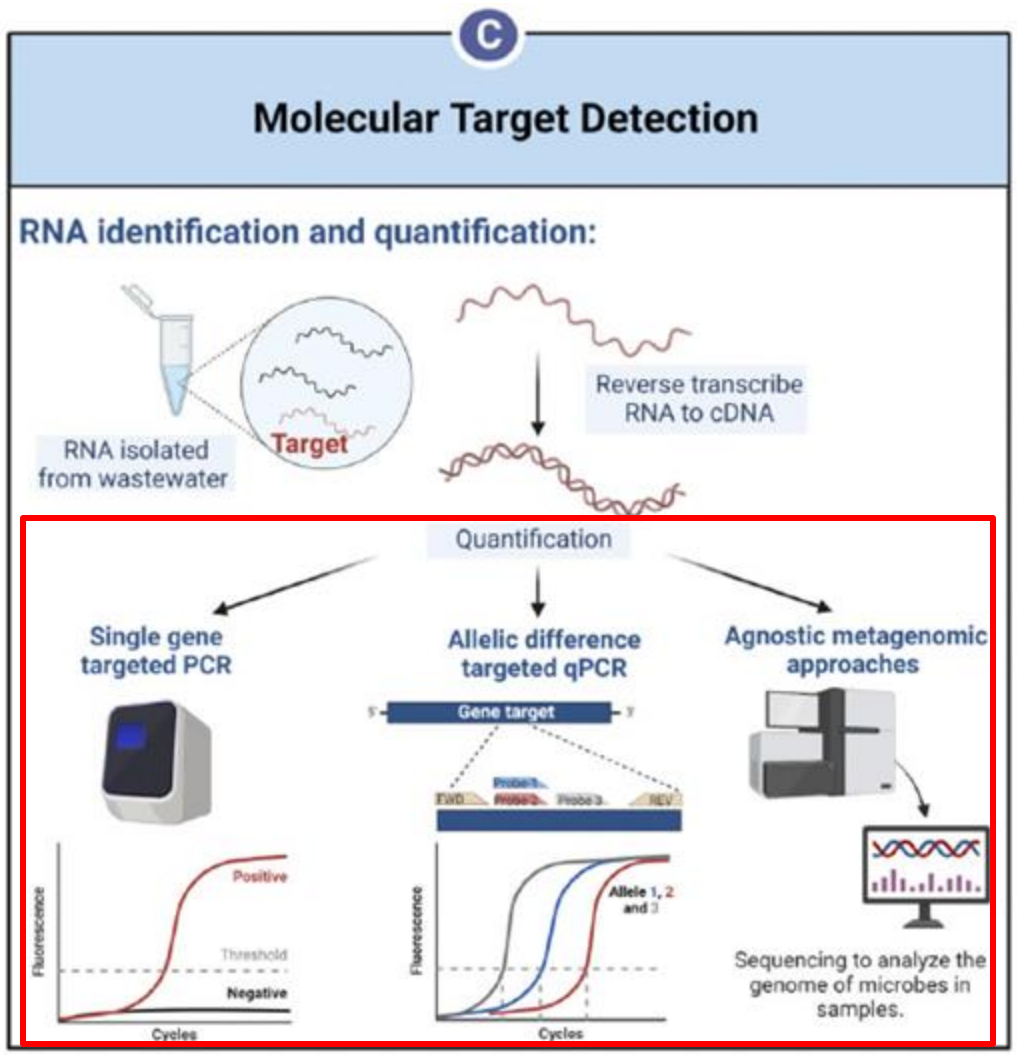
WES surveillance workflow

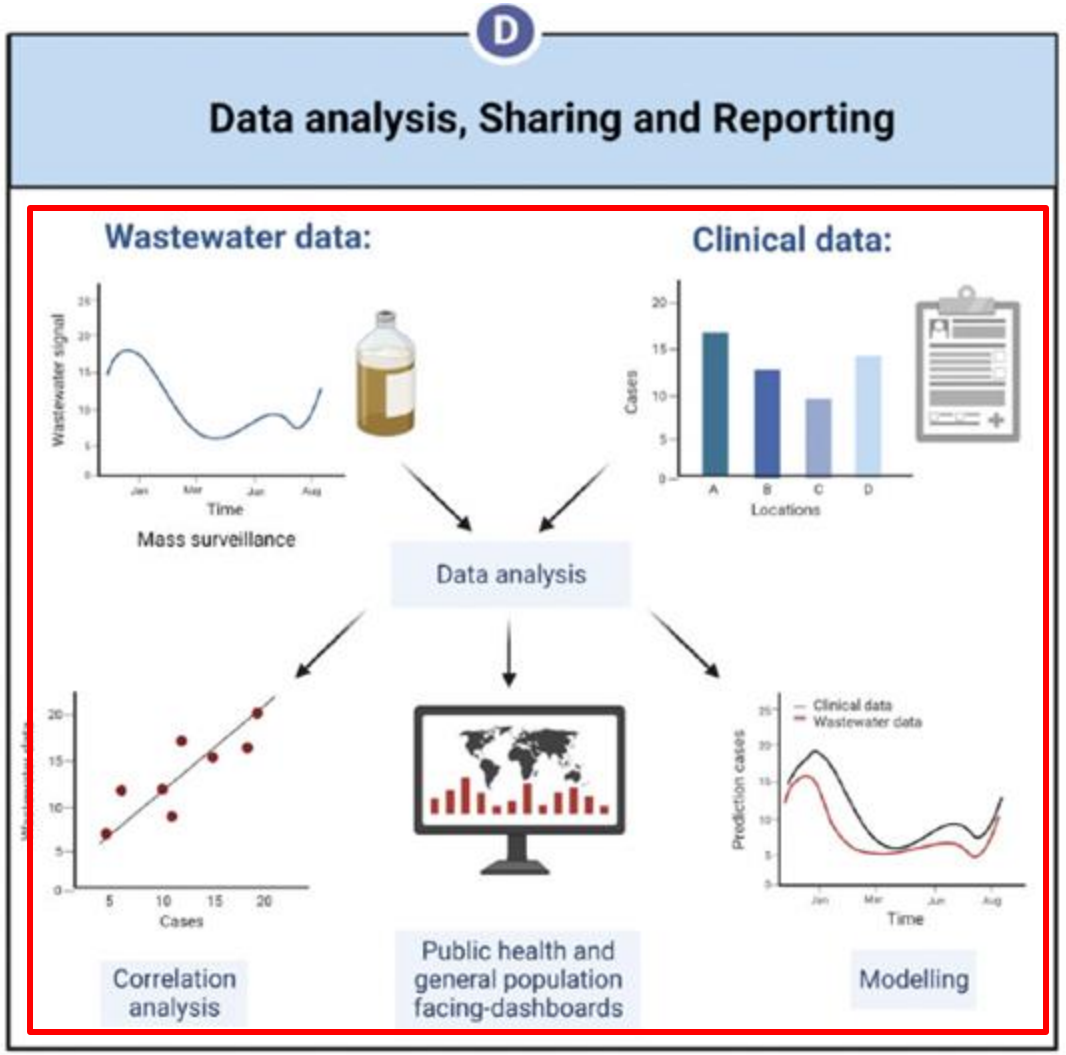




Parkins et al, 2024

WES surveillance workflow

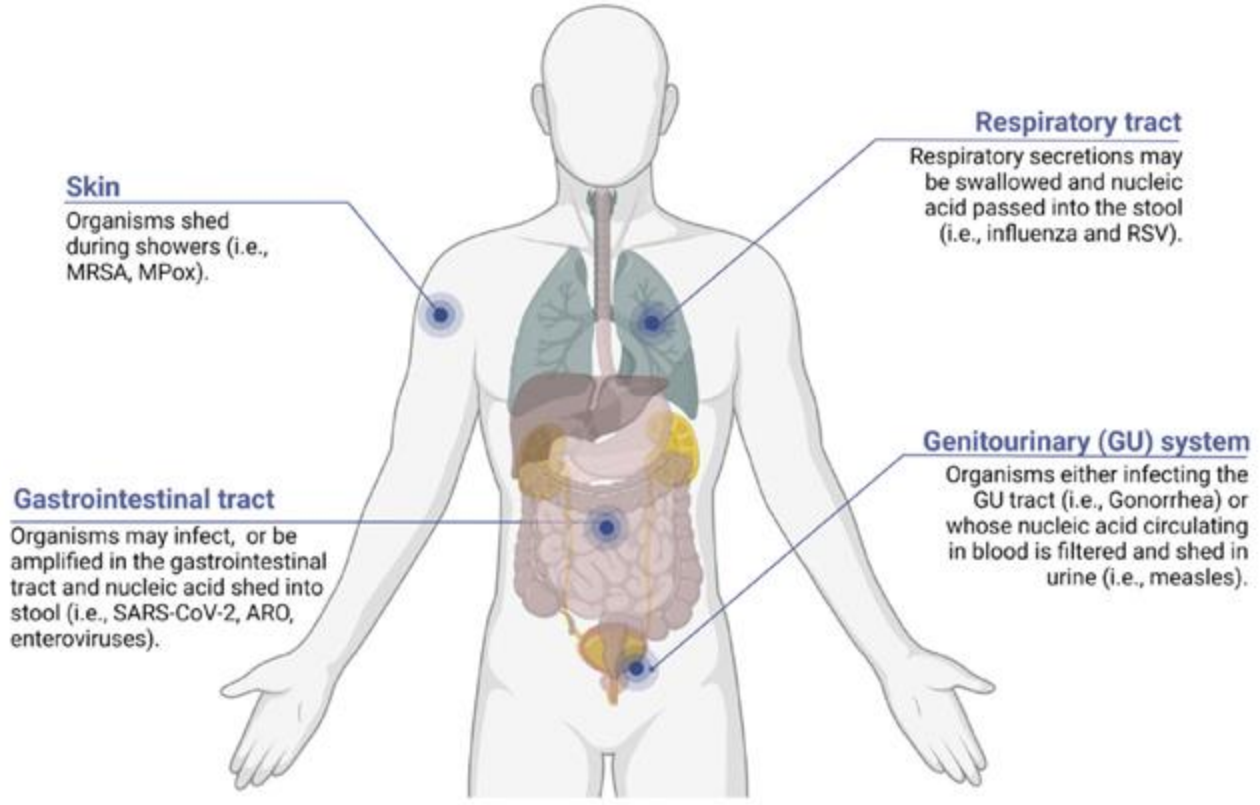




Parkins et al, 2024

Pathogen considerations

- Pathogen dynamics - relationship with shedding & natural history of disease
- Pathogen characteristics - enveloped vs non enveloped, hydrophobicity
- How pathogen enter wastewater system



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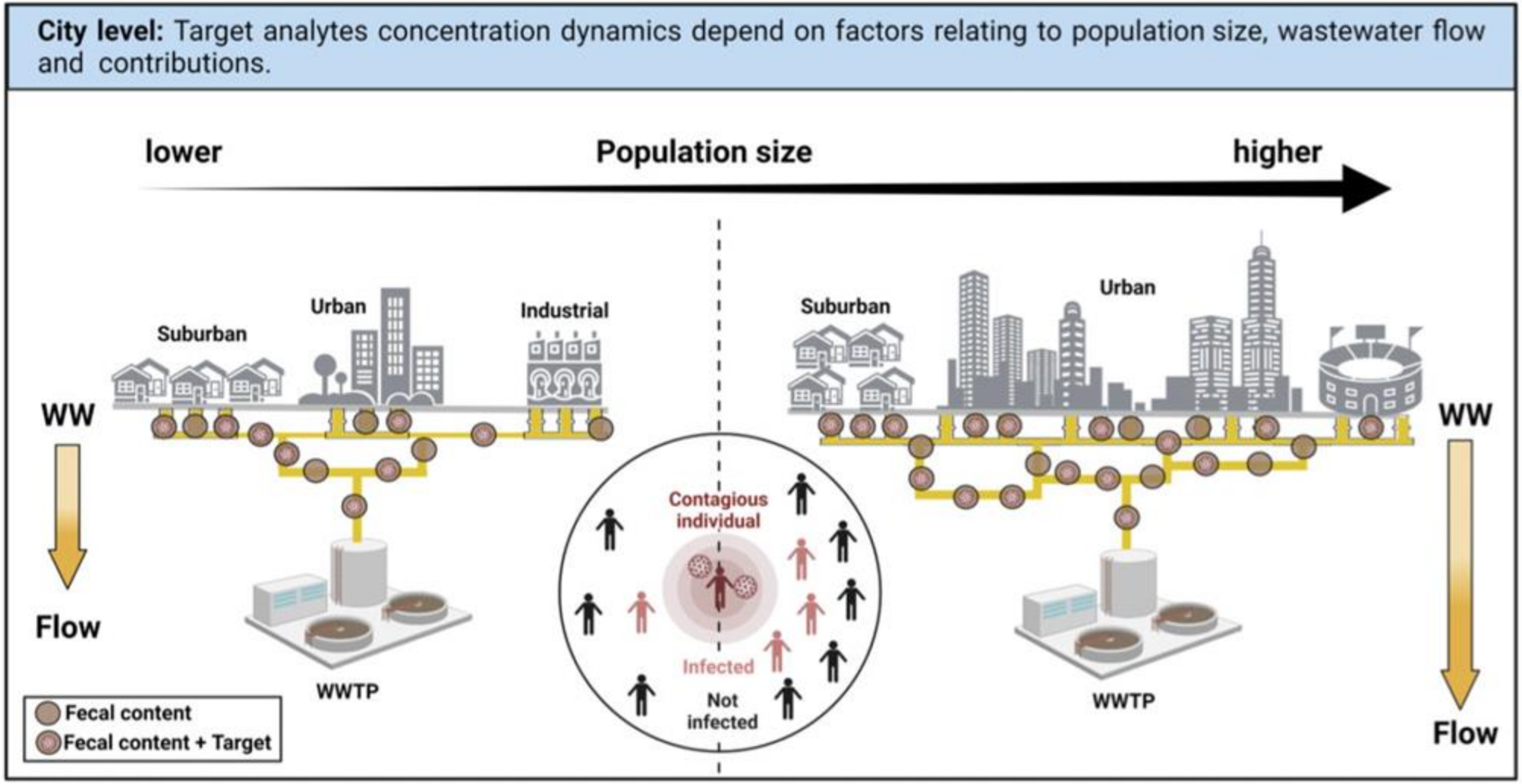
Wastewater concentration dynamics



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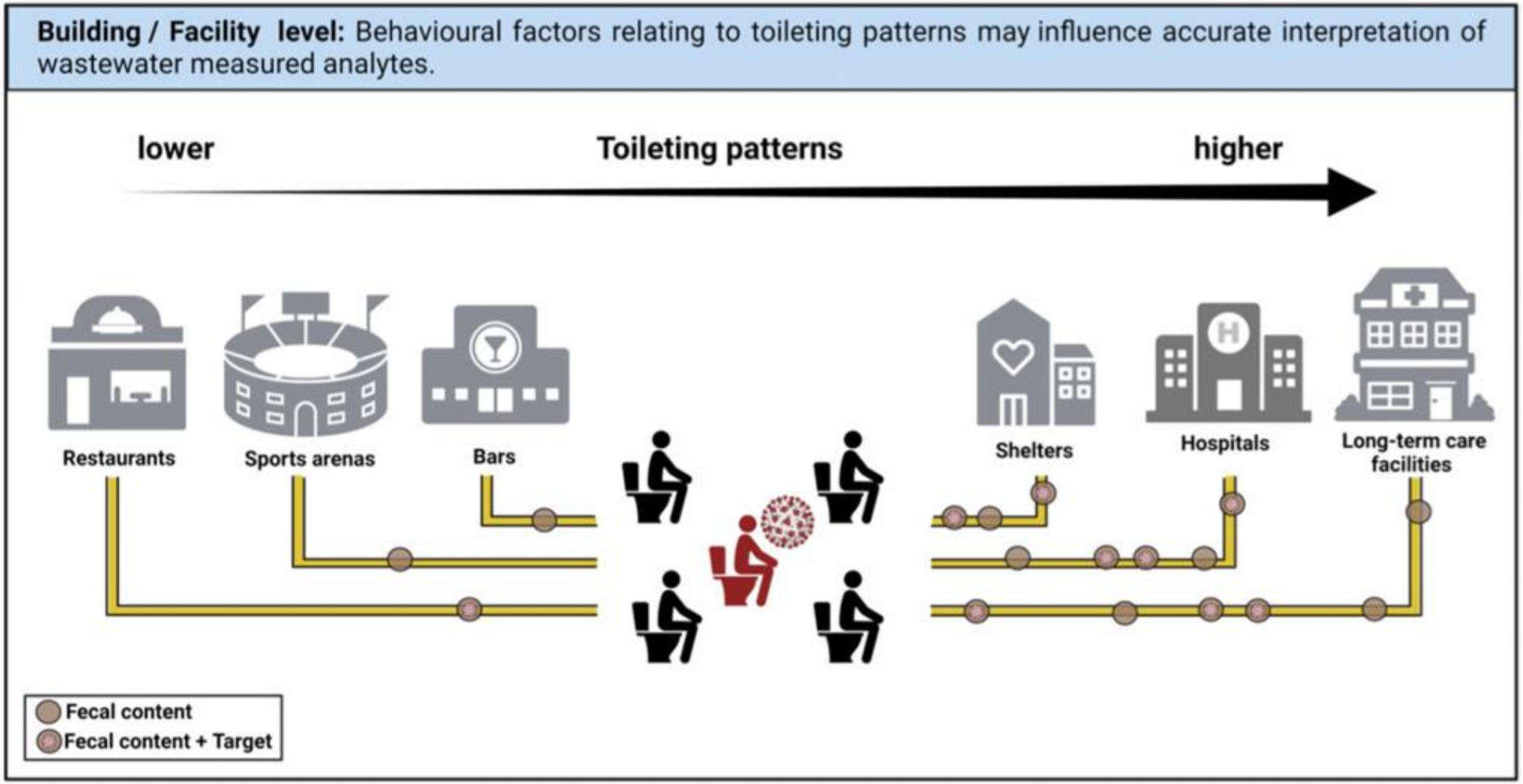
Population behaviour



Parkins et al, 2024

Still many unknowns and variables

To fully utilise data, there is a need to:

- **Optimised workflows** for extraction, concentration, identification and quantification
- **Understanding pathogen dynamics** e.g shedding load and pathogen characteristics
- **Understanding sewage infrastructure** e.g open vs closed sewage system, how the pathogen enter sewage system, other contaminants in the system
- **Correlating WES data** with clinical disease burden

Bacterial and viral pathogens: Feasible to detect in wastewater and actionable

Pandemic potential

Vaccine-preventable

- Yellow fever virus*
- SARS CoV-2^
- Respiratory Syncytial Virus
- Polio virus
- Dengue virus
- Ebola virus* ^
- Hepatitis A & B
- Hepatitis E
- Highly Pathogenic Avian Influenza*
- Seasonal Influenza
- Measles
- Rotavirus
- Rubella virus
- Japanese encephalitis virus*
- Human Papilloma Virus
- M-Pox
- Varicella zoster virus
- Salmonella Typhi
- Tuberculosis*
- Vibrio cholerae

Drug-treatable

- Seasonal Influenza
- Ebola virus*
- SARS CoV-2^
- HIV
- Tuberculosis*
- Salmonella
- AMR bacteria

Vector control

- Japanese encephalitis virus*
- Dengue virus
- Yellow fever virus*
- West Nile Virus*
- Zika virus
- Alphaviruses* ^

Non-pharmaceutical

- SARS Co-V2^
- Respiratory Syncytial Virus
- Astrovirus
- Enterovirus
- Norovirus
- Parainfluenza virus
- Seasonal Coronavirus
- Salmonella
- E. coli (EHEC O157:H7)

Pandemic potential

- Other filiovirus *
- Henipahviruses * ^
- Nairoviruses
- Phleboviruses * ^
- Arenaviruses * ^
- MERS ^
- Picornoviruses
- Hantaviruses
- Influenza C virus

References

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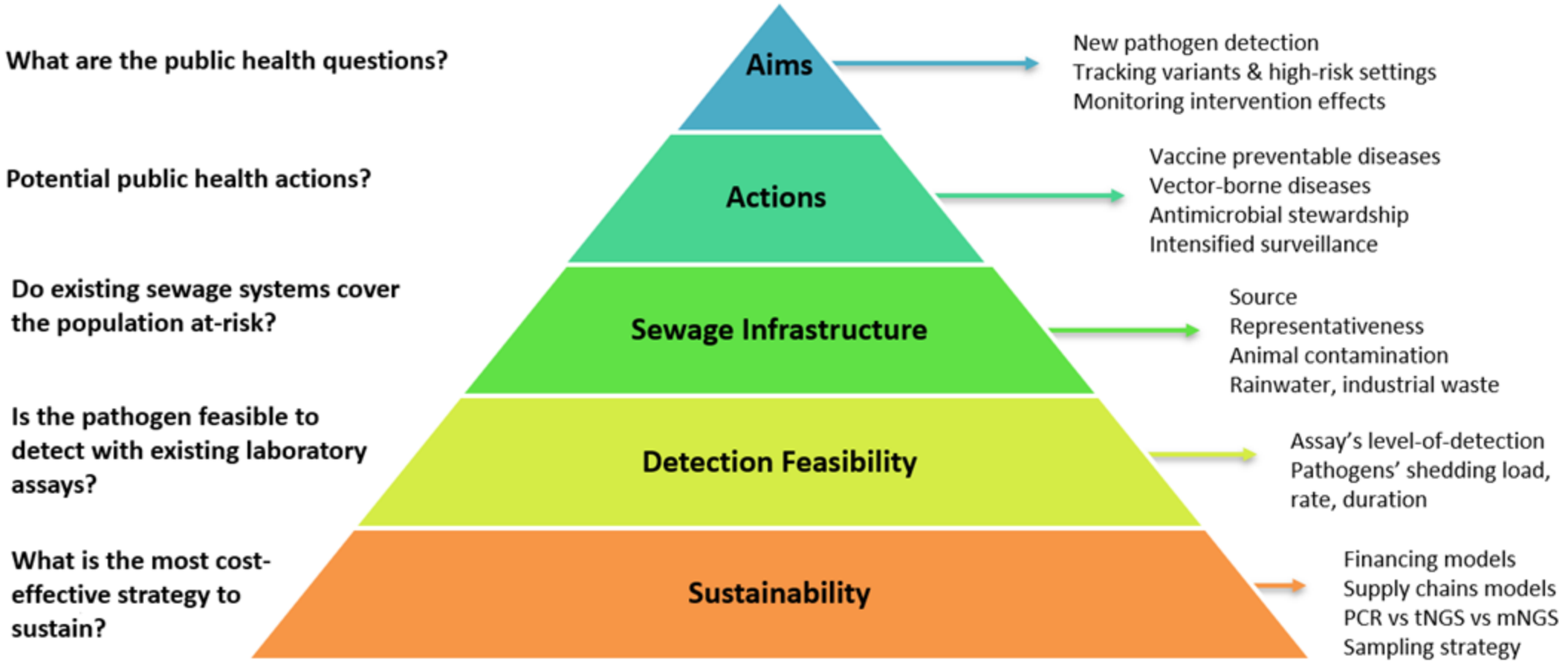
https://Biosafety in Microbiological and Biomedical Laboratories—6th Edition (cdc.gov)

Unique pathogens / pathogen-groupings Pathogens appearing in more than one grouping * Potential BSL 3 or above requirement ^ CEPI priority pathogen list

Considerations for a multi pathogen WES system



Case study

Learning objectives:

- To understand system requirements for multi-pathogen WES
- To understand genomic utility of multi-pathogen WES

Scenario: Country context and wastewater surveillance planning

Country A is in Asia with a population of 70 million people with centralized healthcare system and an **established communicable disease surveillance system.** It has a national reference lab with a network of satellite labs with a **moderate capacity for genomic sequencing.**

Most cities in the country have a closed sewage system with a treatment plant. There are rural areas that use open sewage systems.

Country A wants to **use WES to assess other pathogens beyond SARS-CoV-2.**

Question 1 and 2 (25 mins)

Q1. Discuss the advantages and limitations of having a multi pathogen WES system. What are the capacities needed to establish a multi pathogen WES system?

Q2. Discuss the sampling strategies for WES in relation to

- Priority pathogens
- Sampling populations
- Sampling frequency and locations

Consider how WES complements existing surveillance systems

Questions 3 – 6 (25 mins)

Genomic utility

Country A introduced the 3-dose rotavirus vaccine into its pediatric immunization schedule. Two years later, it reported an increase in rotavirus infections.

Q3. Discuss the genomic utility in this scenario.

Following the introduction of a typhoid vaccination program targeting Salmonella typhi, there is a decrease in overall prevalence. However, NGS analysis of S.typhi from wastewater shows an increase in resistant genes to ciprofloxacin and ampicillin.

Q4. How does genomic utility guide antimicrobial stewardship in clinical settings, intervention effectiveness and overall public health surveillance?

Country A subsequently adapted WES for the detection of pathogens for pandemic potential. In routine WES surveillance, Nipah virus was detected in the wastewater.

Q5. What changes would you implement to the WES system in this event?

Q6. What implications in terms of One Health does a WES have on other sectors apart from human health?

Pathogen prioritisation tool

THANK YOU!

WORKSHOP PARTNERS

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WHO Southeast Asia Regional Office (SEARO)
WHO Western Pacific Regional Office (WPRO)
WHO International Pathogen Surveillance Network (IPSN)