

10 Things We Know (and 10 Things We Don't) About Wastewater Testing for COVID-19 Lessons from Detroit and beyond

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**CDM
Smith**

Wastewater testing for COVID-19 is increasingly common

Centers for Disease Control



- National Wastewater Surveillance System (NWSS)

Health and Human Services



- 2-phase pilot: 100 then 350 WRRFs

States

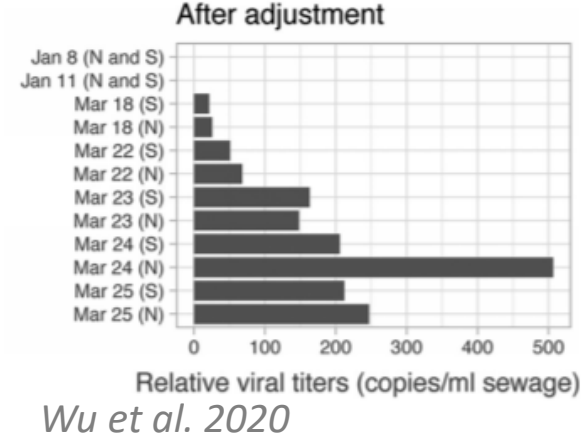
CA • CO • CT • MA • MD • MI
MO • NY • UT • WY

Individual Entities

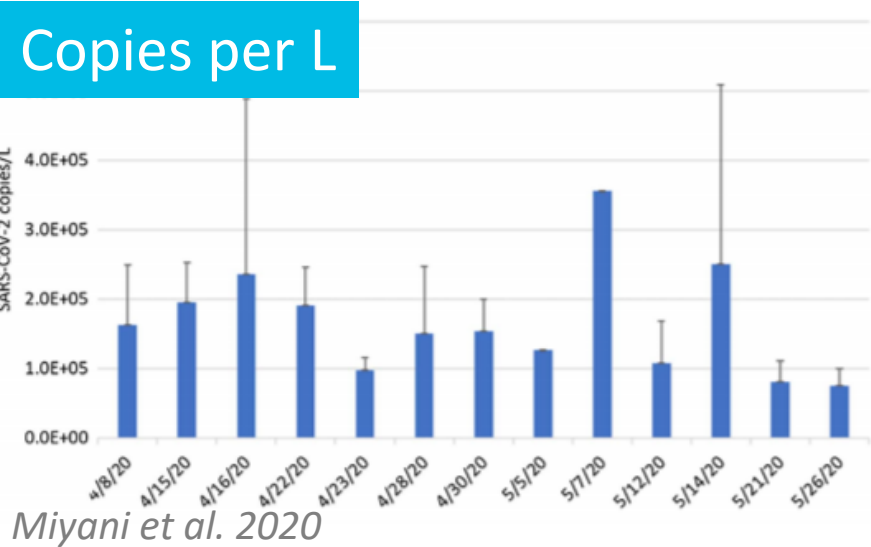
Cities • Utilities/Authorities • Colleges/Universities

But what's the best way to communicate the data?

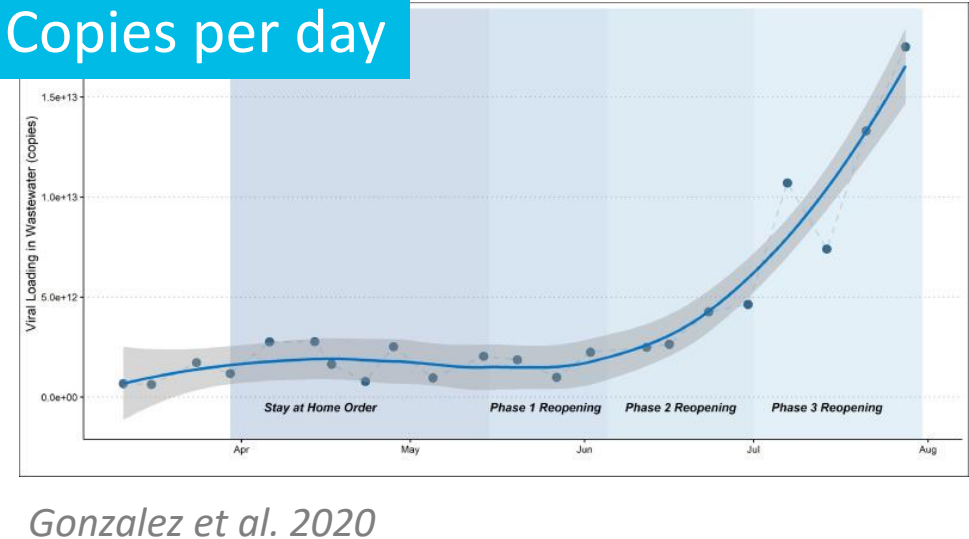
Copies per mL



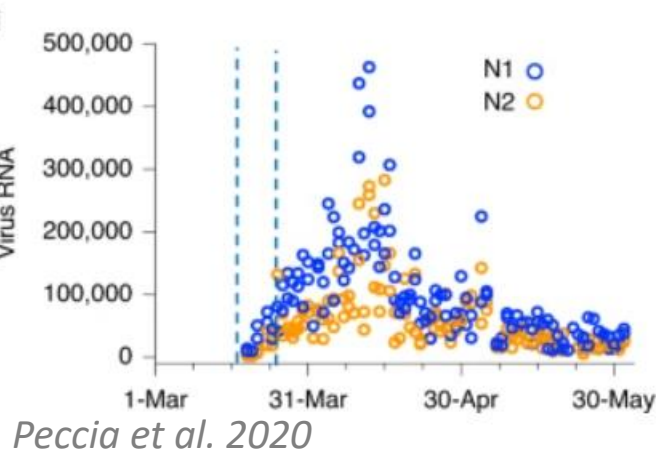
Copies per L



Copies per day

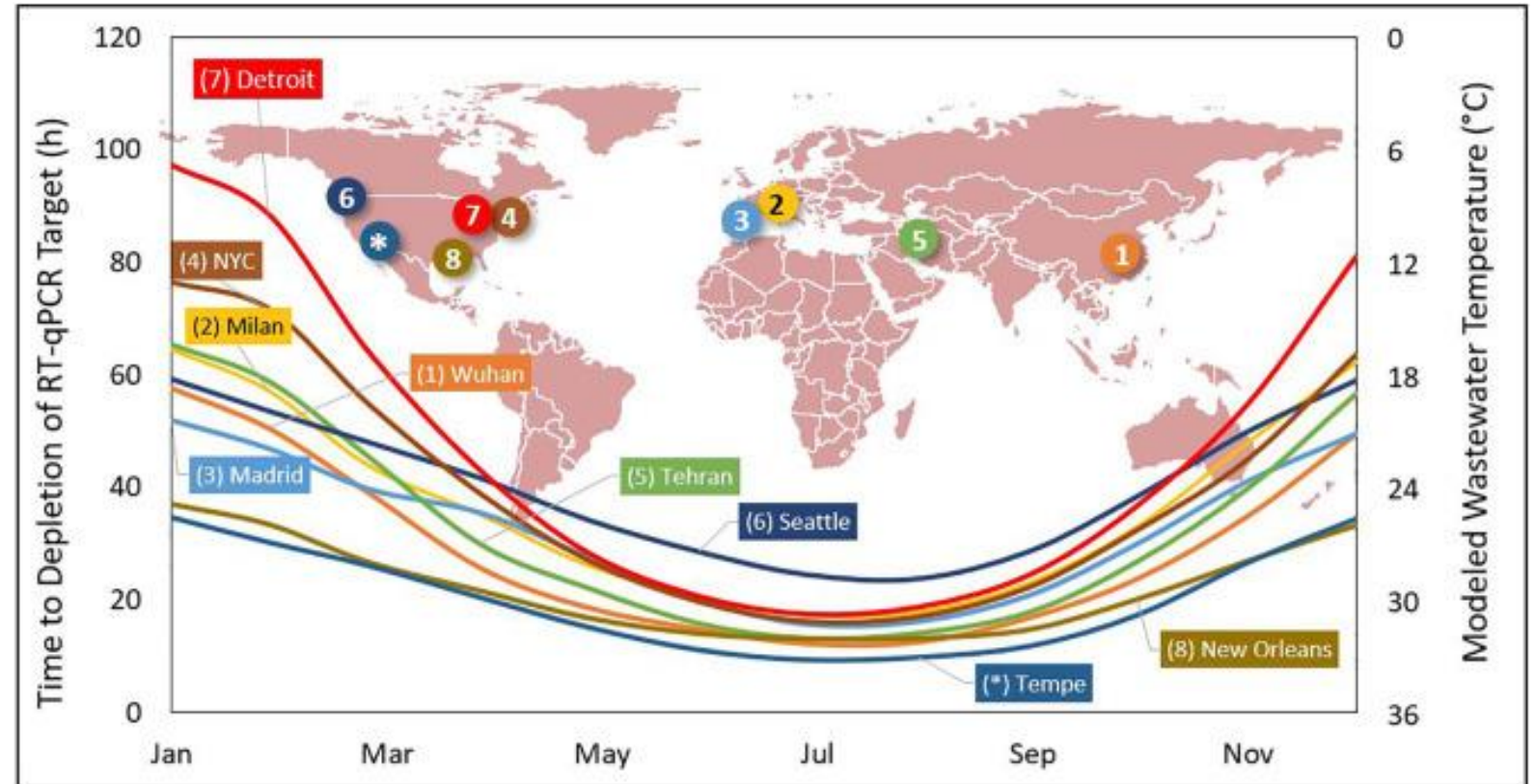


Copies per mL sludge



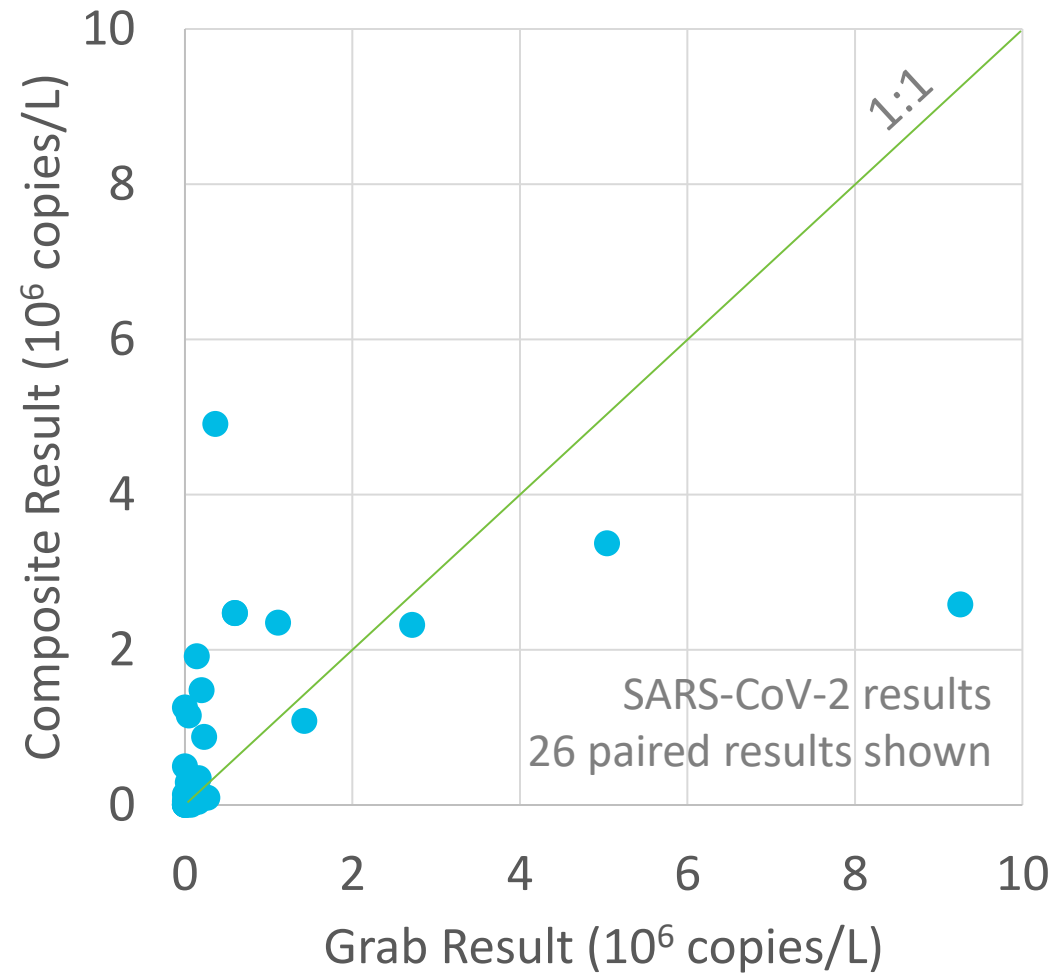
Consistency in sampling is critical

- Type
- Timing
- Temperature
- Transport



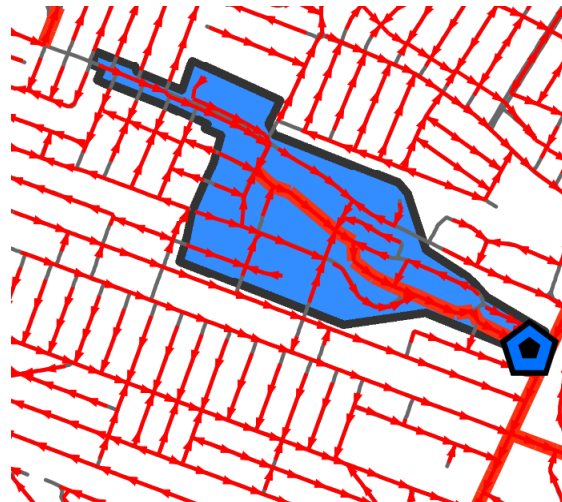
Hart and Halden 2020

But how do grab results compare with composite results?



CDM Smith research

Large-scale and small-scale surveillance are both possible



Different goals for different scales:

- Confirm trend in COVID-19 cases
- Fill in gaps in clinical testing data
- Confirm absence of disease
- Inform outreach and education
- Prompt specific public health actions

But how small is too small?



UNIVERSITY OF ARIZONA/CHRIS RICHARDS

Poop tests stop COVID-19 outbreak at University of Arizona

Science Mag 8/28/20

NJIT detects COVID-19 in sewage, quarantines entire dormitory

NJ Spotlight News 9/18/20

Colleges Turn To Wastewater Testing In An Effort To Flush Out The Coronavirus

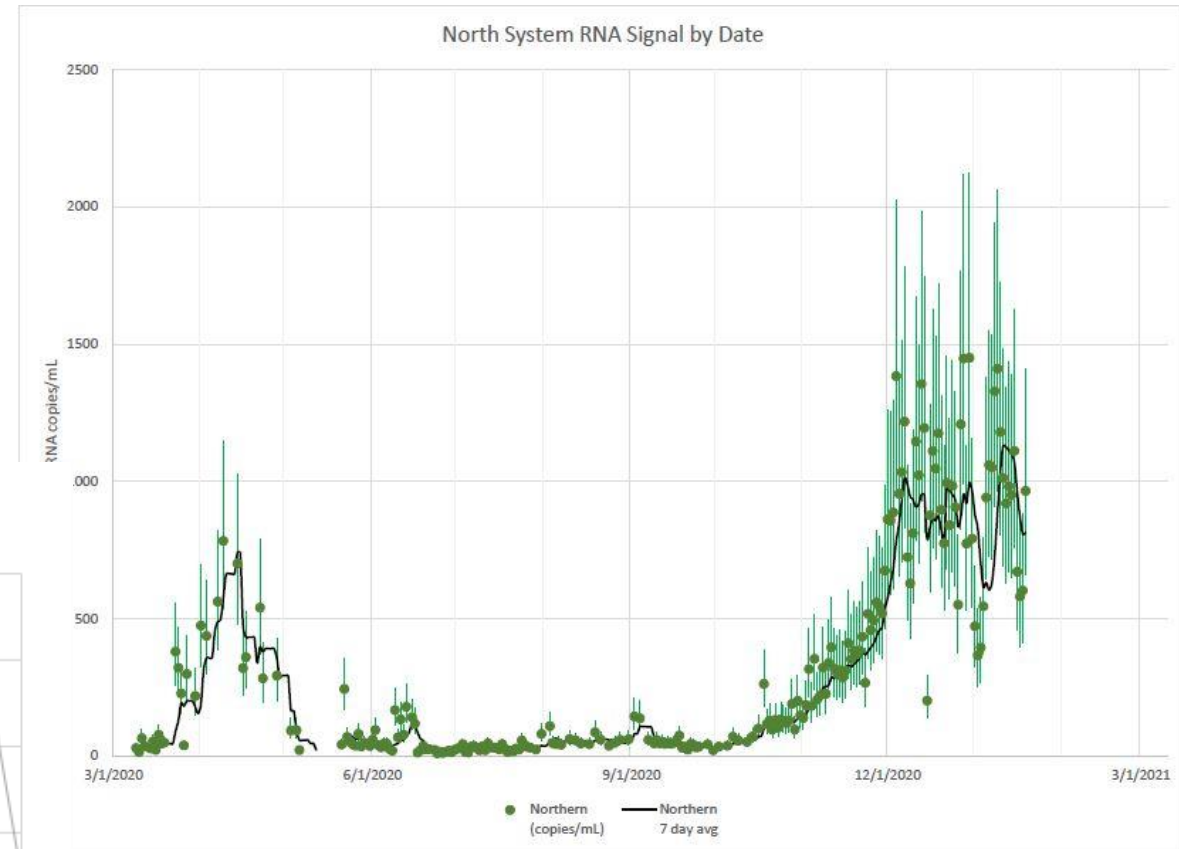
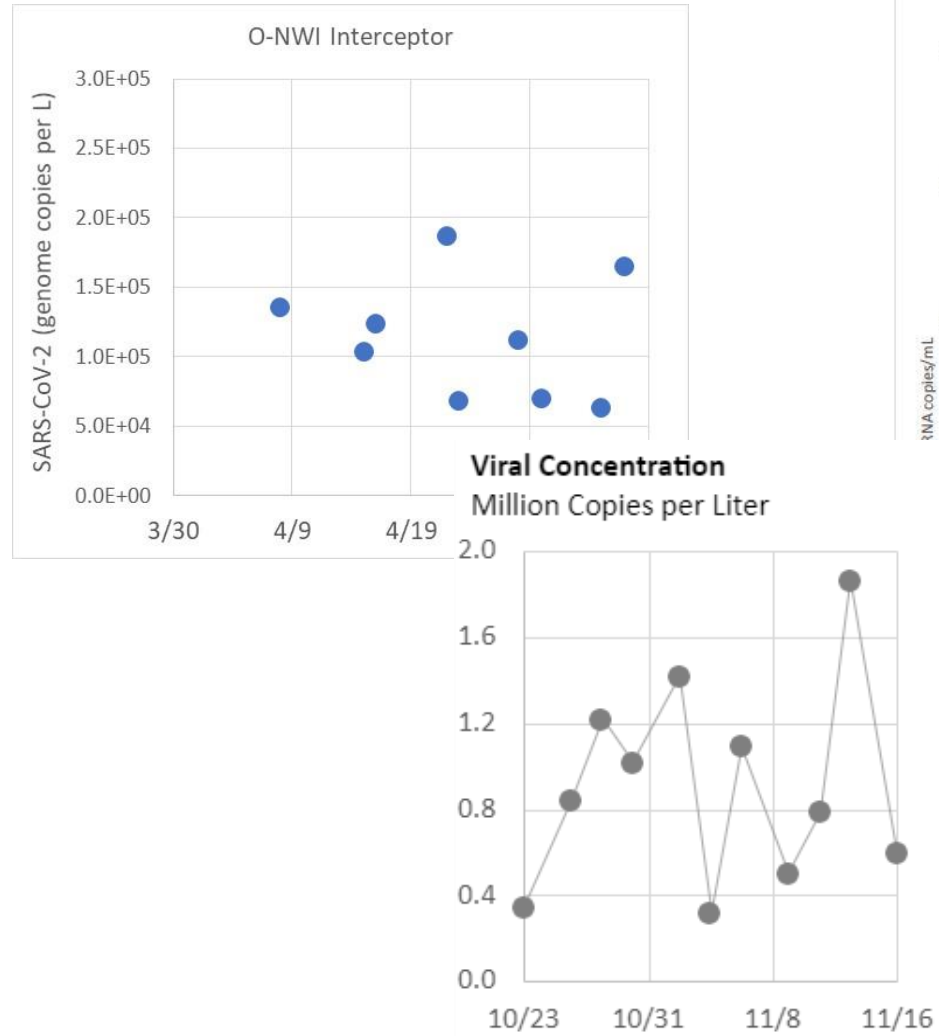
NPR 10/26/20

MIT begins testing wastewater to help detect Covid-19 on campus

The pilot project is designed to determine if wastewater testing can provide early signals about the spread of the virus.

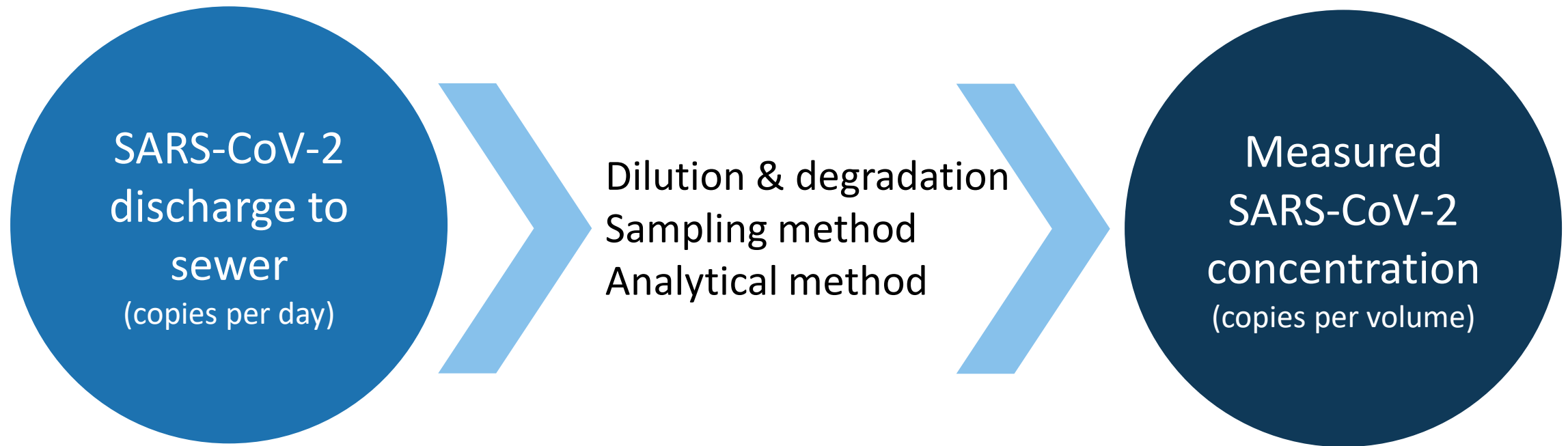
MIT News 10/2/20

SARS-CoV-2 wastewater data are variable



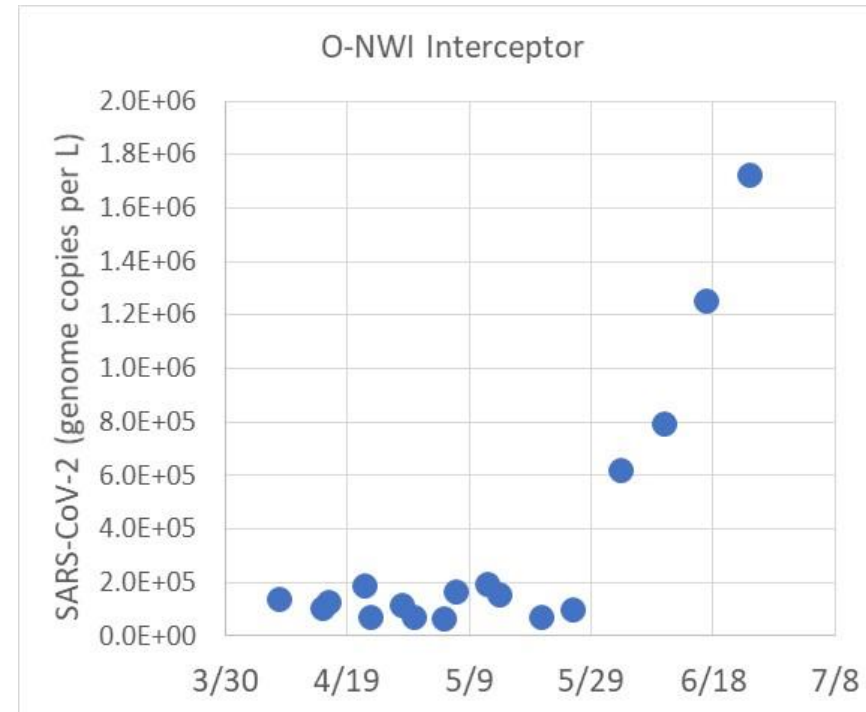
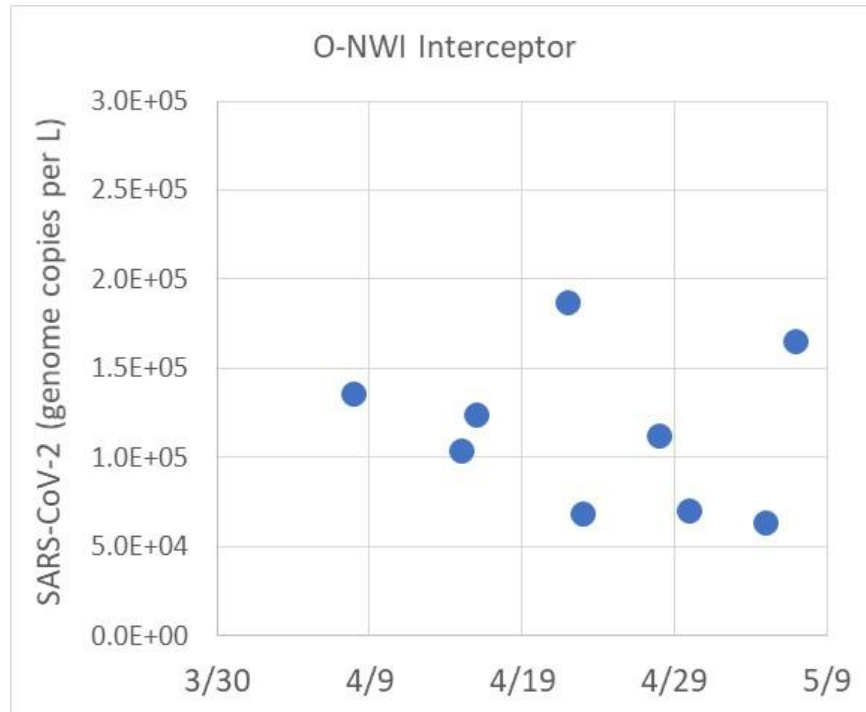
<http://www.mwra.com/biobot/biobotdata.htm>

But should we make “corrections” to minimize variability?



- **Correct for wet weather:** flow meters & H&H models
- **Incorporate analytical process controls:** matrix spikes
- **Consider normalization:** molecular or chemical; population

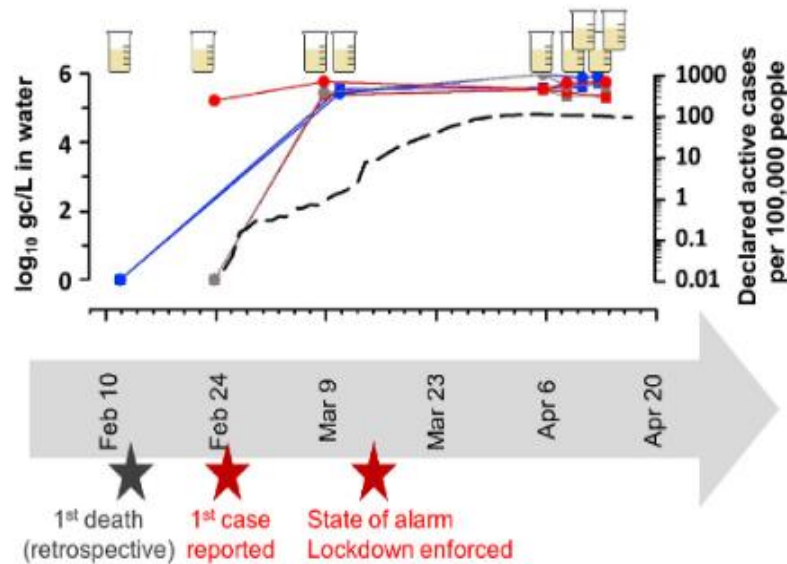
Trends* are (usually) discernible



*Trend = three data points

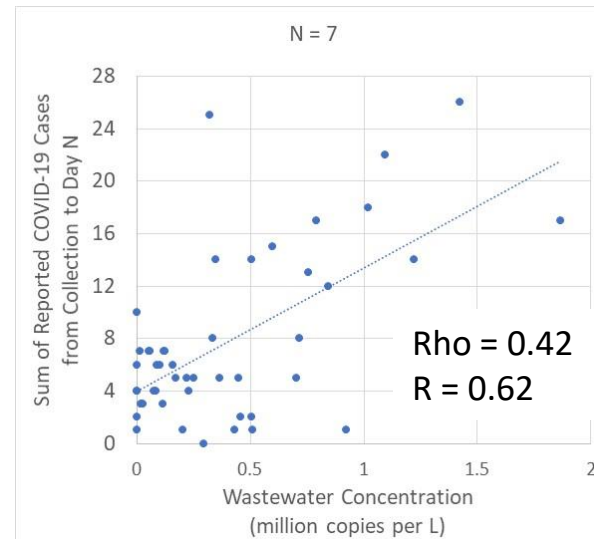
But how much of a leading indicator is the virus trend?

2 weeks?



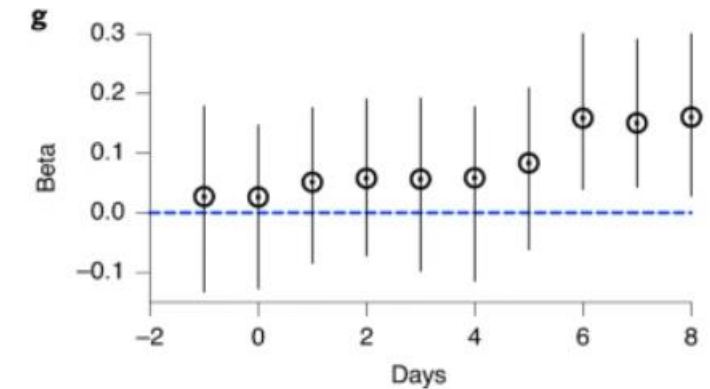
Randazzo et al. 2020 *Wat Res*

1 week?



CDM Smith analysis for MA DPH

A few days?

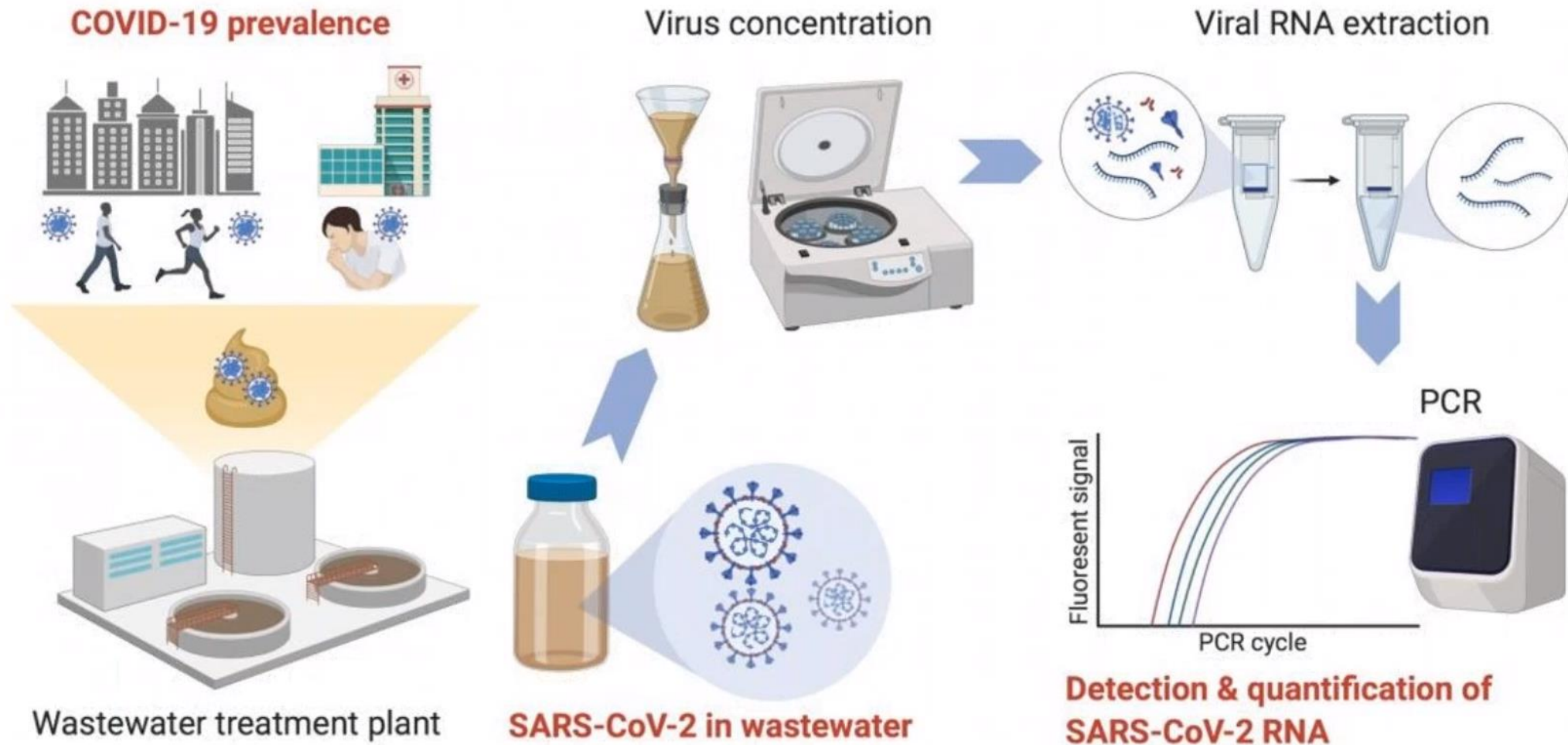


Lag between viral signal and:

- Positive COVID tests based on reporting date = **6 to 8 days**
- Positive COVID tests based on collection date = **0 to 2 days**

Peccia et al. 2020 *Nature*

Wastewater should be concentrated before analysis



Source: Samendra Sherchan via Bradley Schmitz

But what is the preferred method for concentration?

- Adsorption-precipitation
- Electronegative membrane filtration**
- Electropositive membrane filtration
- Polyethylene glycol (PEG) precipitation**
- Skim milk flocculation*
- Ultracentrifugation**
- Ultrafiltration*

**CDC lists these as yielding adequate recoveries based on results to date*

**Studied by Pecson et al. 2020 (WRF 5089); found that methods led to similar results if corrected for recovery*

Analytical process controls are important

- Matrix recovery control
- Human fecal normalization
- Quantitative measurement controls
- Inhibition assessment
- Negative controls

<https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/wastewater-surveillance/testing-methods.html>

But what should we be using and how do we report data?

SARS-CoV-2 in Sample
DETECTED

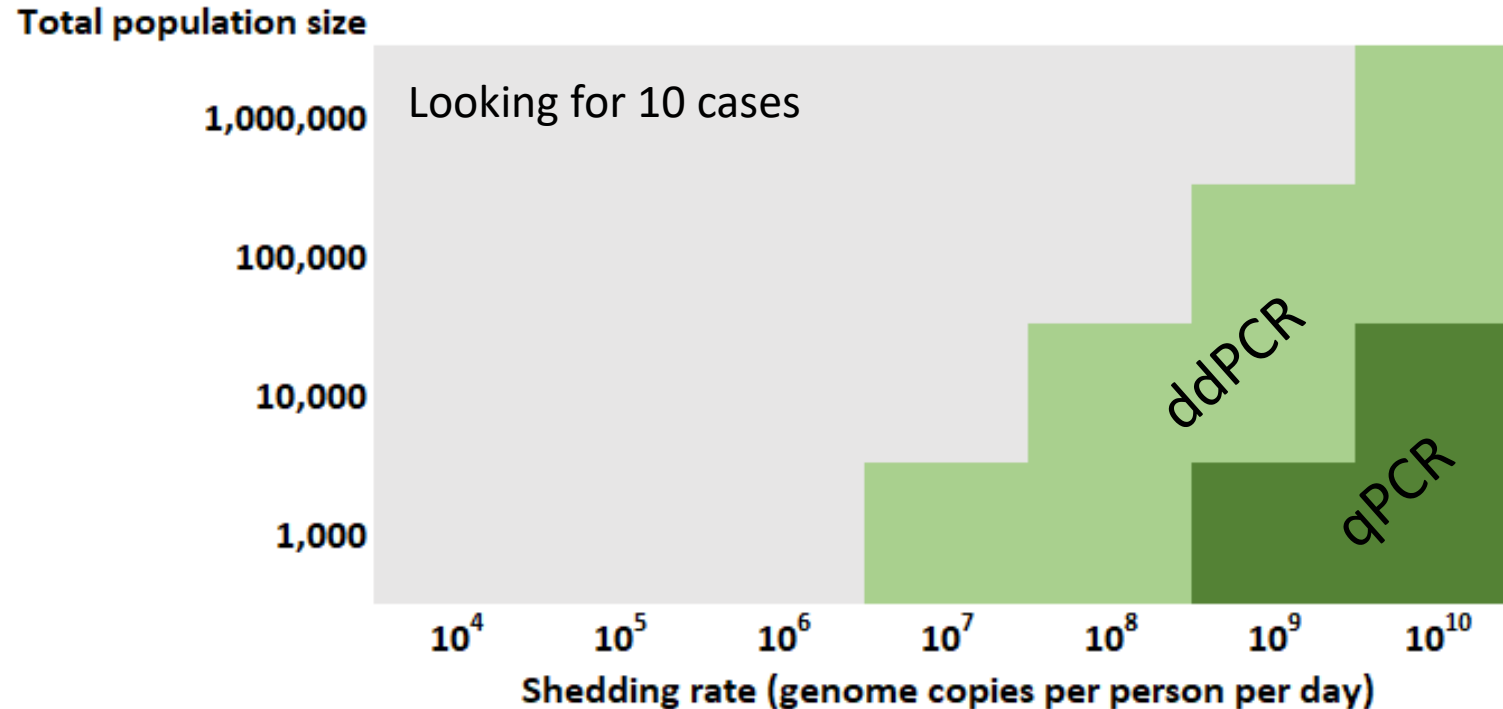
Viral Copies per Liter of Wastewater (recovery adjusted) **333,492** **copies/L**

Your non-recovery adjusted SARS-CoV-2 concentration was 30,302 copies/L.

Metric	Pass Criteria	Measured	Pass or Fail
F+ Prophage Concentration (copies/L)	<i>Detection</i>	5.48E+05	PASS
Internal Process Control (% Viral Recovery)	>5%	9.1%	PASS
ddPCR Positive Control (Copies/Rxn)	>20	1814	PASS
ddPCR Negative Control (Positive Droplets in NTC)	<1	0	PASS

GT Molecular example report

Linking the virus signal to COVID-19 prevalence or incidence depends on a few uncertain factors

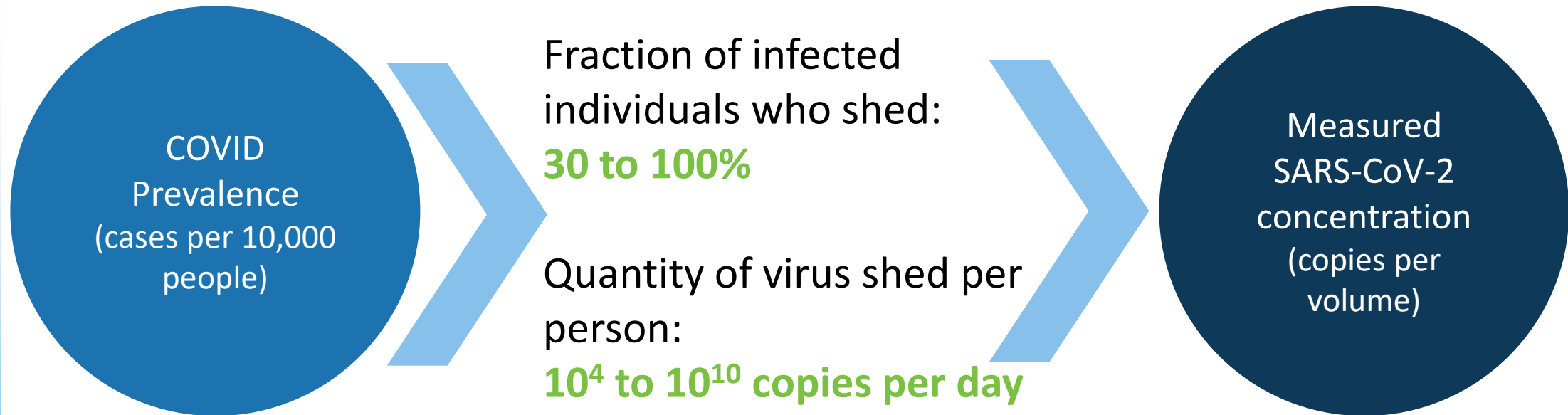


Assumptions:

50% of infected individuals shed SARS-CoV-2
100 L wastewater generated per person
LOD: 600 GC/L (ddPCR) to 10,000 GC/L (qPCR)

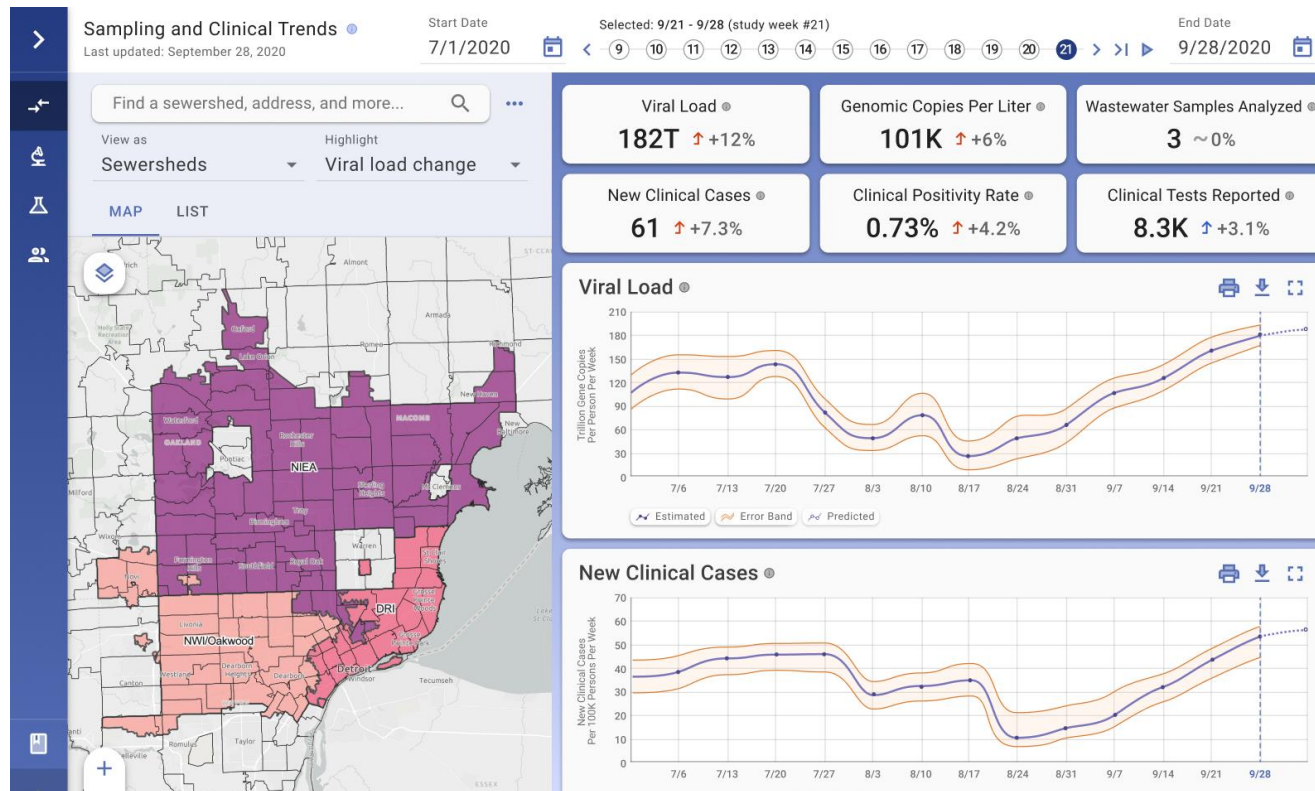
Inspiration:
Hart and Halden 2020
Sci Tot Environ

How can we reduce that uncertainty?

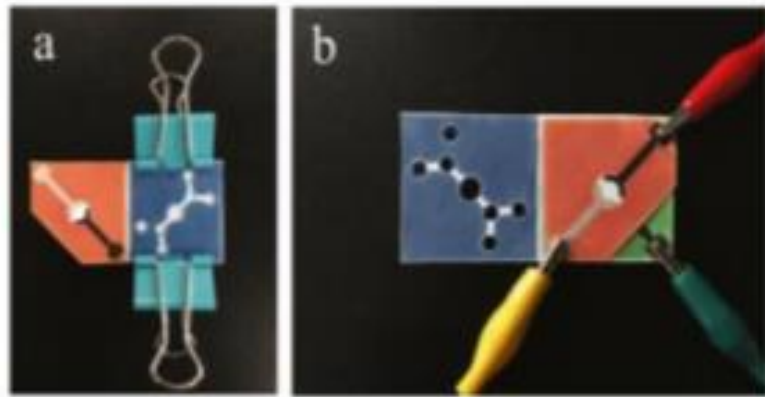


The techniques we learn can be useful for water reuse

Digital tools can help enhance source control through monitoring and data trending

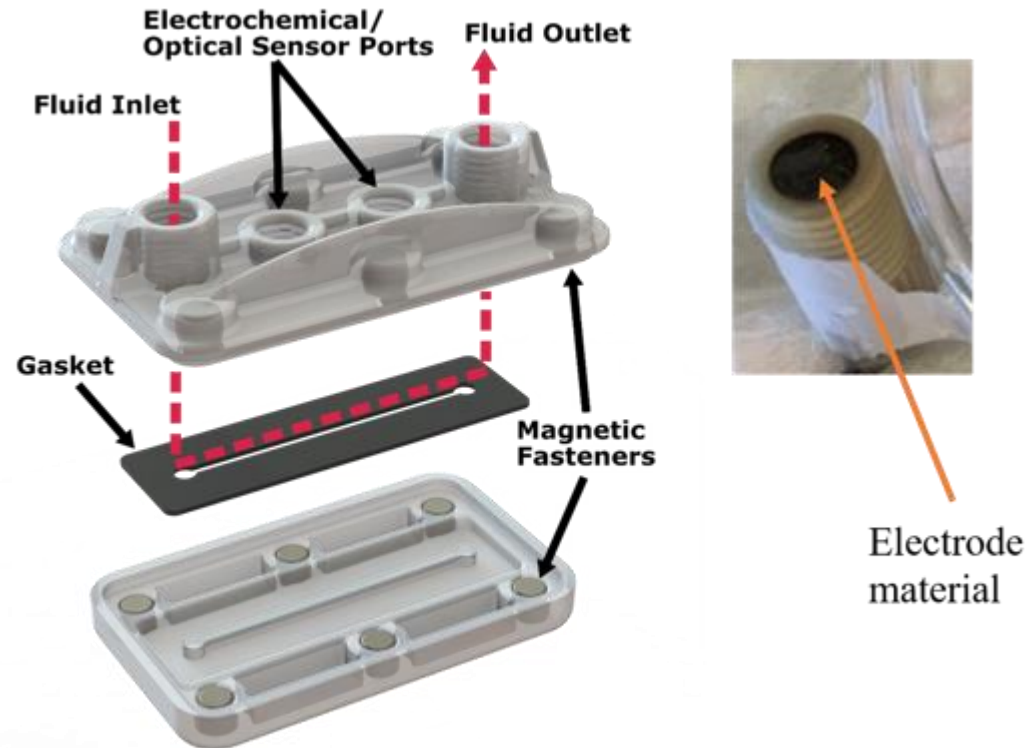


But can we develop advanced instrumentation to be used for both disease surveillance and reuse applications?



Electrochemical paper-based device

Channon et al. 2018 Analytical Chemistry

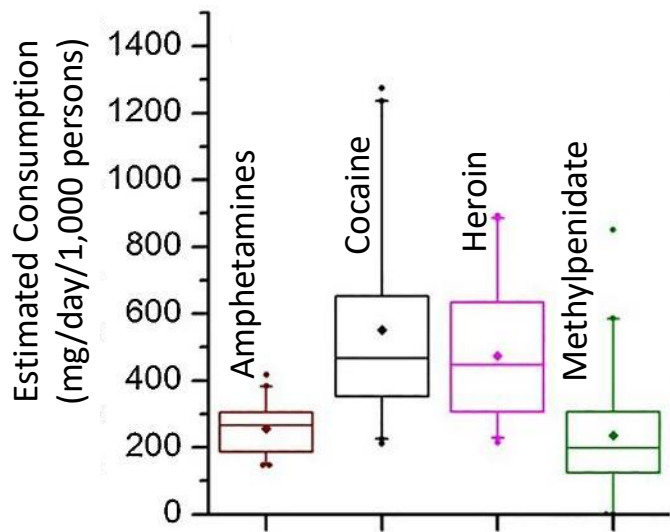


Electrochemical microfluidic device

Klunder et al. 2017 J Am Chem Soc

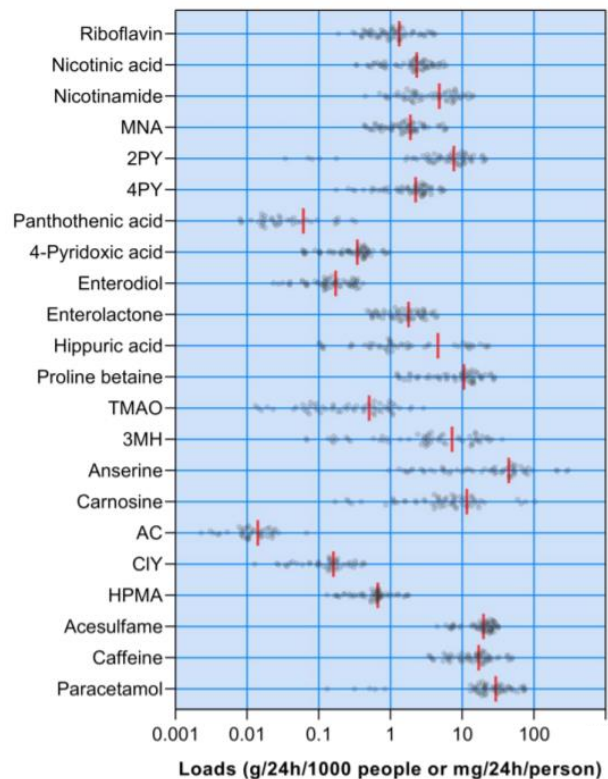
Wastewater-based epidemiology has utility beyond COVID-19

Illicit drugs



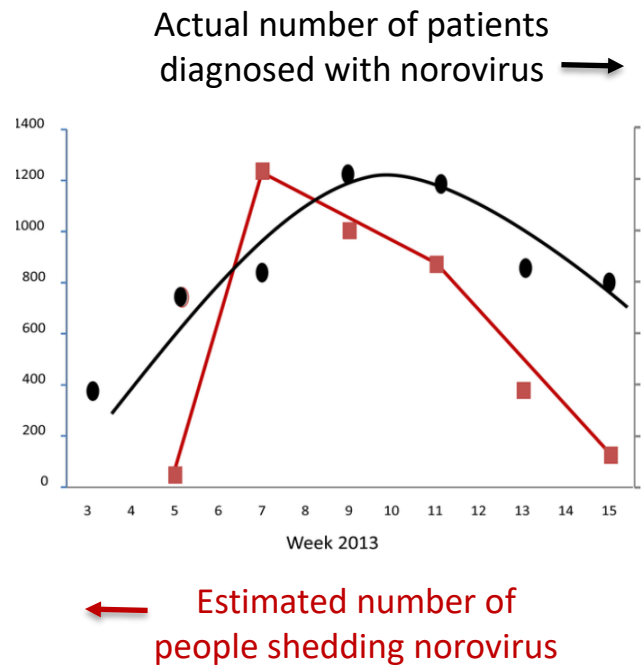
Gushgari et al. 2018. *J Haz Mat*

Biomarkers of nutrition & stress



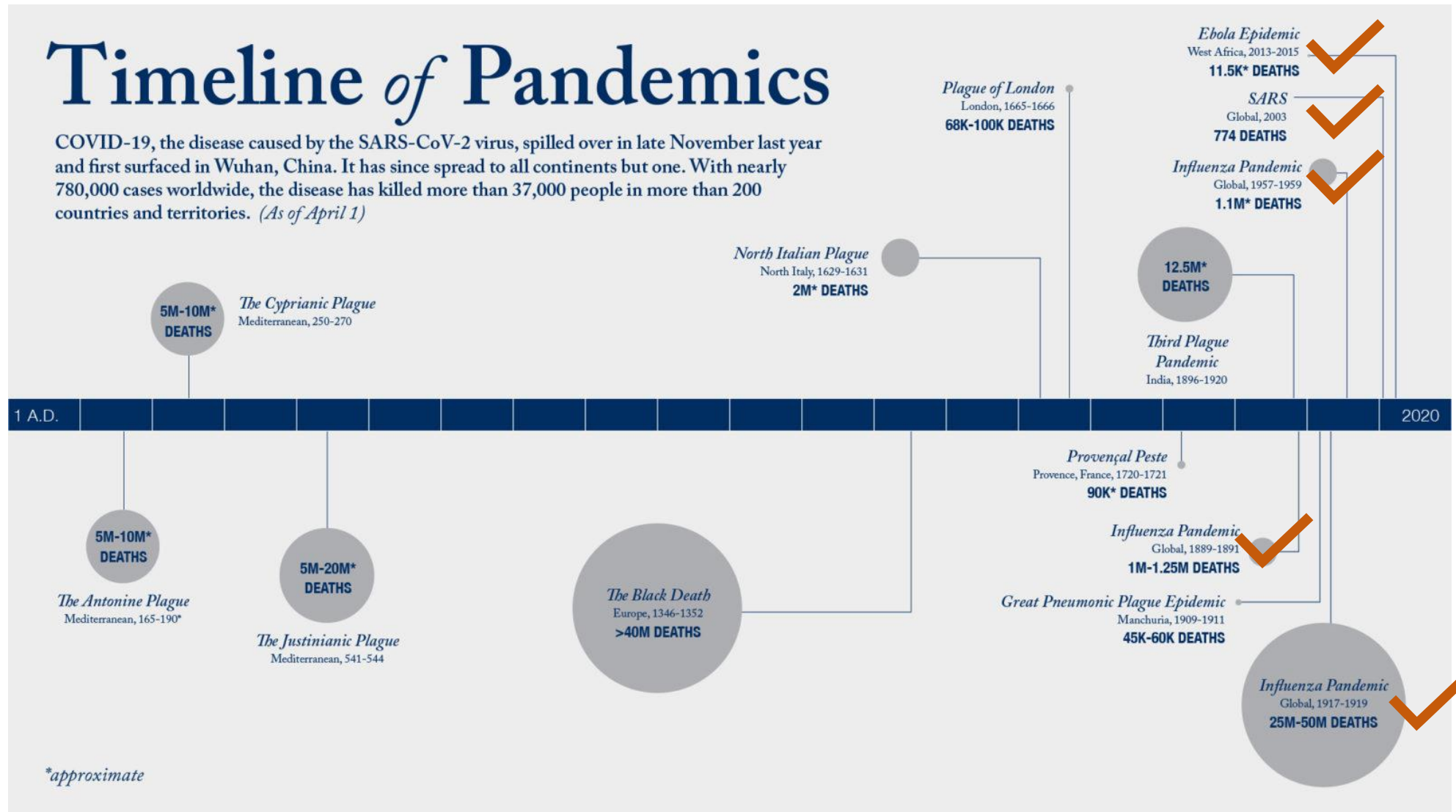
Choi et al. 2020. *Sci Total Environ*

Viruses



Hellmér et al. 2014. *App Environ Microbiol*

But how do we make sure we use it well during the next pandemic?



<https://www.georgetown.edu/news/dont-compare-past-pandemics-to-the-covid-19-crisis-professor-says/>

Thank you!

CDM Smith

Jim Broz
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City of Salem

Great Lakes Water Authority

Xavi Fonoll
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GT Molecular

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Michigan State University

Brijen Miyani
Irene Xagorarakis

*Miyani, B., Fonoll, X., Norton, J., Mehrotra, A. and Xagorarakis, I.,
2020. SARS-CoV-2 in Detroit wastewater. Journal of
Environmental Engineering, 146(11), p.06020004.*

Contact us!



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