Using wastewater to monitor the emergence of variants of concern

Gertjan Medema

On behalf of a research consortium

Bridging Science to Practice

Towards a Water-wise World

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TOPSECTOR WATER & MARITIEM

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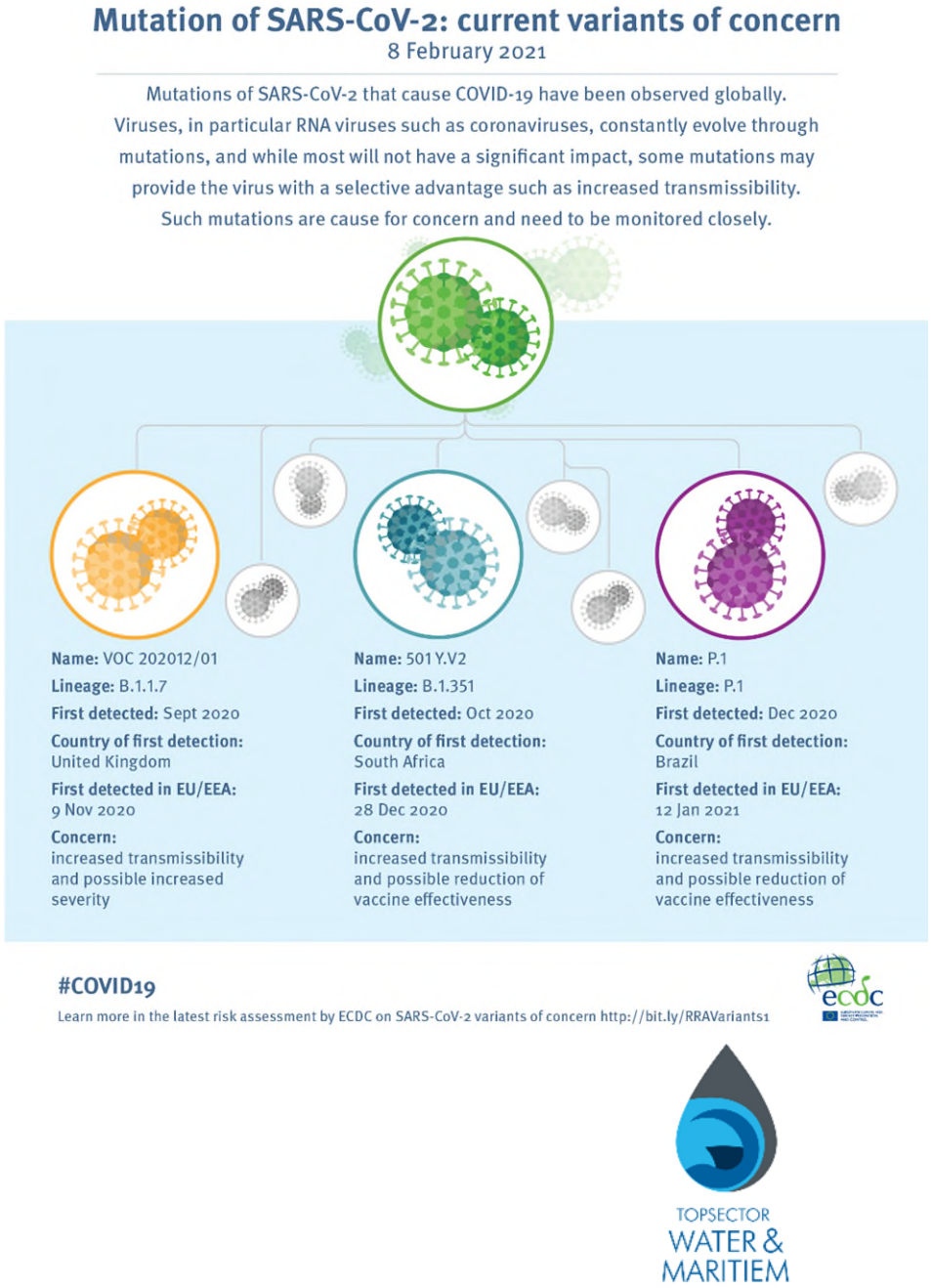
TOPSECTOR WATER & MARITIEM

MARITIEM

SARS-CoV-2 Variants of Concern

Why concern?

- Impact on diagnostics (drop-out PCR)
- Increased transmissibility
- Increased disease severity
- Reduction of therapy effectiveness
- Reduction of immunity/vaccination effectiveness



TOPSECTOR WATER & MARITIEM

Concern

More difficult to control transmission

Tougher, longer lockdowns to reduce transmission

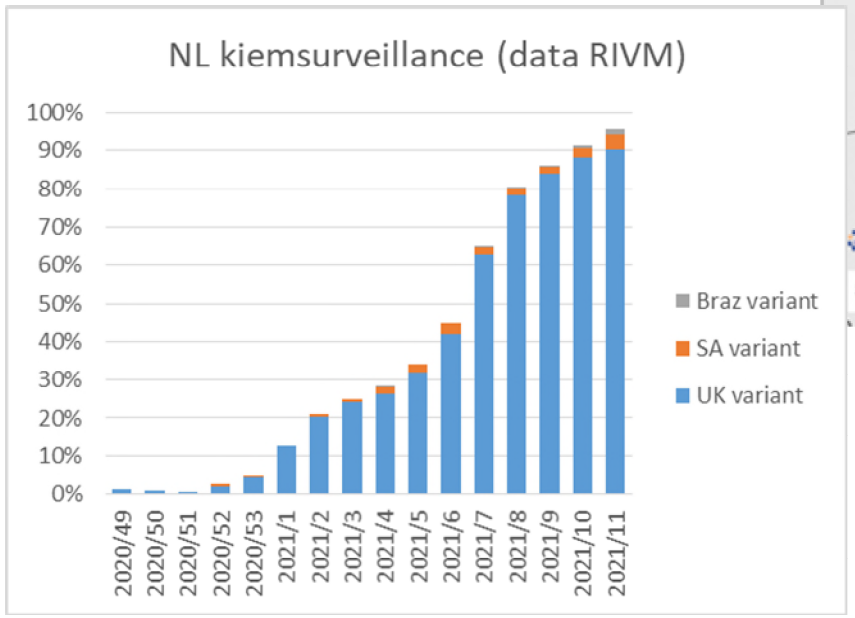
Immunity/vaccination less effective
- Reinfection and illness
- Reinfection and transmission
- Re-vaccination

Role of surveillance

Observe emergence/circulation of new VoC

Understand disease, transmission dynamics

Observe vaccination efficacy to VoC



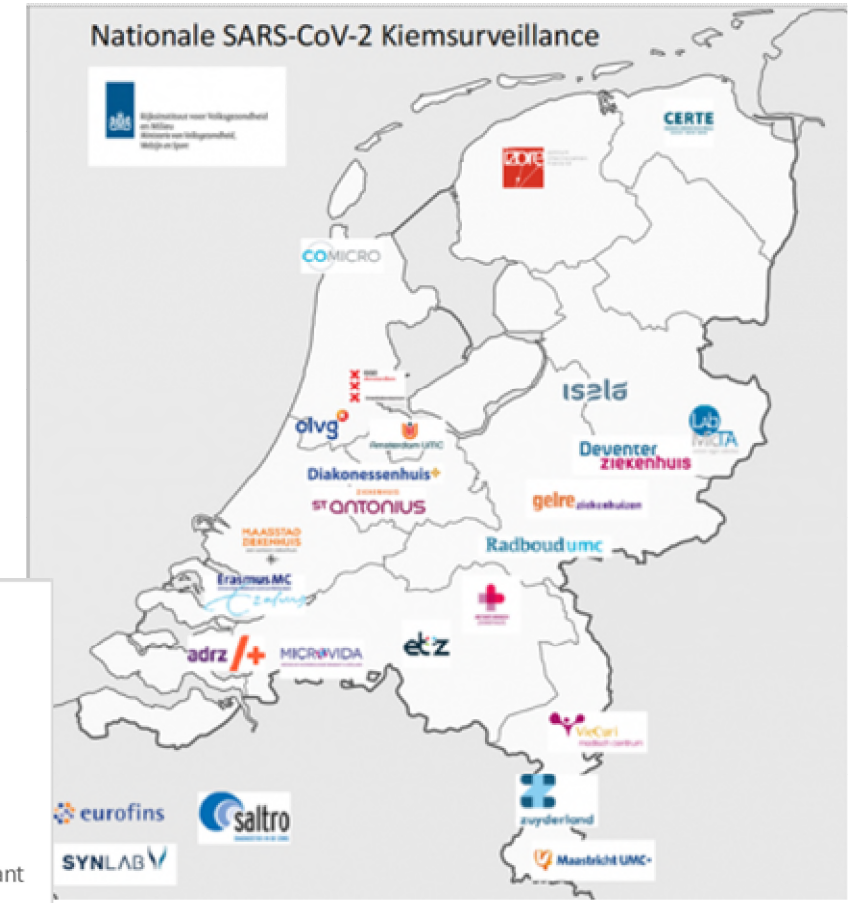


Image: RIVM

The use case of surveillance: trends in SARS-CoV-2 VoC

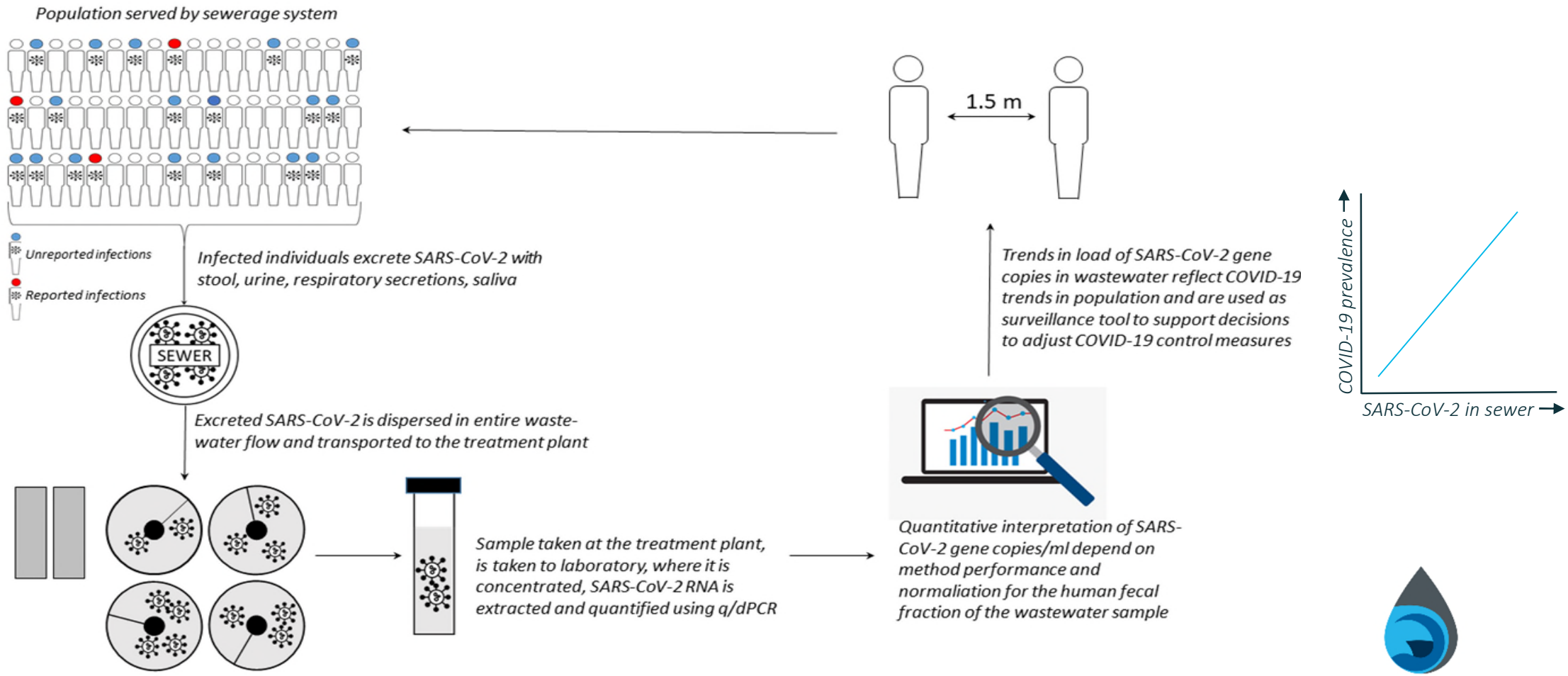


Image: Medema et al., COESH 2021

Detection of variants of concern in wastewater

VoC do not affect the ability to detect SARS-CoV-2 in current surveillance studies

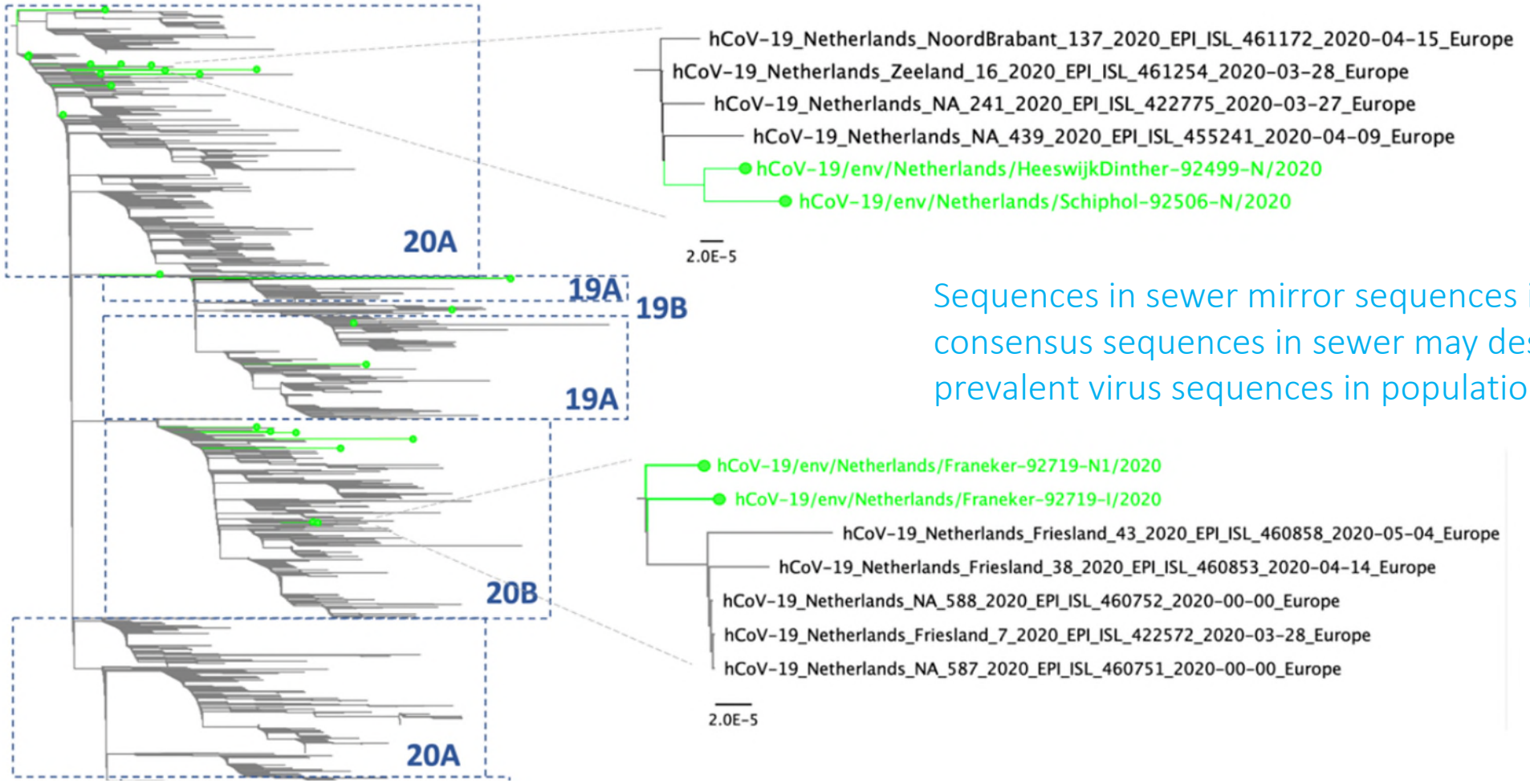
Wastewater is a mixture of variants from multiple cases: more complex methods/bioinformatics needed than for clinical samples

Next generation sequencing of wastewater with bioinformatics to analyse SARS-CoV-2 genomic information

Digital droplet PCR of ‘signature mutations’ of variants of concern

NGS for variant circulation in wastewater

Conducted by Viroscience at Erasmus Medical Centre

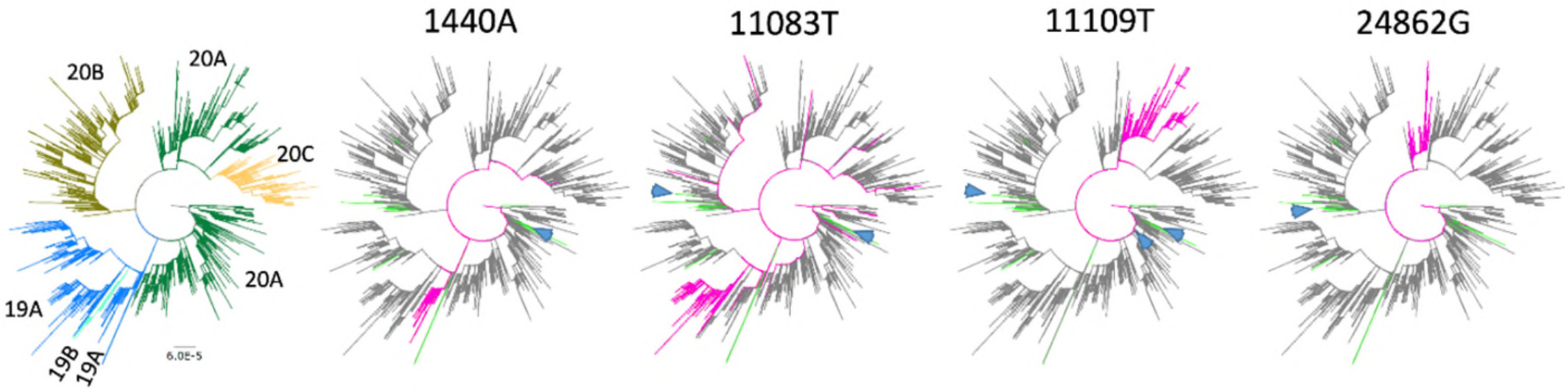


Sequences in sewer mirror sequences in population: consensus sequences in sewer may describe most prevalent virus sequences in population

Lara et al, 2021, EM INF DIS

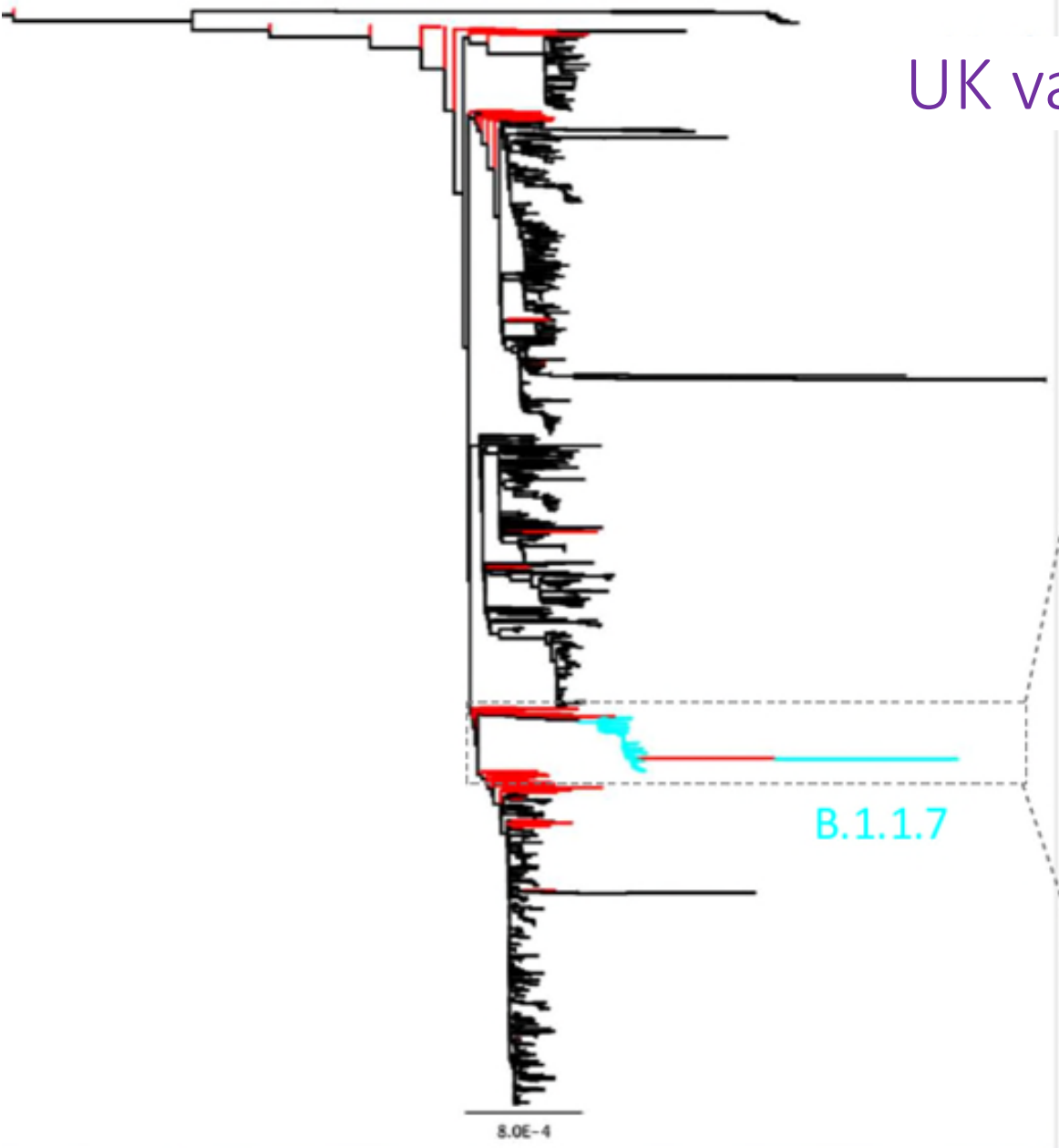
NGS of SARS-CoV-2 mutations in sewage

Conducted by Viroscience at Erasmus Medical Centre



Detection of novel mutations in the virus genome that are not seen in patients

UK variant in Rotterdam wastewater

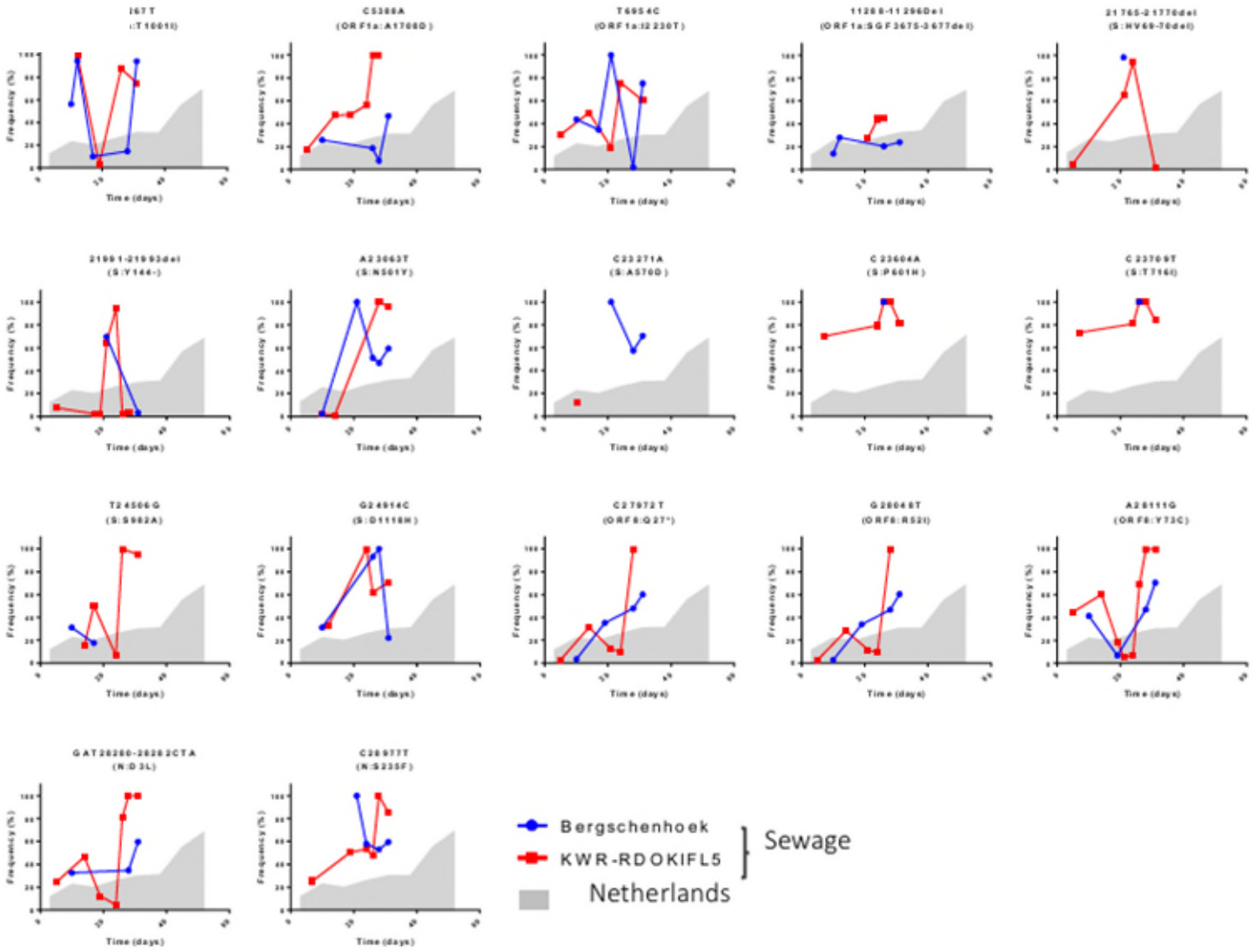


This work is supported by European Unio"s Horizaon 2020 research and innovation programme under Grant No.874735 (VEO).

UK variant mutations/deletions in Rotterdam wastewater

gene	nucleotide	amino acid
ORF1ab	C3267T	T1001I
	C5388A	A1708D
	T6954C	I2230T
	11288-11296 deletion	SGF 3675-3677 deletion
spike	21765-21770 deletion	HV 69-70 deletion
	21991-21993 deletion	Y144 deletion
	A23063T	N501Y
	C23271A	A570D
	C23604A	P681H
	C23709T	T716I
	T24506G	S982A
	G24914C	D1118H
Orf8	C27972T	Q27stop
	G28048T	R52I
	A28111G	Y73C
N	28280 GAT->CTA	D3L
	C28977T	S235F

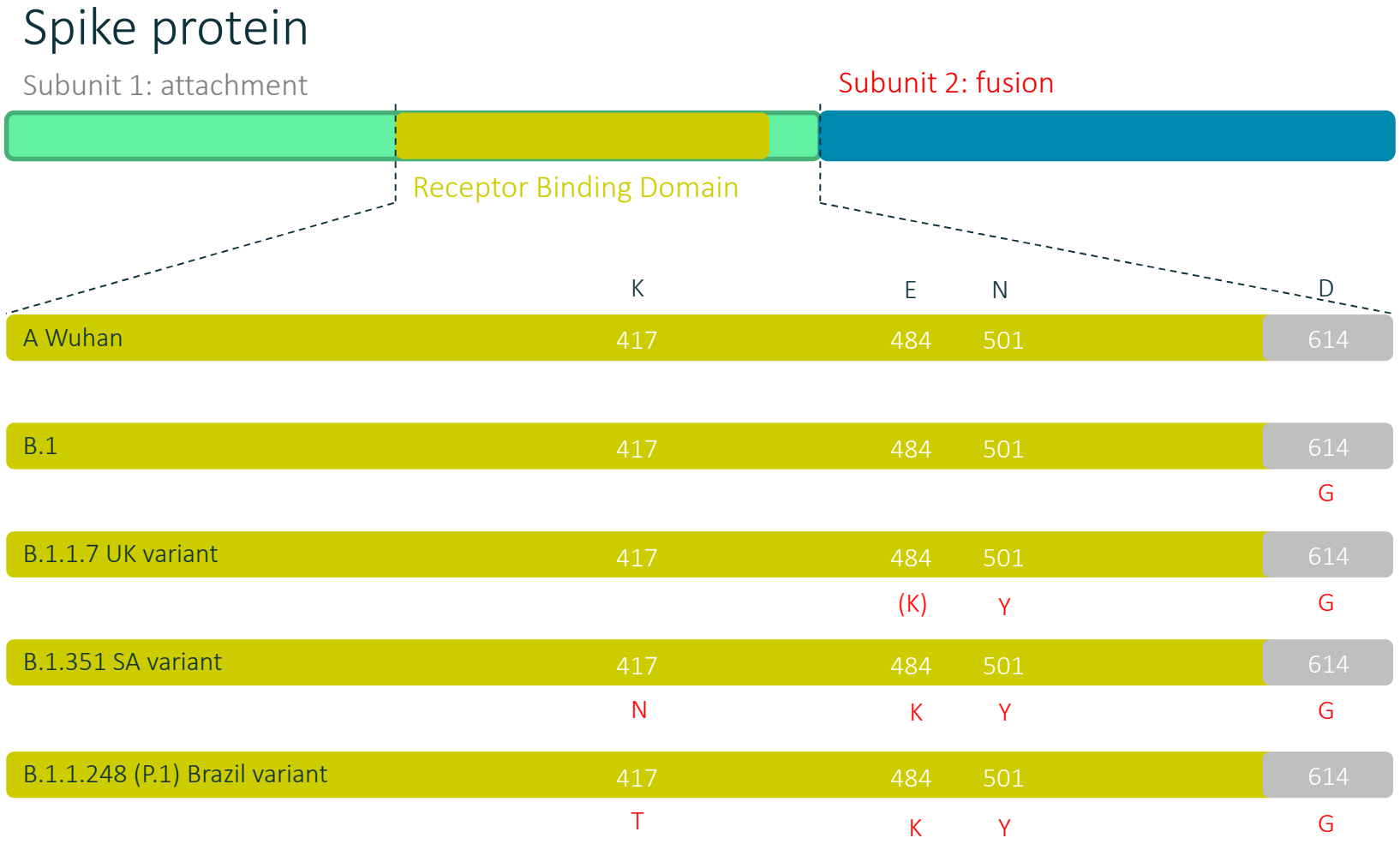
Vanaf 01-01-2021



Versatile Emerging Infectious Disease Observatory

This work is supported by European Unio"s Horizaon 2020 research and innovation programme under Grant No.874735 (VEO).

Variants of Concern: signature mutations



Simultaneous detection of N501Y and Wild Type with multiplex ddPCR

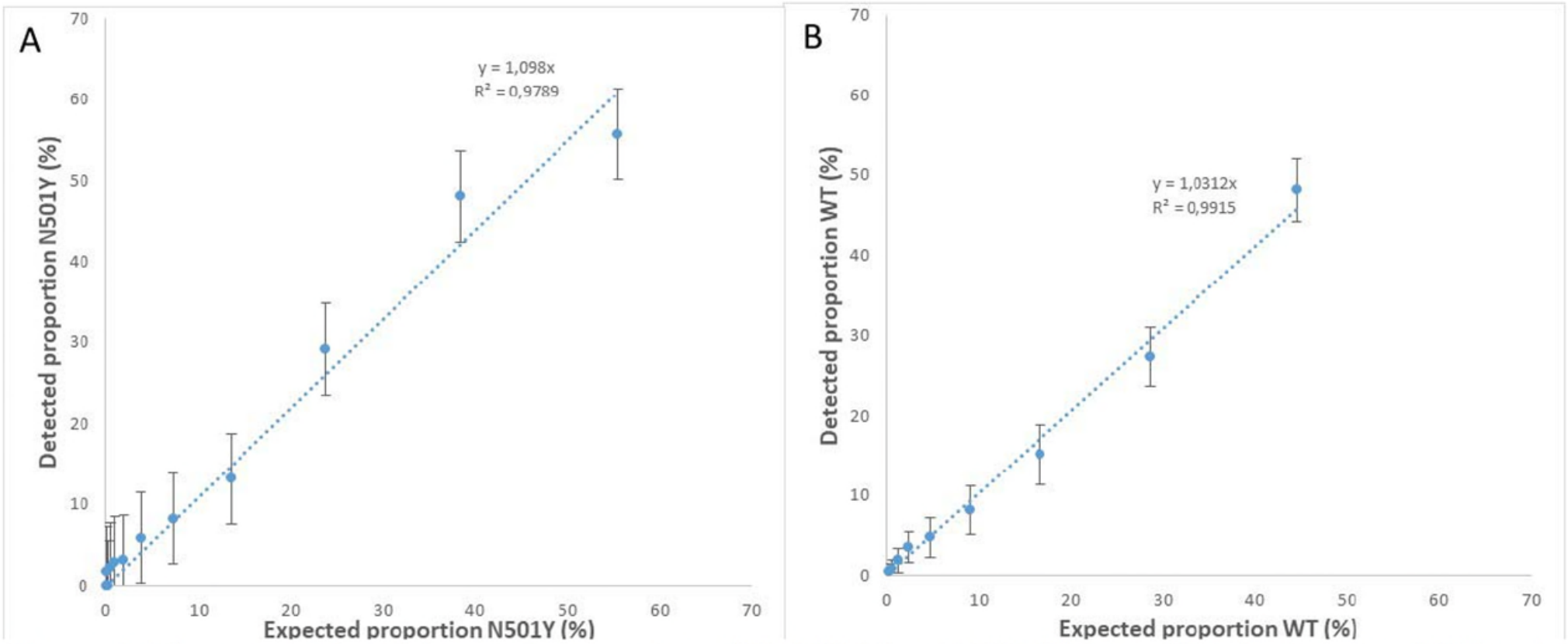
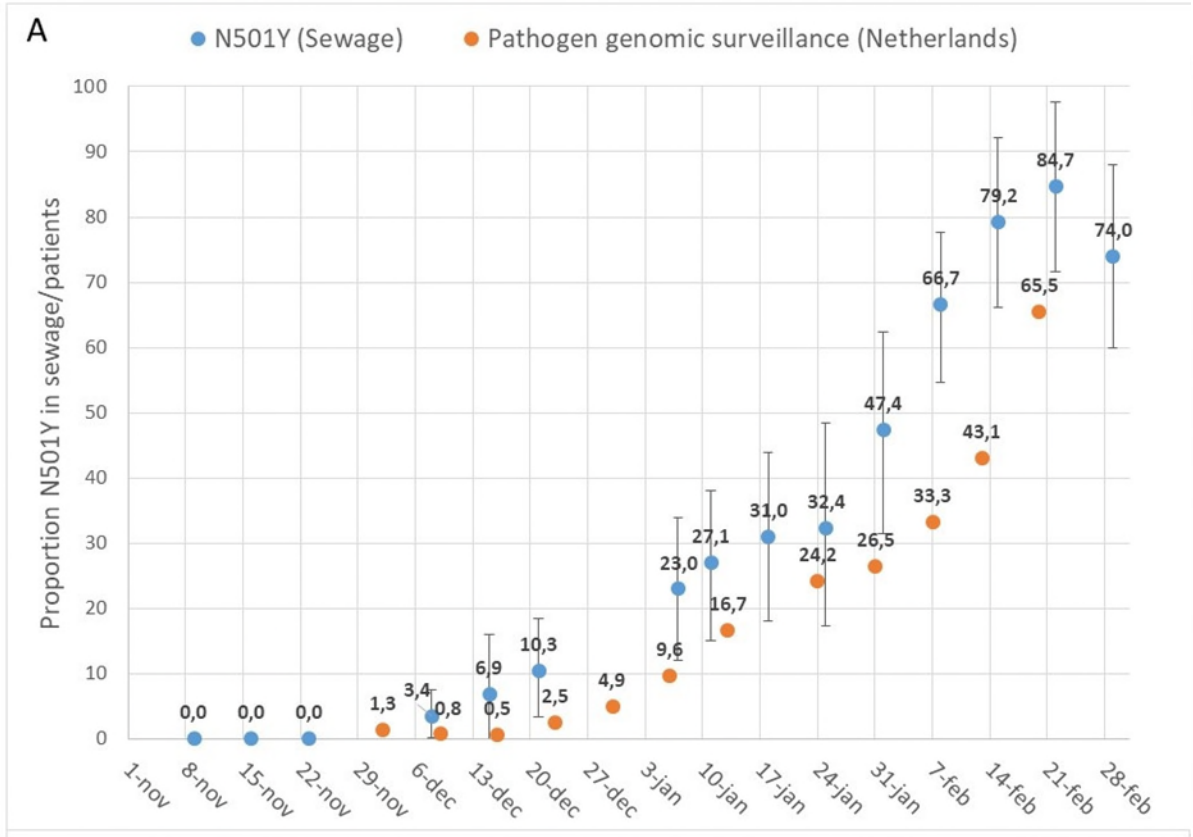


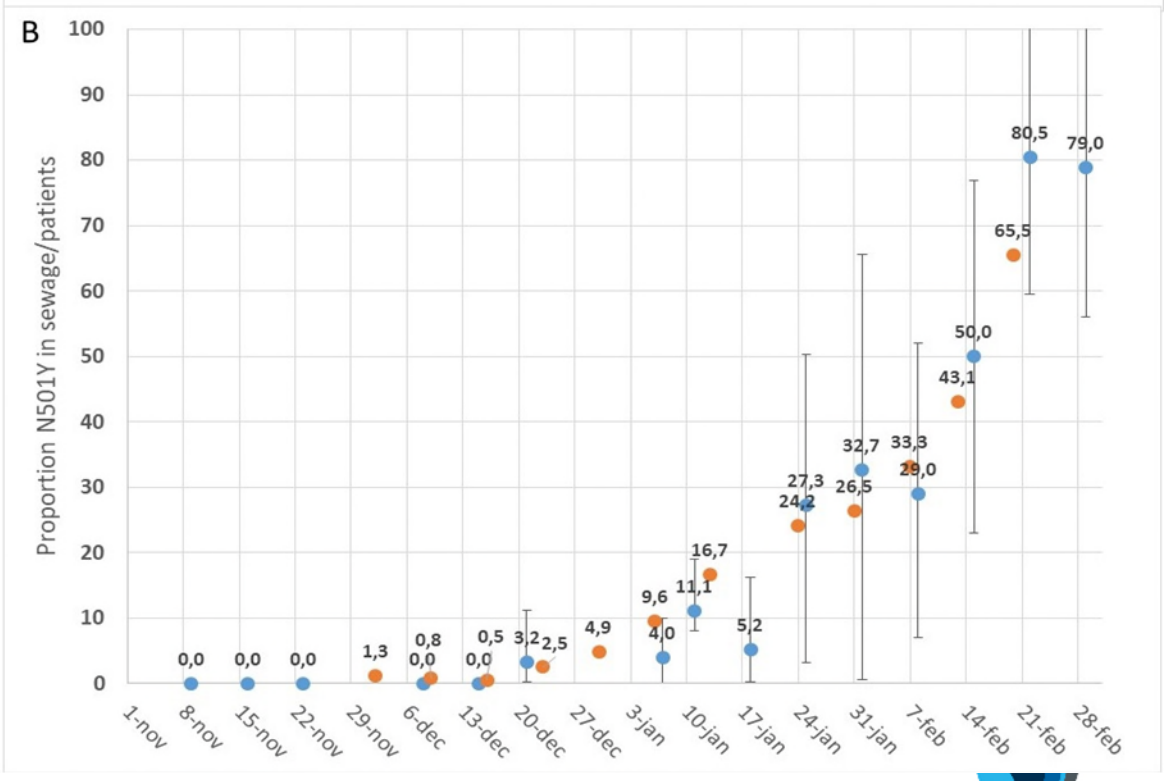
Figure 3. The expected and detected proportion of N501Y (A) and WT (B) in artificial mixtures of WT and lineage B.1.351 as detected by ddPCR.

Heijnen et al, 2021 medxriv

Use case: Variants of Concern introduction N501Y mutation vs 'wild type' by ddPCR



Amsterdam



Utrecht

Wastewater surveillance is of added value for VoC surveillance

Feasible for emergence of (signature mutations of) VoC

Fast (with ddPCR within days, compared to 3-4 weeks for clinical surveillance with NGS)

Efficient: on population sample, allowing high resolution surveillance

EU HERA incubator: recommendation to Member States to apply wastewater surveillance of variants of concern


Thank you
for your
attention
Bridging Science to Practice
Towards a Water-wise World