**University Medicine Essen**
Institute for Artificial Intelligence in Medicine

# Sampling across scales - An experience report on sampling Corona variants from wastewater

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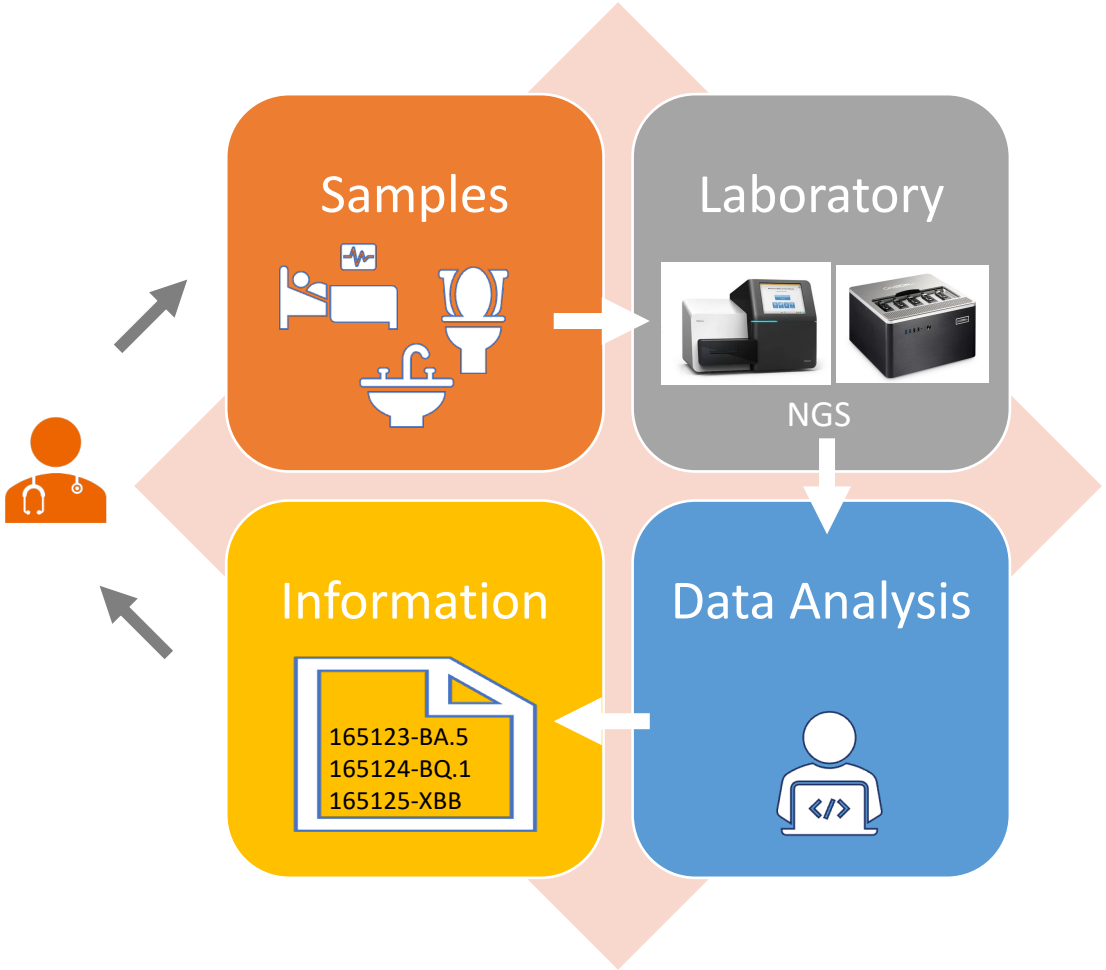
# Institute for Artificial Intelligence in Medicine (IKIM) University Hospital Essen

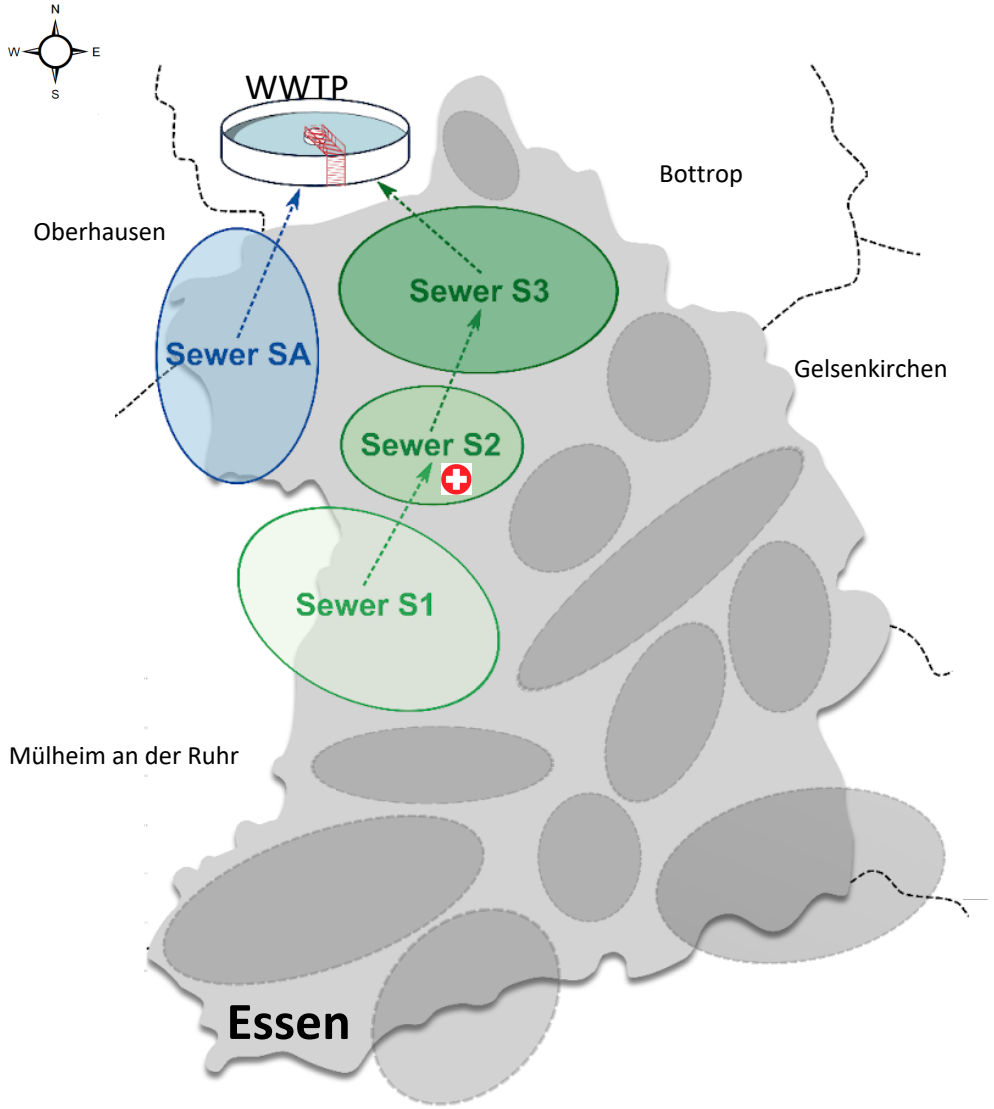



Applying Data Science and **predictive methods:**

- patients (early **prediction** of sepsis, antibiotic resistance)
- environmental surveillance (inside/outside hospital)
- Wastewater-based epidemiology (**predicting** emerging diseases)

*https://ikim.uk-essen.de/groups/ds*

# Complex sampling: the metropolitan Ruhr area




- >4,5 Mio people, many cities, few WWTP
- Complex setup
- **What can we detect at the WWTP?**
- **Can we detect more in the sewer system?**

intra-urban differences ↑ neighborhoods

trends of community infections ↑ (multi)-city

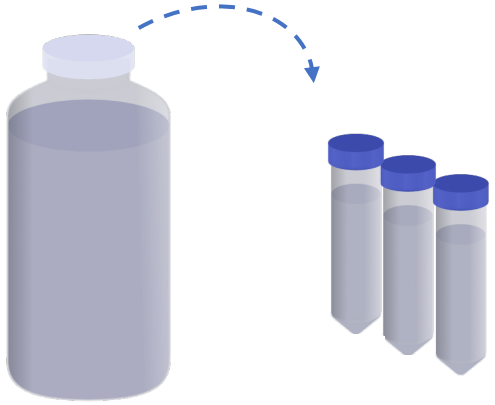
| S1 | S2 | S3 | SA | WWTP |
|---|---|---|---|---|
| 100,218 | 125,512 | 292,012 | 33,932 | >1,4 Million |

- inhabitants represented in sewer

**UK-Essen**: Germany's second largest provider of COVID-care (>10,000 COVID patients)

# From wastewater to SARS-CoV-2 variants

## Sampling/Pre-processing



**24 h Mixed Samples**
1-2 L

**Controls and spike-ins**
BRSV, IC, s-SARS-CoV-2

## Concentration/Extraction

**PEG-NaCl**
3x35 ml

**Nanotraps**
1x50 ml

**Filtration**
2x100 ml

**Power Microbiome kit**
Qiagen

**AnniPath DNA/RNA kit**
InnuPrep - Jena

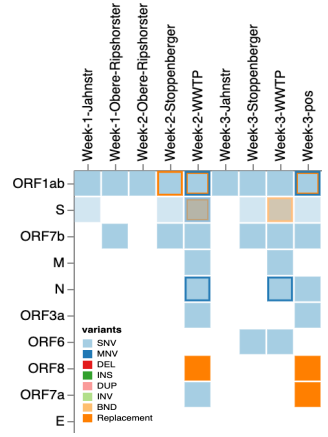
## Sequencing/Quantification

**Tiling amplicon sequencing**
Nimagen
Illumina
Artic

**Illumina Miseq V2**
2x150 bp

**Nanopore**
GridION

**qPCR**
SARS-CoV-2 n1-2; PMMoV; BRSV




UnCoVar Wastewater

- Bovine Respiratory Syncytial Virus (BRSV): viral recovery
- Pepper mild mottle virus (PMMoV): human waste loads
- Internal Control: qPCR (i.e. inhibitors)
- Synthetic non-replicative virus (s-SARS-CoV-2): positive control

https://github.com/IKIM-Essen/uncovar

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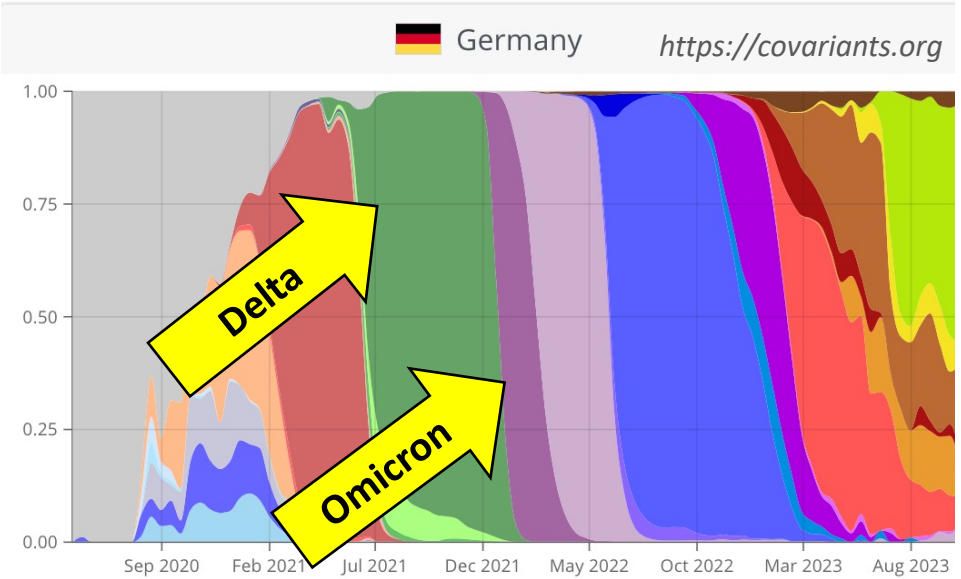
# Sampling in October-December 2021

| | Wastewater | | Patients | |
|---|---|---|---|---|
| Week (2021) | WWTP | Sewer 2 | UK-Essen | DE %BA.1 |
| 25.10 | - | B.1.617.2 | B.1.617.2 | 0 |
| 01.11 | B.1.617.2 | - | B.1.617.2 | 0 |
| 08.11 | B.1.617.2 | B.1.617.2 | B.1.617.2 | 0 |
| 15.11 | - | B.1.617.2 | B.1.617.2 | 0 |
| 22.11 | B.1.617.2; B.1.640 | - | B.1.617.2 | 1 |
| 29.11 | B.1.617.2; B.1.640 | B.1.617.2; **BA.1** | B.1.617.2; B.1.640 | 1 |
| 06.12 | B.1.617.2; **BA.1** | No sample | B.1.617.2; B.1.640 | 8 |
| 13.12 | No sample | No sample | B.1.617.2; B.1.640; **BA.1** | 8 |
| Represented individuals | 10^6 | 10^5 | 5% 10^2 | |




22 Nov 2021 - 06 Dec 2021

| Variant | Num seq | Freq |
|---|---|---|
| 21J (Delta) | 22473 | 0.96 |
| 21I (Delta) | 505 | 0.02 |
| 21K (Omicron) | 195 | 0.01 |
| 21A (Delta) | 110 | 0.00 |
| others | 14 | 0.00 |
| 21L (Omicron) | 2 | 0.00 |

* Patients-data

*Schmiege, Kraiselburd, … Science of The Total Environment, 2023*
*Wilhelm et al, Science of The Total Environment, 2023*

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← First diagnosis in DE 27.11

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- Local sewer 1 week before WWTP

**Early detection of emerging variant: Omicron (BA.1)**

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- Local sewer 1 week before WWTP

- Local sewer 2 weeks before first clinical reported case in UK-Essen

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# Original Omicron timeline

- 24.11.21: 2 passengers BA.1 (Munich)
- 27.11.21: 1st cases confirmed (Munich)
- 27.11.21: 1st case confirmed (Essen)
- 06.12.21: 2nd case confirmed (Essen)
- 13.12.21: 3rd case confirmed (UK-Essen)

# Alternate Omicron timeline

**➔ Circulating already in Essen**

**(additional entry point DUS?)**

24.11.21: 2 passengers enter BA.1 (Munich)

27.11.21: 1st cases confirmed (Munich)

27.11.21: 1st case confirmed (Essen)*

**29.11.21: observed in local sewer (Essen)**

**06.12.21: observed in WWTP (Essen)**

06.12.21: 2nd case confirmed (Essen)*

13.12.21: 3rd case confirmed (UK-Essen)

* ZIP code not sampled (4 out of 23 sewers in Nord Essen)

# What have we learned?

- Wastewater as early warning system
- WWTP seems to require more infections in population for detection
- **First detectable in local sewer: for even earlier warning of emerging VOCs**
- Comprehensive local sampling is resource impossible
  - **Requires models to drive sampling strategies for generating early information for decision makers (Public Health local interventions, Hospital preparedness)**
- Future investigation to define detection limits for local sewers and WWTP

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# *Thank you!!!*


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