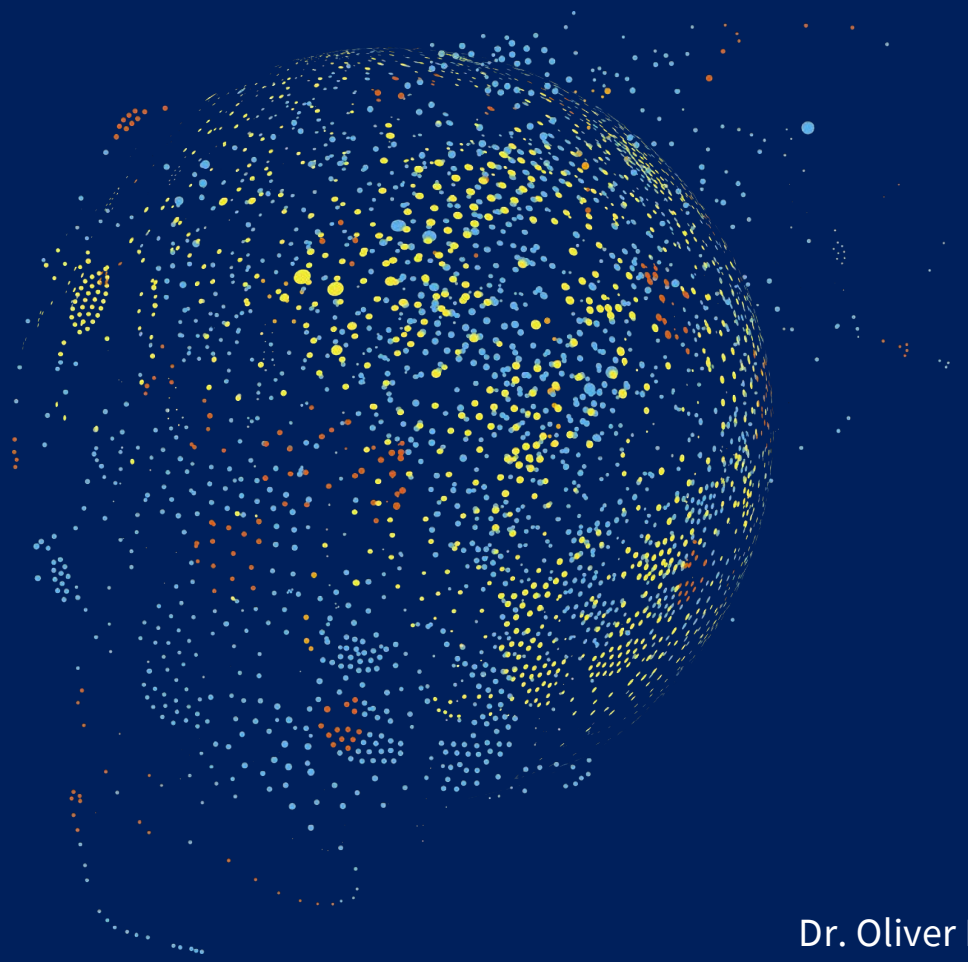
World Health Organization

# HUB

Pandemic and Epidemic Intelligence

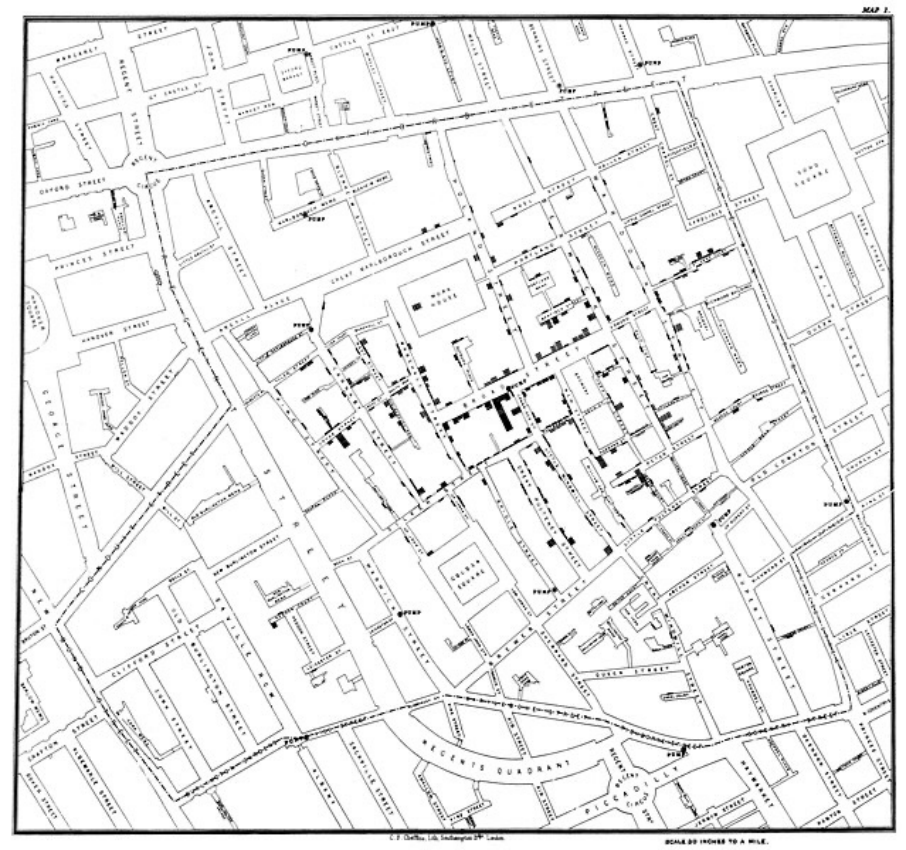


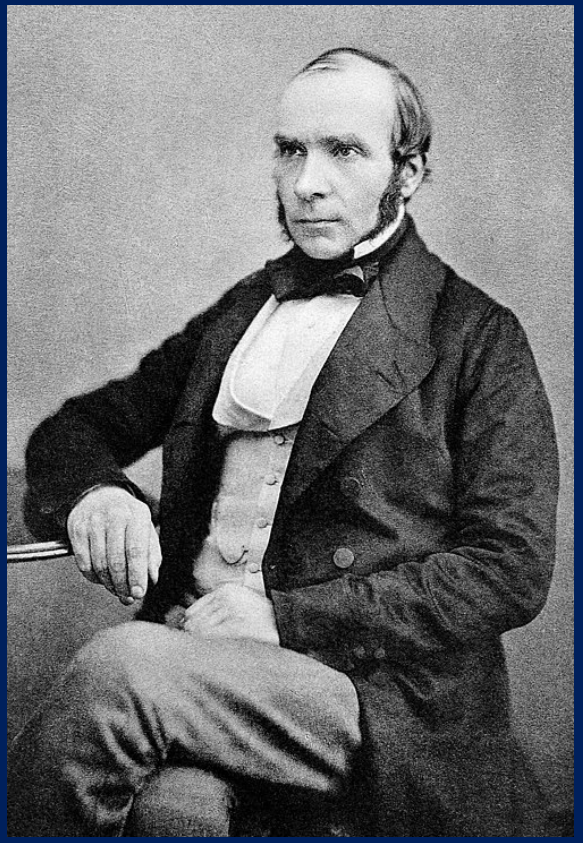
Dr. Oliver Morgan

22 April 2025

# The History of Public Health Intelligence

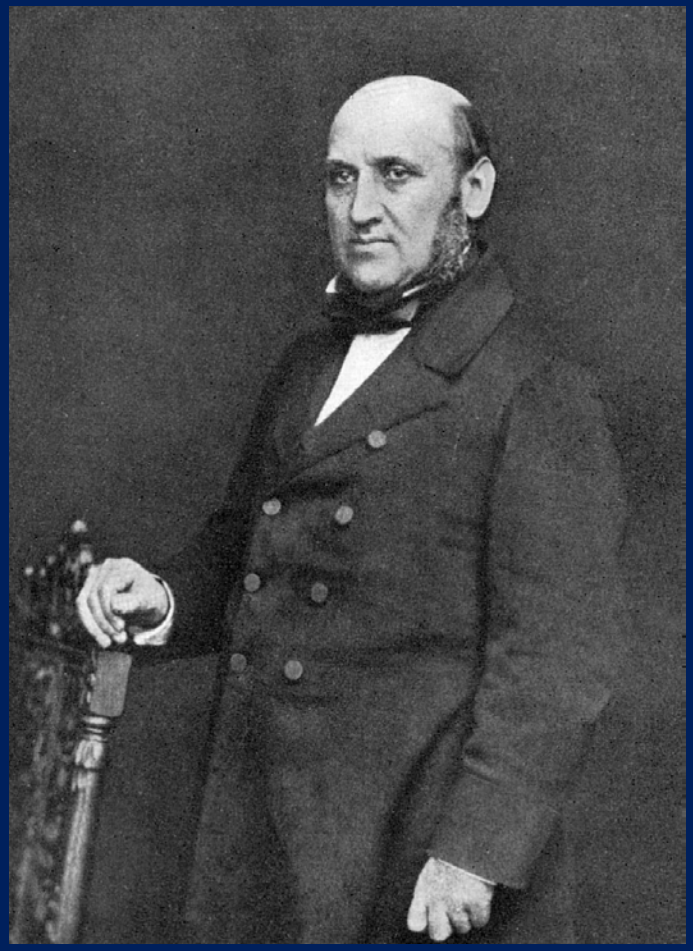
# John Snow 1854



https://www.ph.ucla.edu/epi/snow/highressnowmap.html

# William Farr (1807-1883)



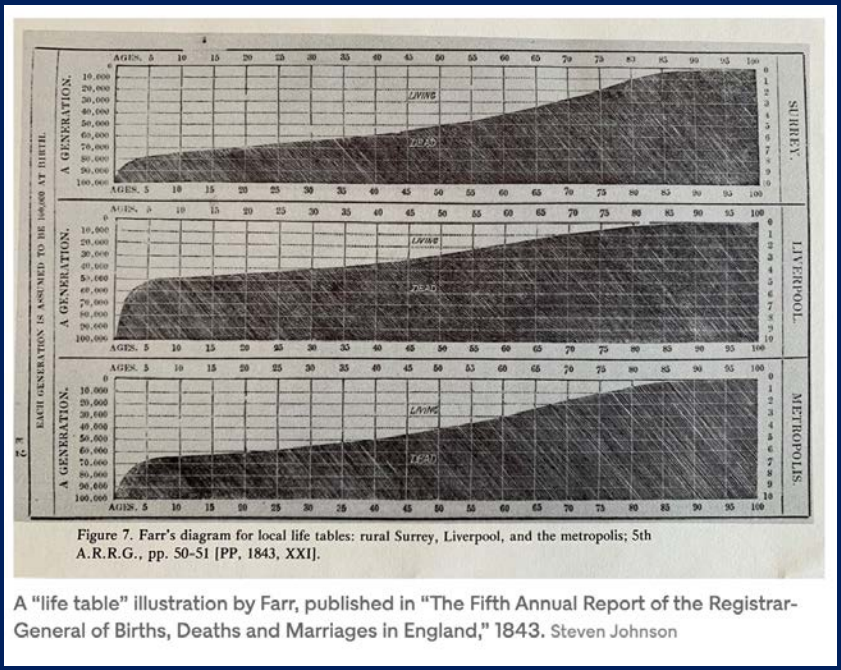
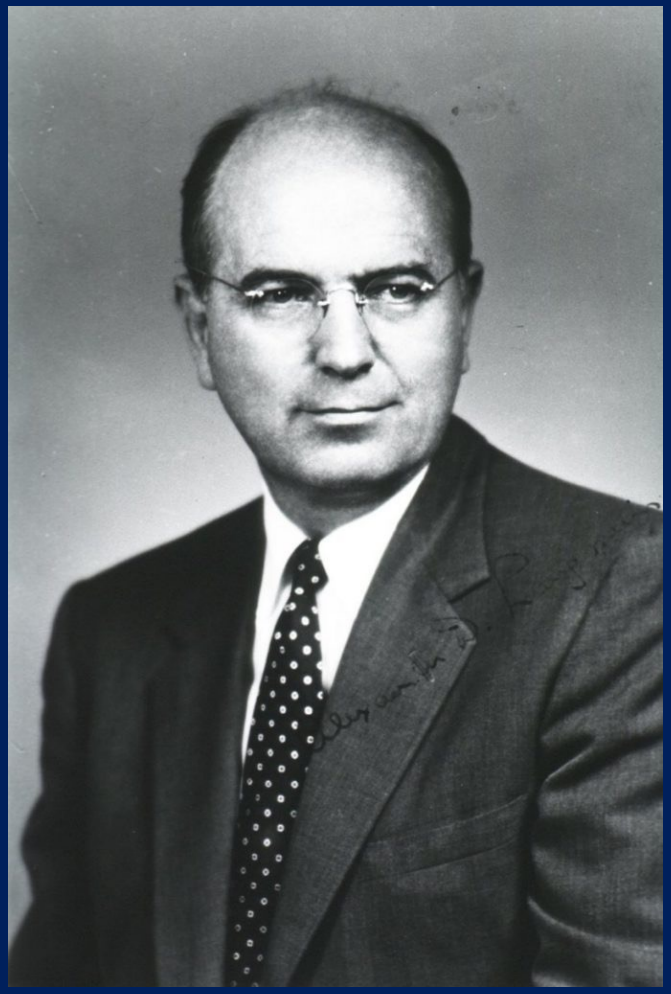



Figure 7. Farr's diagram for local life tables: rural Surrey, Liverpool, and the metropolis; 5th A.R.R.G., pp. 50-51 [PP, 1843, XXI].

A "life table" illustration by Farr, published in "The Fifth Annual Report of the Registrar-General of Births, Deaths and Marriages in England," 1843. Steven Johnson

# Alexander Langmuir (1910-1993)



- Chief Epidemiologist at CDC 1949-1970
- Combined disease surveillance with rapid field investigations
- Described the use of surveillance to drive decision-making as "epidemic intelligence"

# ProMED – 1994

- Stephen Morse
- Jack Woodall
- Barbara Hatch Rosenberg

ProMED mail
Program for Monitoring Emerging Diseases

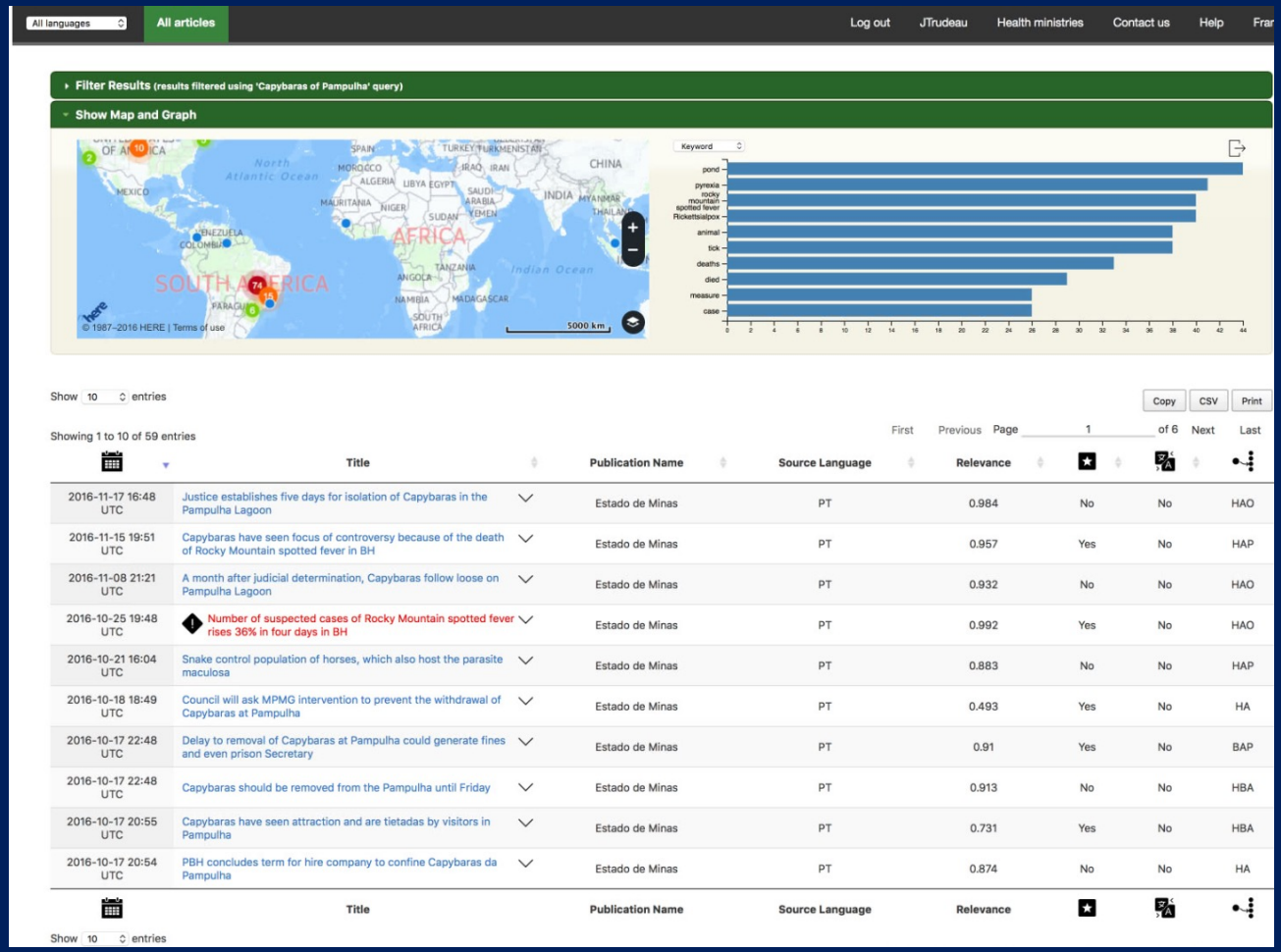
*Source: Nature, 432:544,2004*

# WHO’s Public Heatlh Intelligence Unit Established - 1994

Plague in Surat, India, 1994

*Source: Council on Foreign Relations https://www.cfr.org/blog/surat-yumen-plagued-paranoia*

# Global Public Health Intelligence Network - 1997



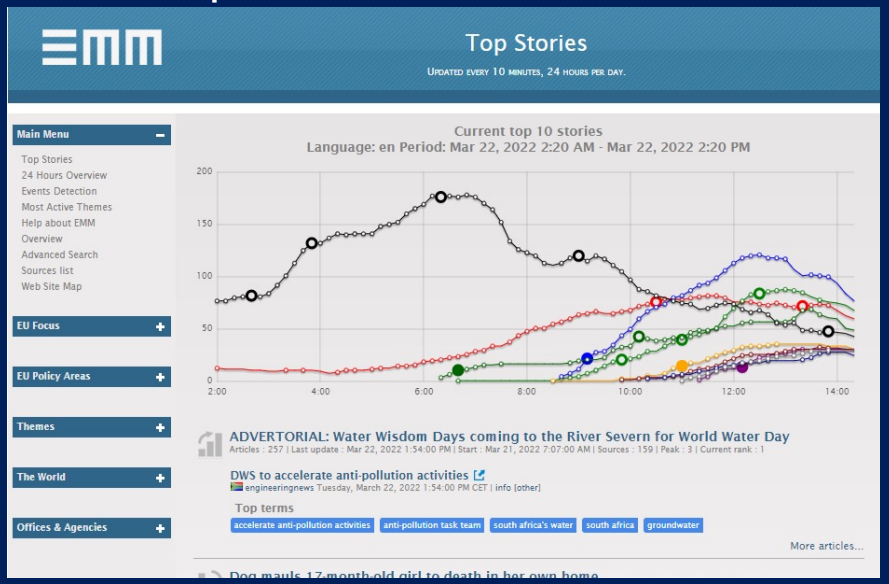

| | Title | Publication Name | Source Language | Relevance | | | |
|---|---|---|---|---|---|---|---|
| 2016-11-17 16:48 UTC | Justice establishes five days for isolation of Capybaras in the Pampulha Lagoon | Estado de Minas | PT | 0.984 | No | No | HAO |
| 2016-11-15 19:51 UTC | Capybaras have seen focus of controversy because of the death of Rocky Mountain spotted fever in BH | Estado de Minas | PT | 0.957 | Yes | No | HAP |
| 2016-11-08 21:21 UTC | A month after judicial determination, Capybaras follow loose on Pampulha Lagoon | Estado de Minas | PT | 0.932 | No | No | HAO |
| 2016-10-25 19:48 UTC | Number of suspected cases of Rocky Mountain spotted fever rises 36% in four days in BH | Estado de Minas | PT | 0.992 | Yes | No | HAO |
| 2016-10-21 16:04 UTC | Snake control population of horses, which also host the parasite maculosa | Estado de Minas | PT | 0.883 | No | No | HAP |
| 2016-10-18 18:49 UTC | Council will ask MPMG intervention to prevent the withdrawal of Capybaras at Pampulha | Estado de Minas | PT | 0.493 | Yes | No | HA |
| 2016-10-17 22:48 UTC | Delay to removal of Capybaras at Pampulha could generate fines and even prison Secretary | Estado de Minas | PT | 0.91 | Yes | No | BAP |
| 2016-10-17 22:48 UTC | Capybaras should be removed from the Pampulha until Friday | Estado de Minas | PT | 0.913 | No | No | HBA |
| 2016-10-17 20:55 UTC | Capybaras have seen attraction and are tietadas by visitors in Pampulha | Estado de Minas | PT | 0.731 | Yes | No | HBA |
| 2016-10-17 20:54 UTC | PBH concludes term for hire company to confine Capybaras da Pampulha | Estado de Minas | PT | 0.874 | No | No | HA |



Government of Canada / Gouvernement du Canada

# Other Notable Public Health Intelligence Platforms

## European Media Monitor 2002

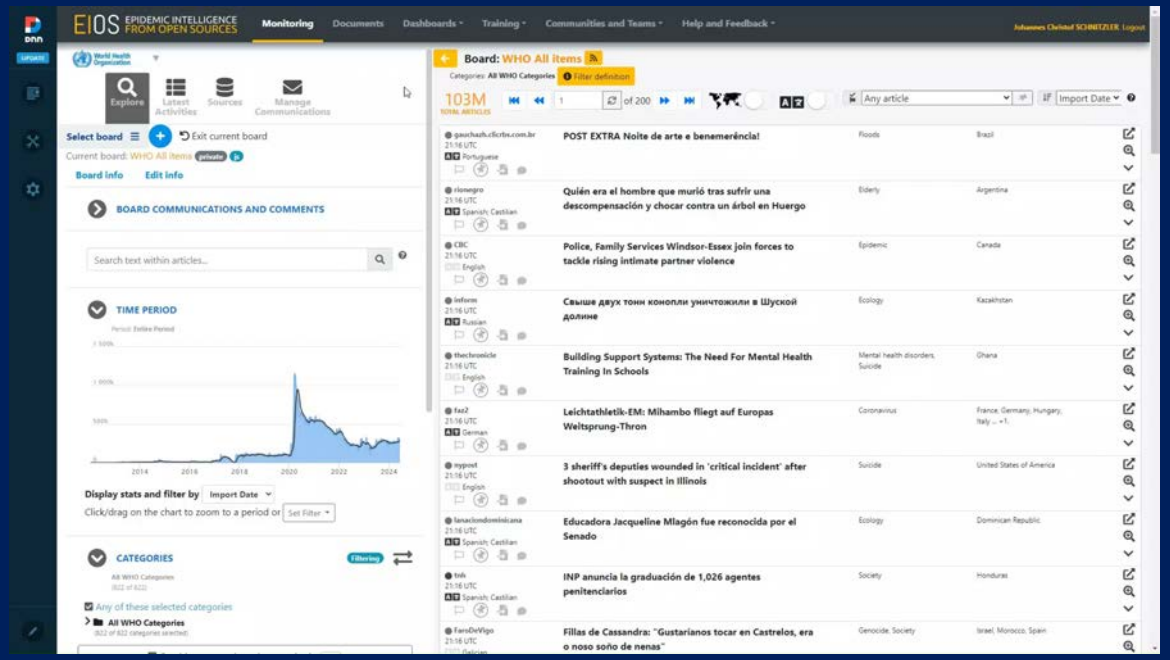



## HealthMap 2006

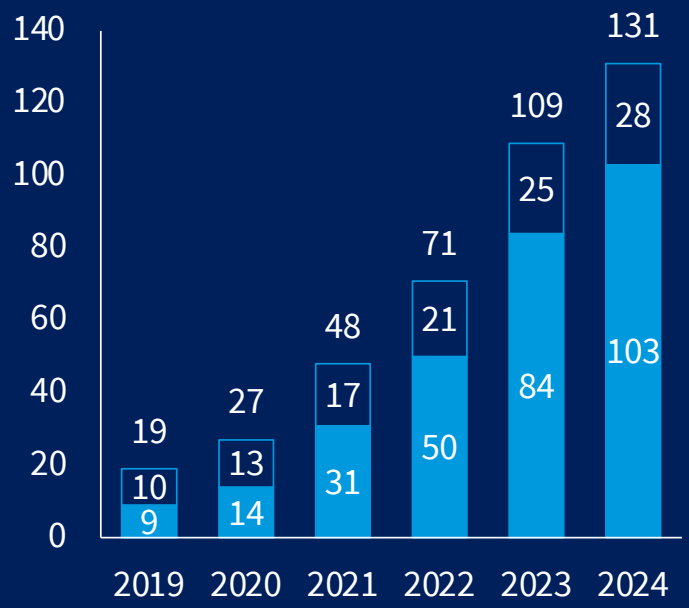
# Global Health Security Initiative: Early Alert and Response - 2001

Canada, France, Germany, Italy, Japan, Mexico, the United Kingdom, the United States and the European Commission. WHO is an observer.

# Epidemic Intelligence from Open Sources - 2017




## EIOS Communities: Cumulative Growth*




* All communities have relevant training, enabling them to effectively use the EIOS system. Communities can be Member States, regional CDCs, as well as other organizations and networks. Relevant entities, including Member States , can join the initiative individually or as part of a network (e.g. GHSI).

EIOS
EPIDEMIC INTELLIGENCE FROM OPEN SOURCES

A GLOBAL INITIATIVE LED BY THE WORLD HEALTH ORGANIZATION

BEACON
Biothreats Emergence, Analysis, and Communications Network

Boston University Center on Emerging Infectious Diseases

# Advances in Global Disease Surveillance: An Introduction to BEACON

Featured speakers:

**Dr. Robbie Goldstein**
Commissioner, MA Dept. of Public Health

**Yvonne Hao**
Secretary, MA Executive Office of Economic Development

April 24, 2025
2:00-6:30pm EST

665 Commonwealth Ave, Room 1750, Boston (Hybrid)

Operated in Collaboration with:

HARIRI INSTITUTE

Boston Children's Hospital

HealthMap

# Emerging Challenges for Public Health Intelligence

# Pandemic and Epidemic Risks are Inherently Uncertain

**Uncertainty before a pandemic or epidemic**

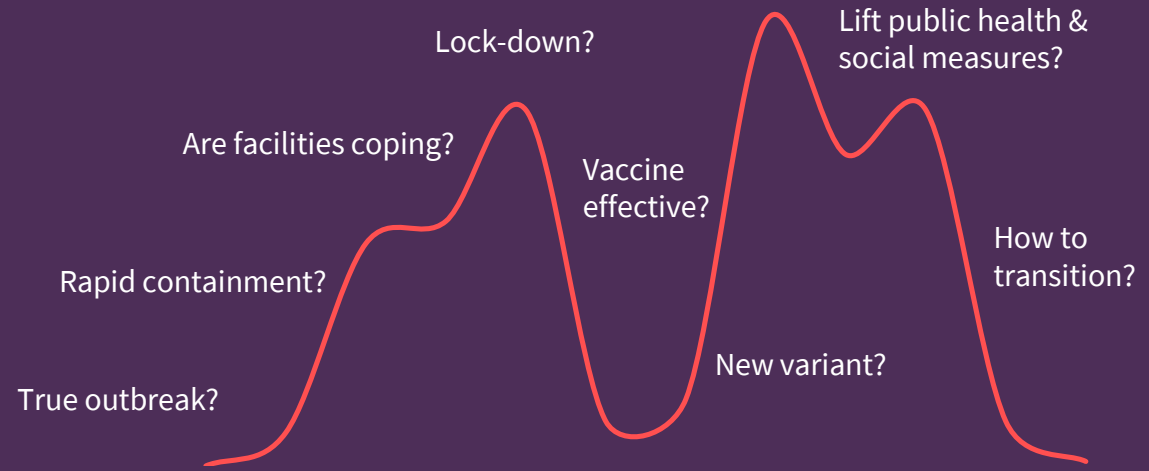
Pathogen?

Where?

Severity?

When?

**Uncertainty during a pandemic or epidemic**

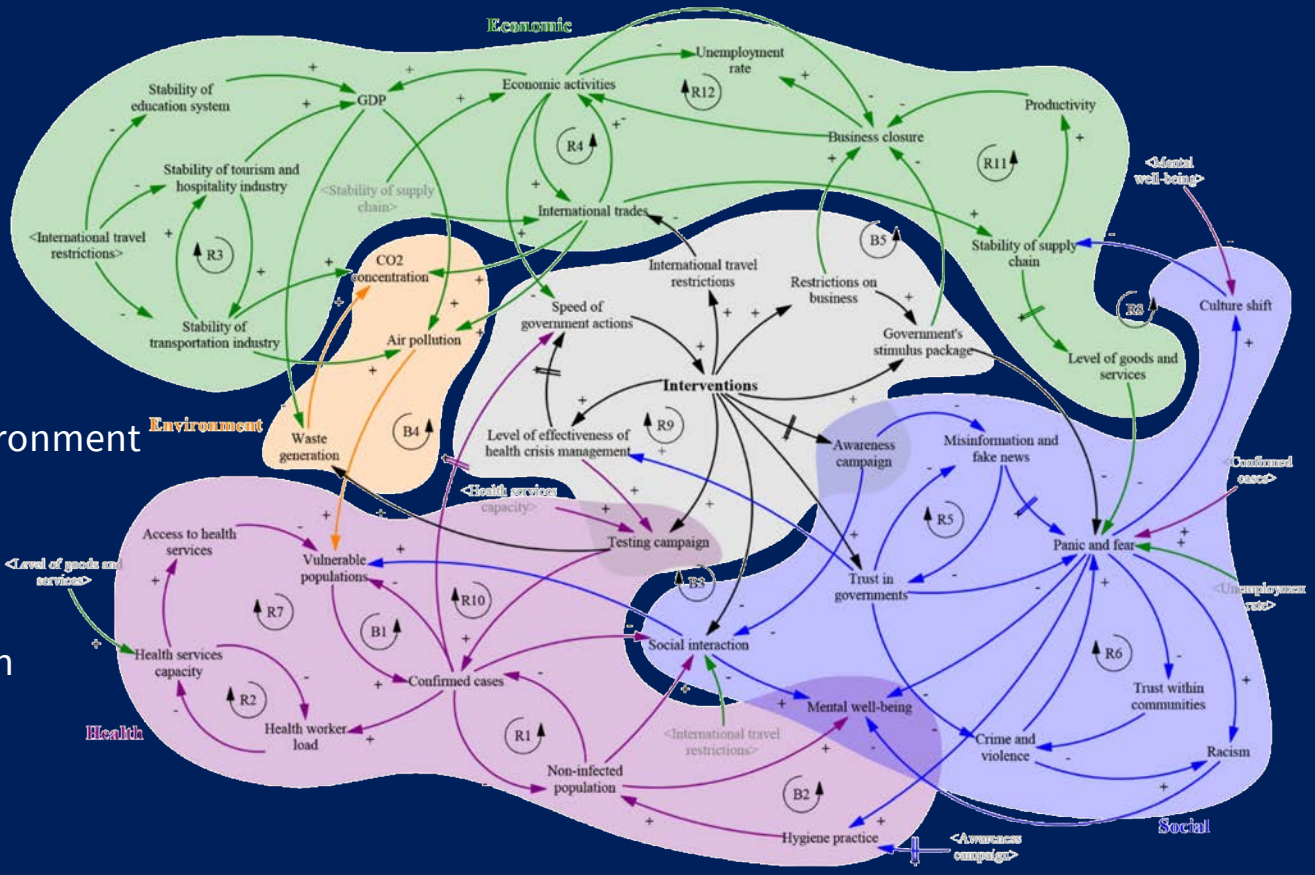


# Public Health Risks are Multi-dimentional

Economic

Environment

Health




Social

Source: Sahin O et al. Developing a Preliminary Causal Loop Diagram for Understanding the Wicked Complexity of the COVID-19 Pandemic. Systems. 2020; 8(2):20.

# Public health decisions must be informed by triangulation of many surveillance inputs

Every public health decision must flexibly draw from **multiple pieces of evidence…**

… by triangulating inputs from multiple **surveillance & other sources**

…requiring sophisticated **people, processes & technology**

***Decisions:***

- ✓ Overall scale of response
- ✓ Selection & targeting of direct protection
- ✓ Selection & targeting of transmission reduction
- ✓ Balance of investments across types of measures
- ✓ Intervention timing & logistics; scale up plan
- ✓ Scale back plan

***Evidence***

- Transmissibility
- Overall severity per case
- Relative severity by host and viral characteristics
- Expected timing & duration of epidemics
- Number of infected to date, by age, region
- Estimated effectiveness of control measures

***Surveillance inputs***

- Confirmed case counts
- Syndromic surveillance
- Outbreak investigations
- Clinical case series
- Serological data
- Surveys
- Hospital-based data
- Viral surveillance

*Other sources (non-exhaustive)*

- Demographics
- Mobility data
- Socio-economic context
- Climate

***Assets***

- People
- Processes
- Technology

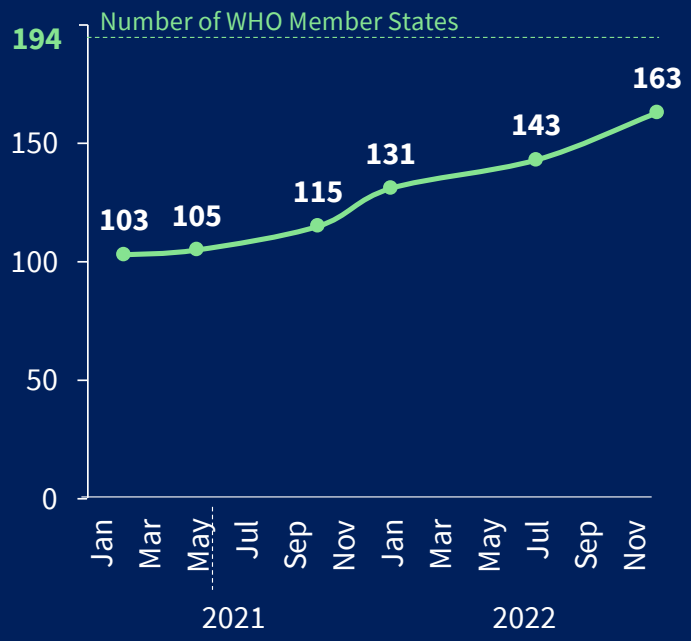


*Source: Lipsitch M & Santillana, Curr Top Microbiol Immunol 2019:424:59-74*

# Innovation Landscape within the Surveillance Domain

## Laboratory Science

**Timely in-country access to SARS-CoV-2 genetic sequencing capability**
Number of Member States, 2021-2022




Source: WHO Regional Offices, as of 31 December 2022 (link to progress report).

## Data Science

**258,000+ Github repositories on COVID-19**
Jan 2020 – Feb 2024

# Future Opportunities for Public Health Intelligence

# The journey of the WHO Hub to date

2021

2022

2023

2024+

# Highlights to strengthen pandemic and epidemic intelligence

## Convenings & workshops

**Over 80 convenings** hosted at the Hub with **3500 participants**

## Regional partnerships & networks

**IPSN** – International Pathogen Surveillance Network

**NPHA** – National Public Health Agencies

**HSPA** – Health Security Partnership in Africa

## Institutional partnerships

**7 Memoranda of Understanding** signed with public health, academic institutions & foundations

**20+ partner staff** at the WHO Hub

# The WHO Hub has Reformed the Way we do Business

**Staff-to-activity ratio**
30% of Hub cost to staff cost;
70% to activities

**Rapid talent acquisition**
53 staff hired in three years

**Agile workforce composition**
50%+ of workforce are secondees, academic partners, consultants

**Important convener in Berlin**
From 2023-24, 3500+ guests for 80+ meetings, events, visits

**Leveraged new funding**
>33M US$ mobilized beyond German grant towards surveillance priorities

**Rapid procurement**
WHO Hub needs 33% less time for high value procurements

**Effective grant allocation**
100% of German investment allocated by end of grant period

**Project management office**
Clear project management methodology, governance and accountability

# EIOS v.2.0 – Platform Re-architecture for Better Partnerships

EIOS
EPIDEMIC INTELLIGENCE FROM OPEN SOURCES
A GLOBAL INITIATIVE LED BY THE WORLD HEALTH ORGANIZATION

New partnership model and re-architecture support a strengthened, sustainable, and scalable EIOS system with more frequent, iterative improvements...

## EIOS v.1 - current

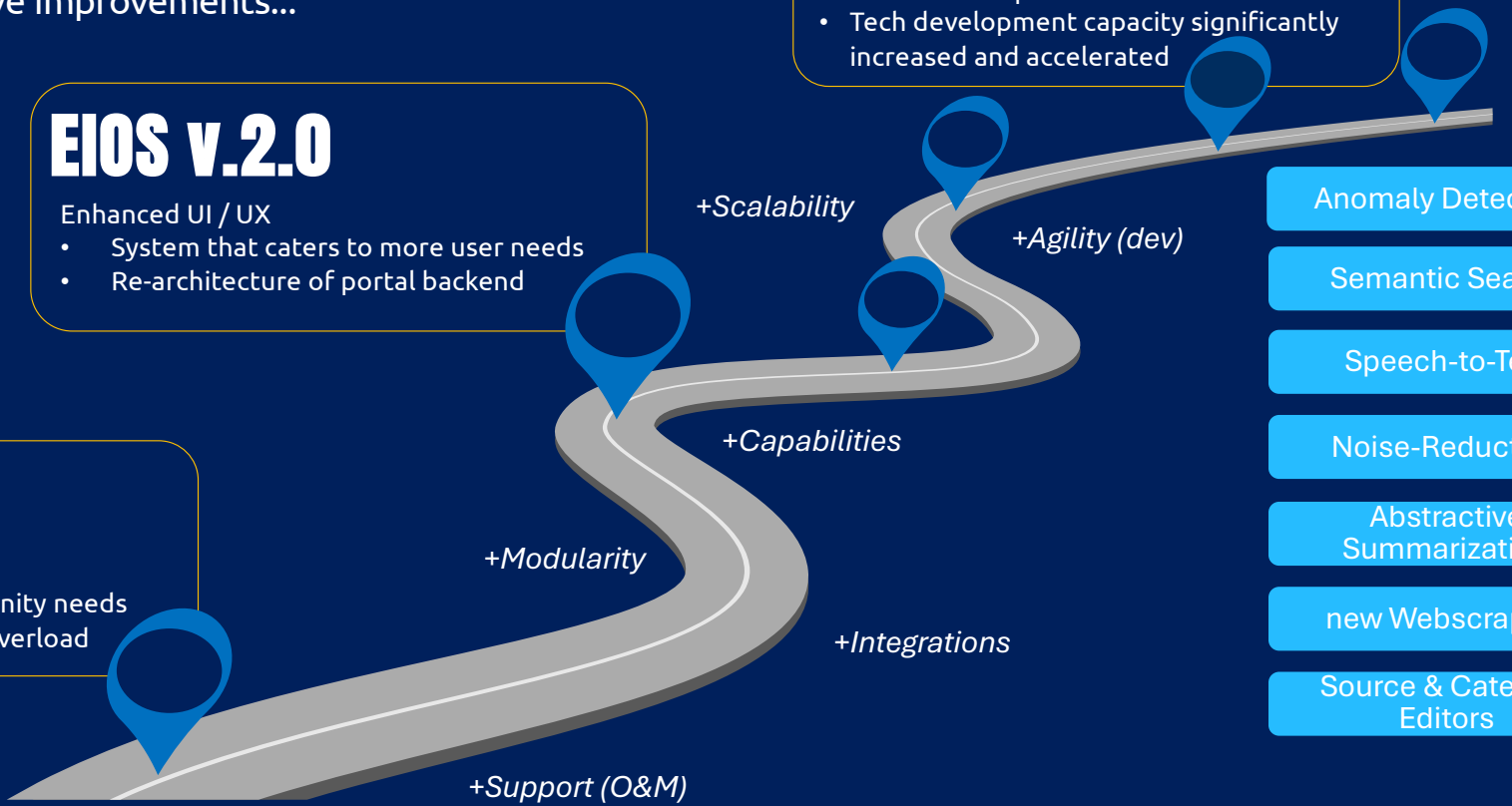
Limited system capabilities
- Time to respond to community needs
- Users report information overload

## EIOS v.2.0

Enhanced UI / UX
- System that caters to more user needs
- Re-architecture of portal backend

## EIOS v.2+

Advanced and optimized
- Tech development capacity significantly increased and accelerated




- Anomaly Detection
- Semantic Search
- Speech-to-Text
- Noise-Reduction
- Abstractive Summarization
- new Webscraping
- Source & Category Editors

World Health Organization

# Speech to text – Listening to Radio Stations Online and locally

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Unite-Wave EIOS Social listening platform

EIOS System

FM Radio signals transferred

Online Radios

News from rural communities

World Health Organization HUB Pandemic and Epidemic Intelligence

UNITED NATIONS OICT

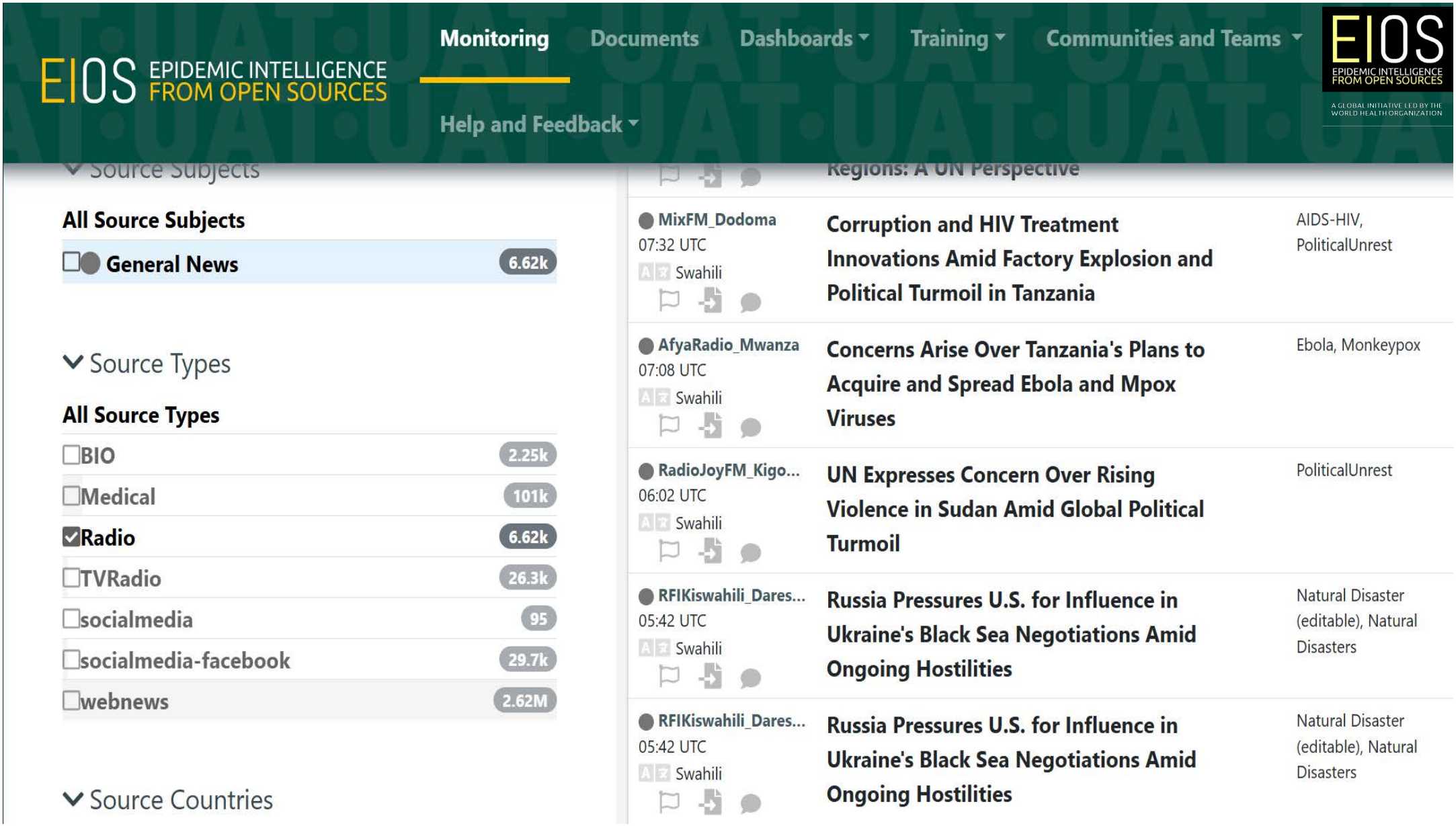
WHO African Region

EIOS EPIDEMIC INTELLIGENCE FROM OPEN SOURCES

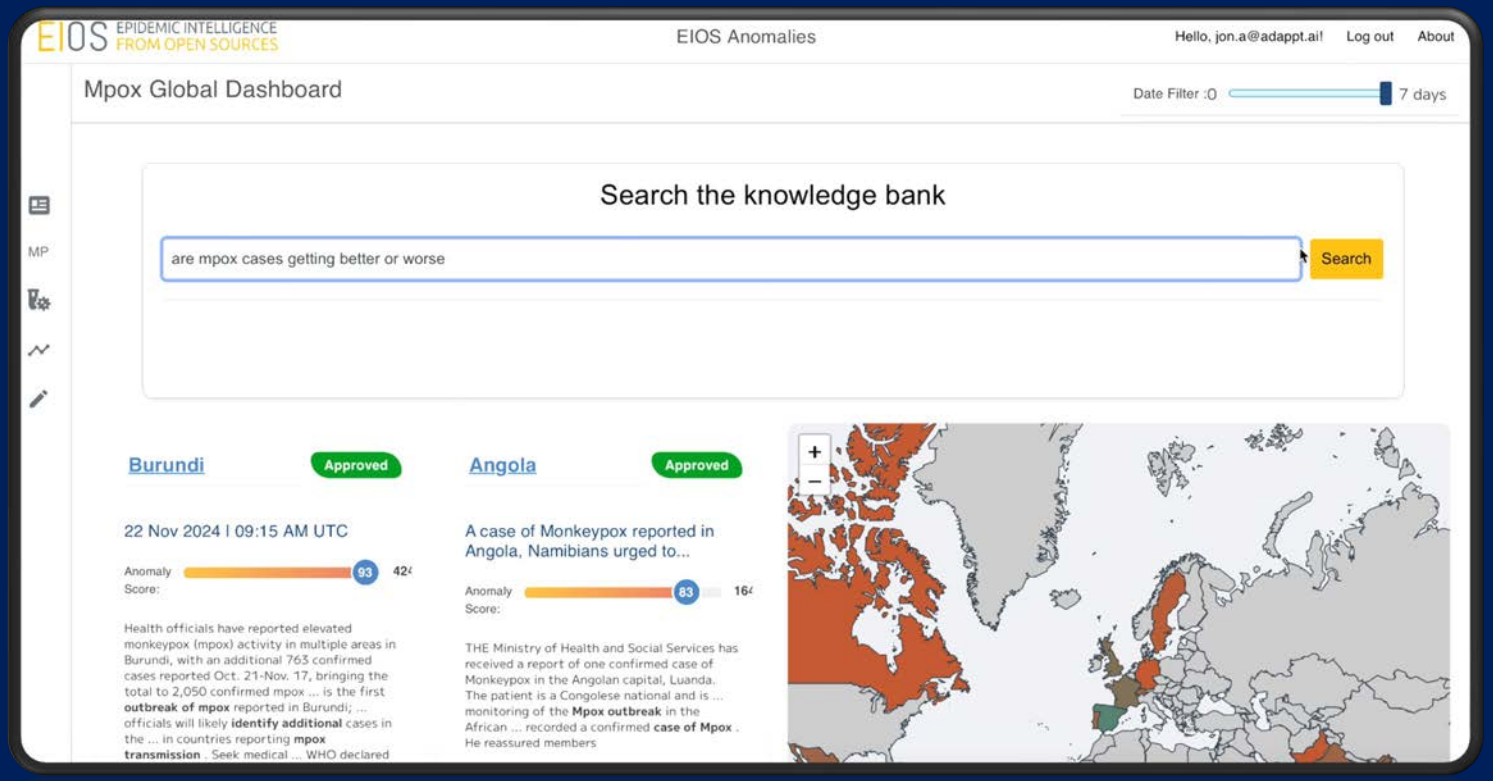
Joint Research Centre JRC

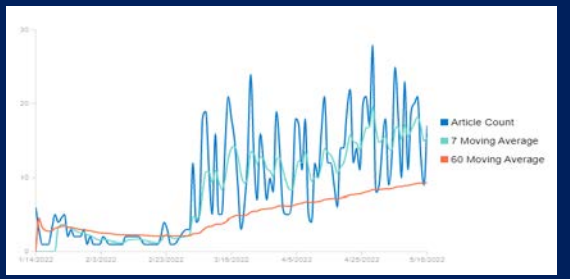
Real-time monitoring

rld Health
janization


EIOS EPIDEMIC INTELLIGENCE FROM OPEN SOURCES
Monitoring
Documents
Dashboards
Training
Communities and Teams
Help and Feedback
EIOS
EPIDEMIC INTELLIGENCE FROM OPEN SOURCES
A GLOBAL INITIATIVE LED BY THE WORLD HEALTH ORGANIZATION
Source Subjects
All Source Subjects
General News 6.62k
Source Types
All Source Types
BIO 2.25k
Medical 101k
Radio 6.62k
TVRadio 26.3k
socialmedia 95
socialmedia-facebook 29.7k
webnews 2.62M
Source Countries
Regions: A UN Perspective
MixFM_Dodoma
07:32 UTC
Swahili
Corruption and HIV Treatment Innovations Amid Factory Explosion and Political Turmoil in Tanzania
AIDS-HIV, PoliticalUnrest
AfyaRadio_Mwanza
07:08 UTC
Swahili
Concerns Arise Over Tanzania's Plans to Acquire and Spread Ebola and Mpox Viruses
Ebola, Monkeypox
RadioJoyFM_Kigo...
06:02 UTC
Swahili
UN Expresses Concern Over Rising Violence in Sudan Amid Global Political Turmoil
PoliticalUnrest
RFIKiswahili_Dares...
05:42 UTC
Swahili
Russia Pressures U.S. for Influence in Ukraine's Black Sea Negotiations Amid Ongoing Hostilities
Natural Disaster (editable), Natural Disasters
RFIKiswahili_Dares...
05:42 UTC
Swahili
Russia Pressures U.S. for Influence in Ukraine's Black Sea Negotiations Amid Ongoing Hostilities
Natural Disaster (editable), Natural Disasters

# Anomaly Detection and Semantic Search





EIOS EPIDEMIC INTELLIGENCE FROM OPEN SOURCES

EIOS Anomalies

Hello, joshua.b@adappt.ai!

# Mpox Global Dashboard

0 8+ Date Filter: 8+ days

MP

## Search the knowledge bank

Type your question... Search

### Rwanda

Approved

Sex, a Hex and a Sick Child Offer Clues to...

Anomaly Score: 87 2615

On Sept. 30, 2023, an anxious father brought his 5-year-old son to the hospital in Kamituga, a muddy, bustling town carved out of the thick forest in the eastern Democratic ... boy had a **high fever** and oozing sores ... months later, the **new strain** of the virus ... have adapted to **spread more easily and quickly between people. More than 62,000 cases** of mpox have ... had its first-ever **case of mpox** , they were ... have been infected. **Mpox transmission**...

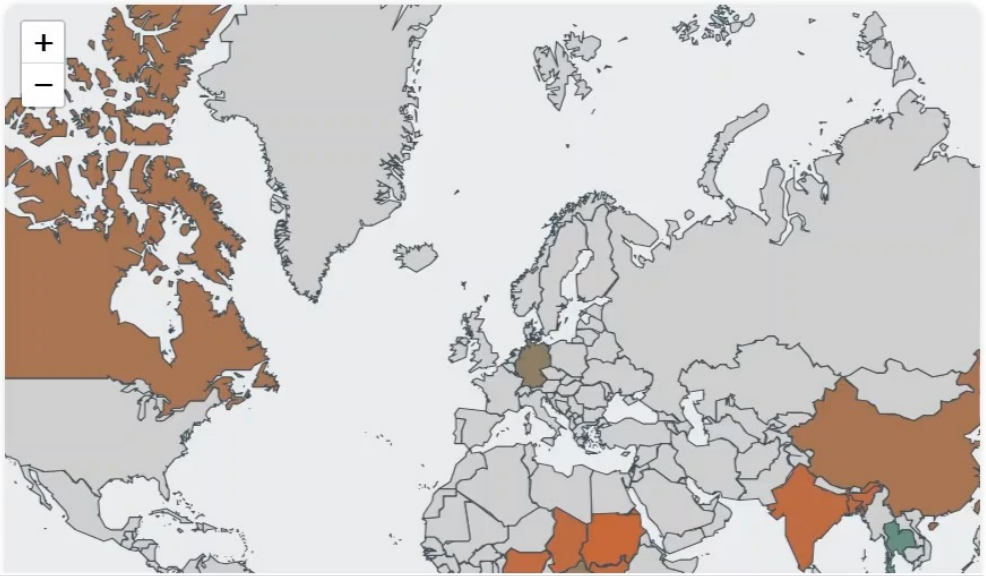
### Brazil

Approved

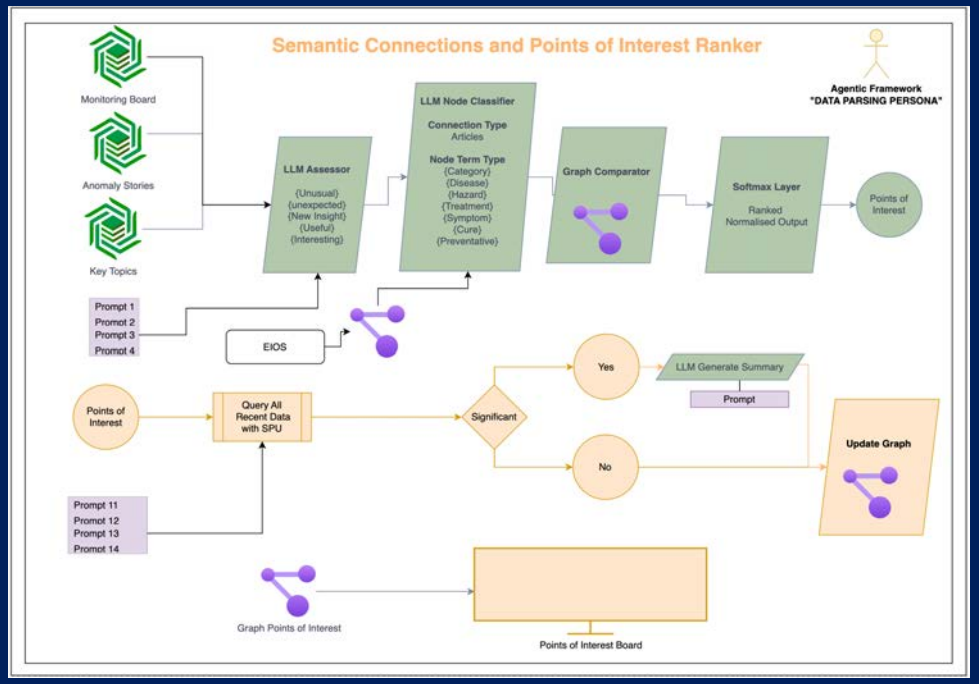
Digital Tools and Analytics in the Fight Against Mpox

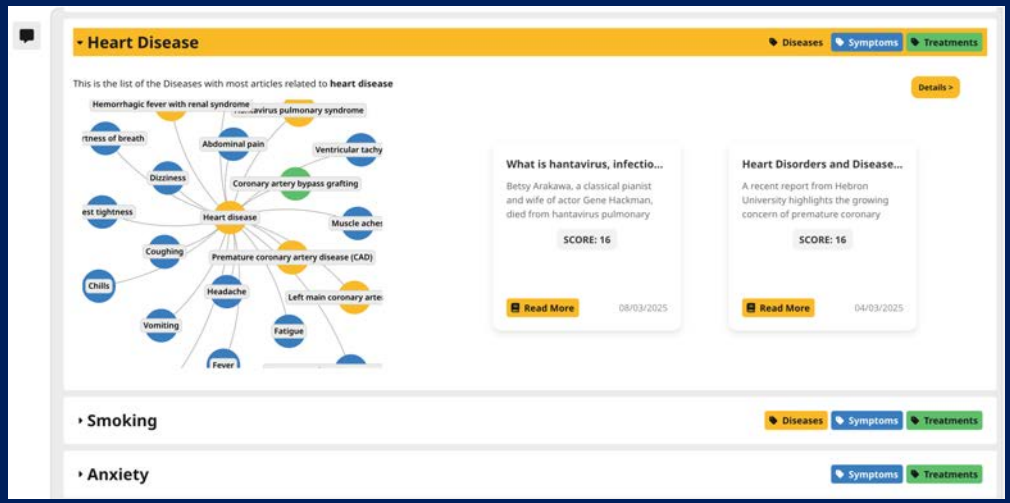
Anomaly Score: 88 2943

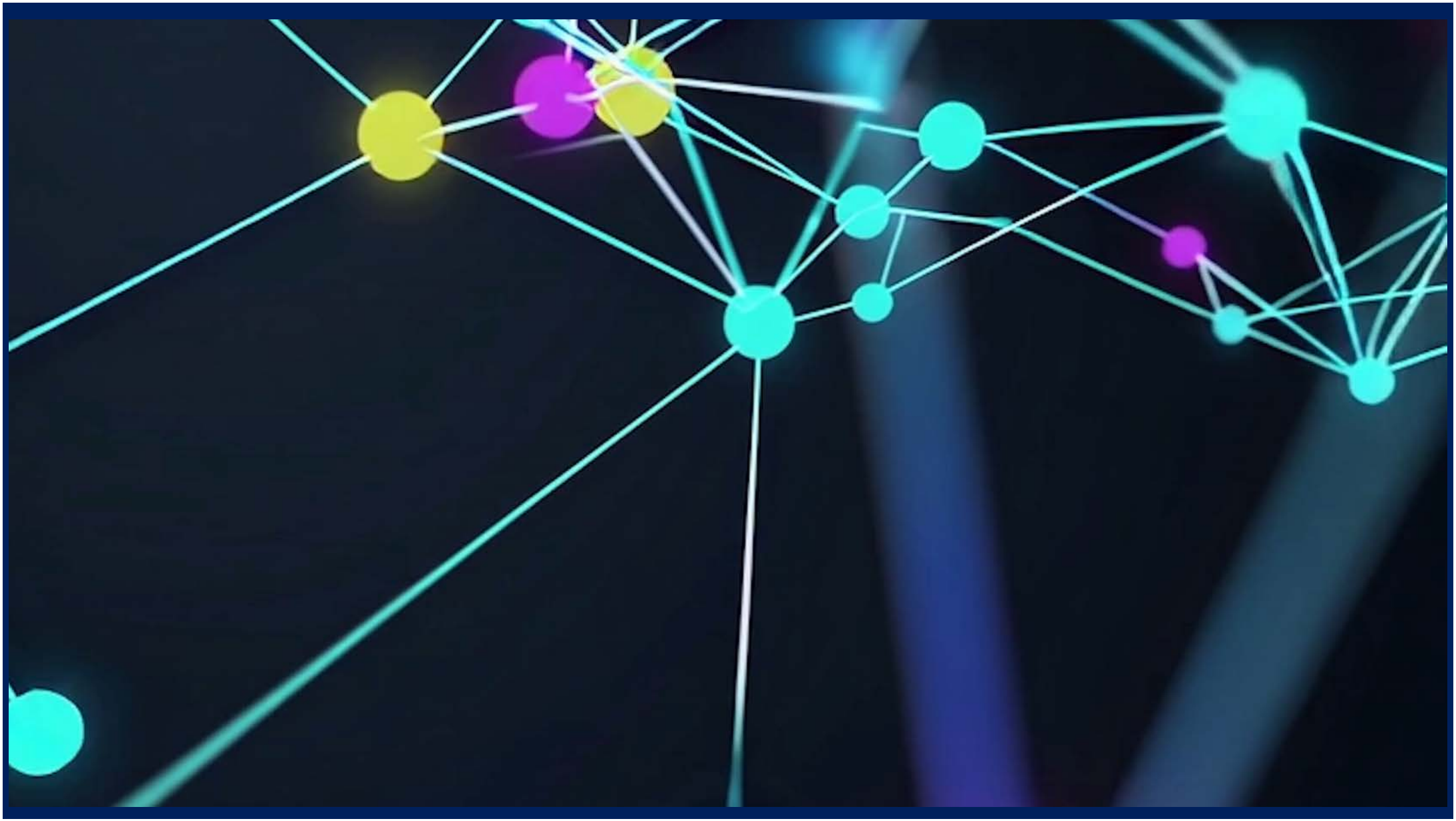
**threat. The virtual meeting, organized by the WHO Hub for Pandemic and Epidemic Intelligence and partners, focused on fostering collaborative actions and leveraging innovative solutions in response to the evolving mpox outbreak** . The meeting ... 2023, a concerning **upsurge of mpox** cases, particularly in ... during the initial **mpox outbreak** . Experiences shared ... responding to the **mpox outbreak** . Dr. Julia ... analyzing ellipses of **mpox outbreaks** . He underscored ... Go.Data, contributing to ...



# Creating a Living Knowledge Graph with Agentic AI





# Using Pathogen Genomics for Public Health Intelligence

International Pathogen Surveillance Network
235 Partners in 85 Countries

- Communities of Practice to solve common challenges
- Country Scale-up Accelerator to enable exchange & amplify country voices
- Catalytic grant fund to support member projects
- PGS advocacy & communications
- Convene partners to share progress and innovations

*Countries in which active IPSN partner organizations are located, *excl. countries in which global/regional organizations are HQ*

IPSN International Pathogen Surveillance Network

# Products from the IPSN

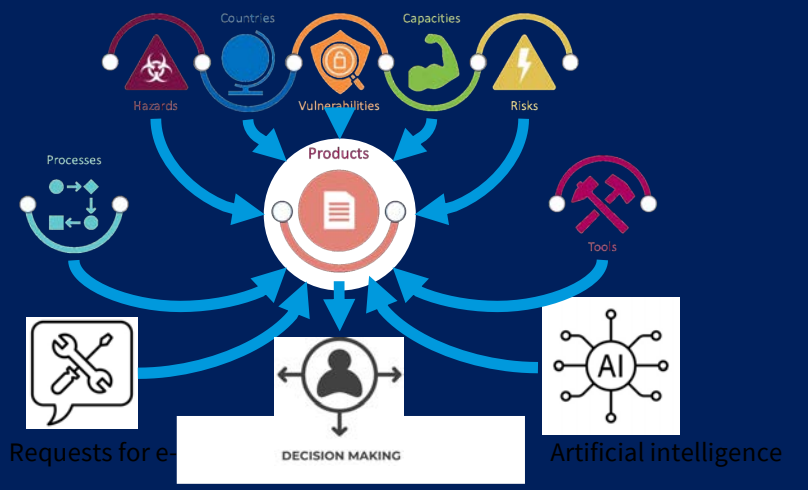
# WHO All-Hazard Information Management Toolkit (WHO EMRO)

Country- and hazard-specific resources

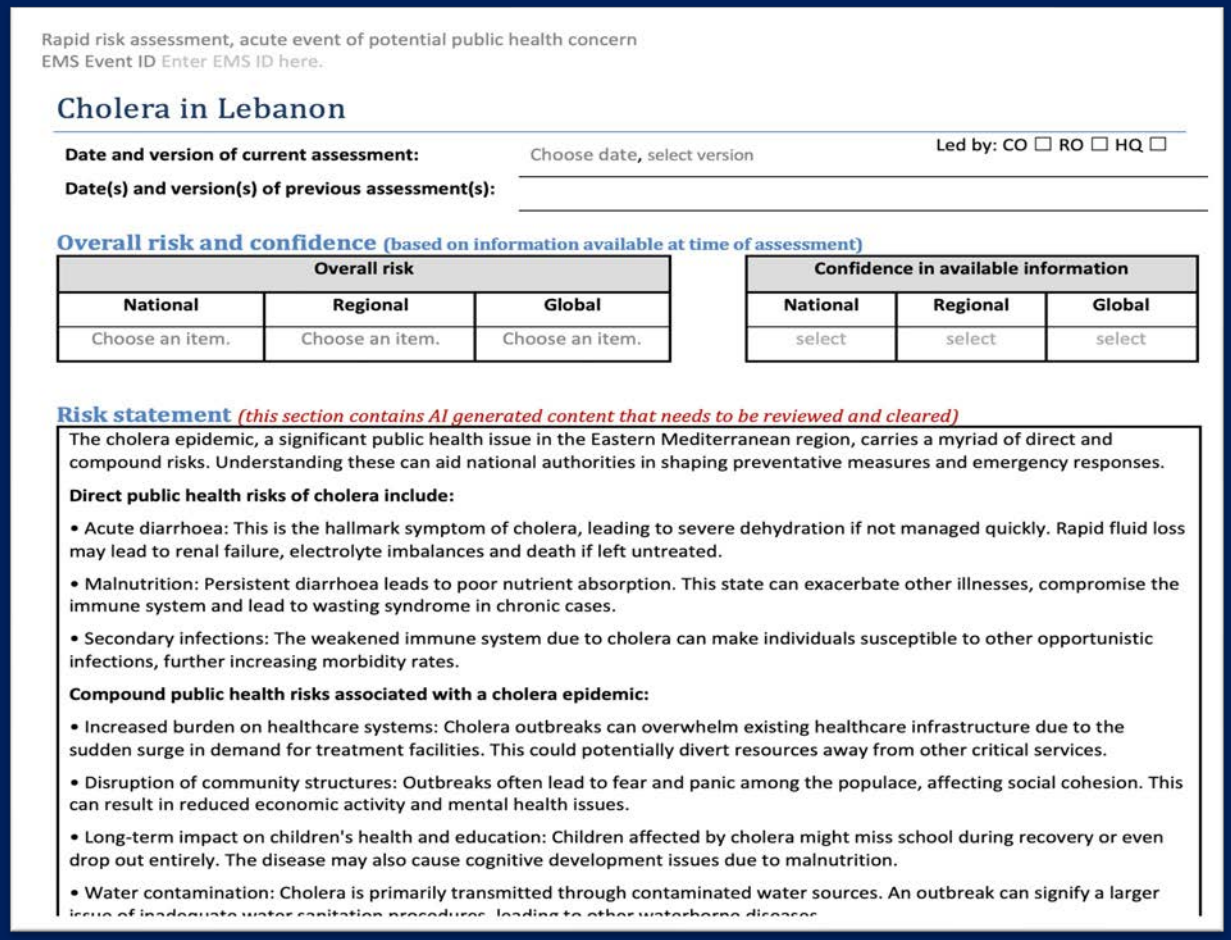
- Pre-crisis baseline data
- Technical guidance
- Standard operating procedures (SOPs)
- Workflows, templates, and checklists

The toolkit integrates AI-assisted pre-filled templates:

- Rapid Risk Assessment
- Public Health Situational Analysis
- Response plans



# Rapid Risk Assessment AI Generated Template



Rapid risk assessment, acute event of potential public health concern
EMS Event ID Enter EMS ID here.

## Cholera in Lebanon

**Date and version of current assessment:** Choose date, select version

Led by: CO ☐ RO ☐ HQ ☐

**Date(s) and version(s) of previous assessment(s):**

### Overall risk and confidence (based on information available at time of assessment)

| Overall risk | | | Confidence in available information | | |
|---|---|---|---|---|---|
| National | Regional | Global | National | Regional | Global |
| Choose an item. | Choose an item. | Choose an item. | select | select | select |

### Risk statement *(this section contains AI generated content that needs to be reviewed and cleared)*

The cholera epidemic, a significant public health issue in the Eastern Mediterranean region, carries a myriad of direct and compound risks. Understanding these can aid national authorities in shaping preventative measures and emergency responses.

**Direct public health risks of cholera include:**

• Acute diarrhoea: This is the hallmark symptom of cholera, leading to severe dehydration if not managed quickly. Rapid fluid loss may lead to renal failure, electrolyte imbalances and death if left untreated.

• Malnutrition: Persistent diarrhoea leads to poor nutrient absorption. This state can exacerbate other illnesses, compromise the immune system and lead to wasting syndrome in chronic cases.

• Secondary infections: The weakened immune system due to cholera can make individuals susceptible to other opportunistic infections, further increasing morbidity rates.

**Compound public health risks associated with a cholera epidemic:**

• Increased burden on healthcare systems: Cholera outbreaks can overwhelm existing healthcare infrastructure due to the sudden surge in demand for treatment facilities. This could potentially divert resources away from other critical services.

• Disruption of community structures: Outbreaks often lead to fear and panic among the populace, affecting social cohesion. This can result in reduced economic activity and mental health issues.

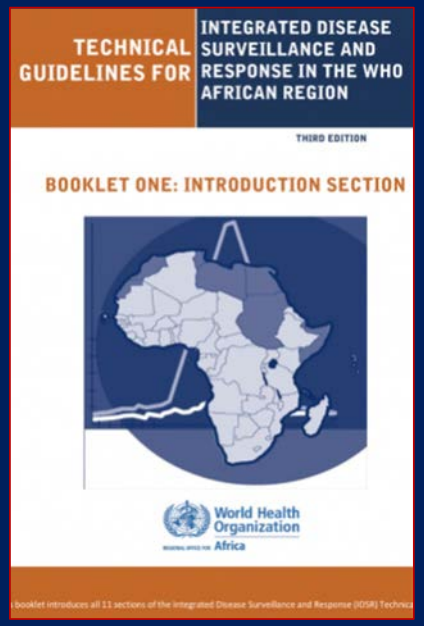
• Long-term impact on children's health and education: Children affected by cholera might miss school during recovery or even drop out entirely. The disease may also cause cognitive development issues due to malnutrition.

• Water contamination: Cholera is primarily transmitted through contaminated water sources. An outbreak can signify a larger issue of inadequate water sanitation procedures, leading to other waterborne diseases

Additional Resources:
*Global public health intelligence: World Health Organization operational practices. PLoS Global Health, 2023;* https://doi.org/10.1371/journal.pgph.0002359

# Data Chat – Interrogating Surveillance Data using Natural Language

Global.health




IDSR

# Data-driven decision making in health emergencies is difficult

Best available data

Appropriate analytics

**Operational teams**

- Limited in-house analytics capacity
- Weak links to analytics community

**Analytics community**

- Unaware of operational realities
- Develop tools in siloes

Timely communication

**Decision makers**

- Removed from analytics process

World Health Organization

# Collaboratory

Leverage WHO's position as a **globally networked** and **trusted** institution to convene communities of practice for **operationalizing analytics**

**Community**
17 CoPs
600+ members
100+ organizations
50+ countries

**Digital Platform**
800+ posts
250+ discussions

**Mpox Analytics**
"How do we estimate the size of the mpox outbreak in DRC from cases detected abroad?"

**Dengue Analytics**
"How do we predict the number of Dengue cases in three months from surveillance and climate data?

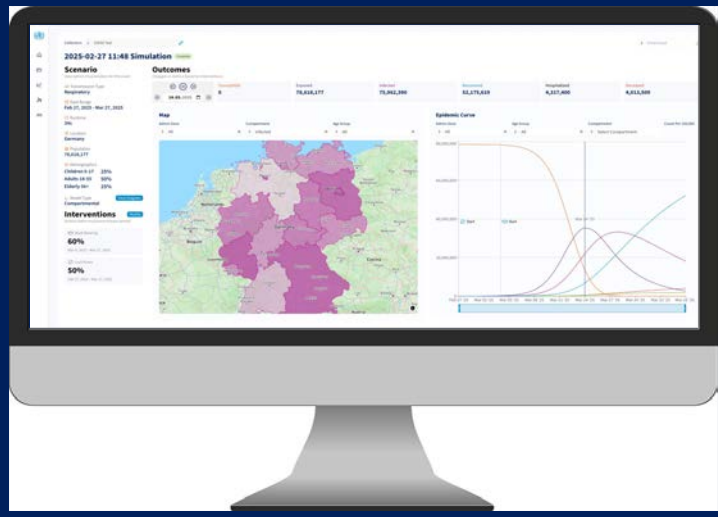
**EpiParameters**
"How do we report epidemiological parameter estimates in a standardized and centralized manner?"

World Health Organization

# Decision Support Pandemic Simulator

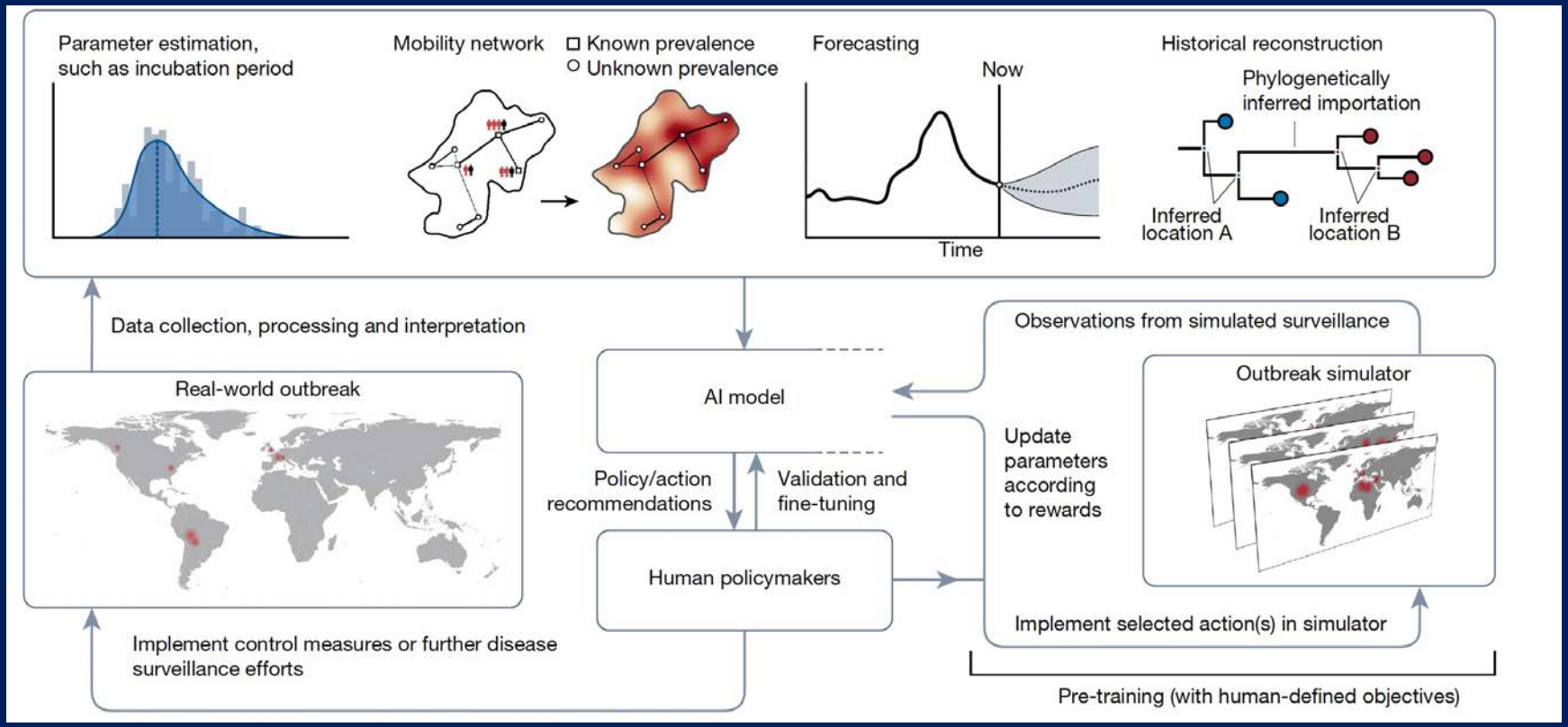
A data-driven decision-aid platform allowing public health officials and policy makers to conduct realistic simulations of the impact of multiple interventions before and during health emergencies on user-defined scenarios.

- Democratize disease modeling access
- Customizable pathogen characteristics
- Rapid translation into policy-making
- Model multiple diseases and compounding interventions



# Pandemic Simulator Prototype

# Using AI for Interative Approaches to Decision Making




Source: Kraemer et al, Artificial intelligence for modelling infectious disease epidemic. Nature 2025 *https://doi.org/10.1038/s41586-024-08564-w*

World Health Organization

# Verification and Epidemiological Understanding will Always Require Field Investigation

*Source: WHO*

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# HUB

Pandemic and Epidemic Intelligence