# Strengthening Surveillance and Diagnostic Capacity in Indonesia

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# Tasks and Expected Output: Indonesia diagnostic and surveillance review

- Review organizational structure of public, private and community-based health laboratory facilities
- Assess public health laboratory supply chain, procurement, governance and quality assurance and gaps in expanding capacity in diagnostic and surveillance capacity
- Provide tailored recommendations to strengthen diagnostic and surveillance capacity
- Provide inputs to ADB support for acceleration and resilience of the HSTA project (SOPHI and InPLUS)

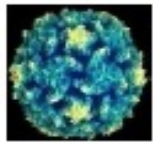
# Technological Advances in Surveillance and Diagnostic Testing

# Technology and Surveillance

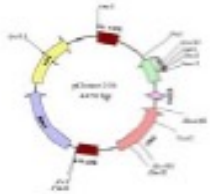
1676 → 2024

Microscope

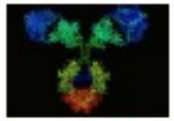
Microbial culture



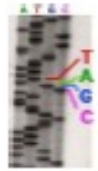
Virus culture



Molecular cloning



Monoclonal Antibodies



Sanger sequencing

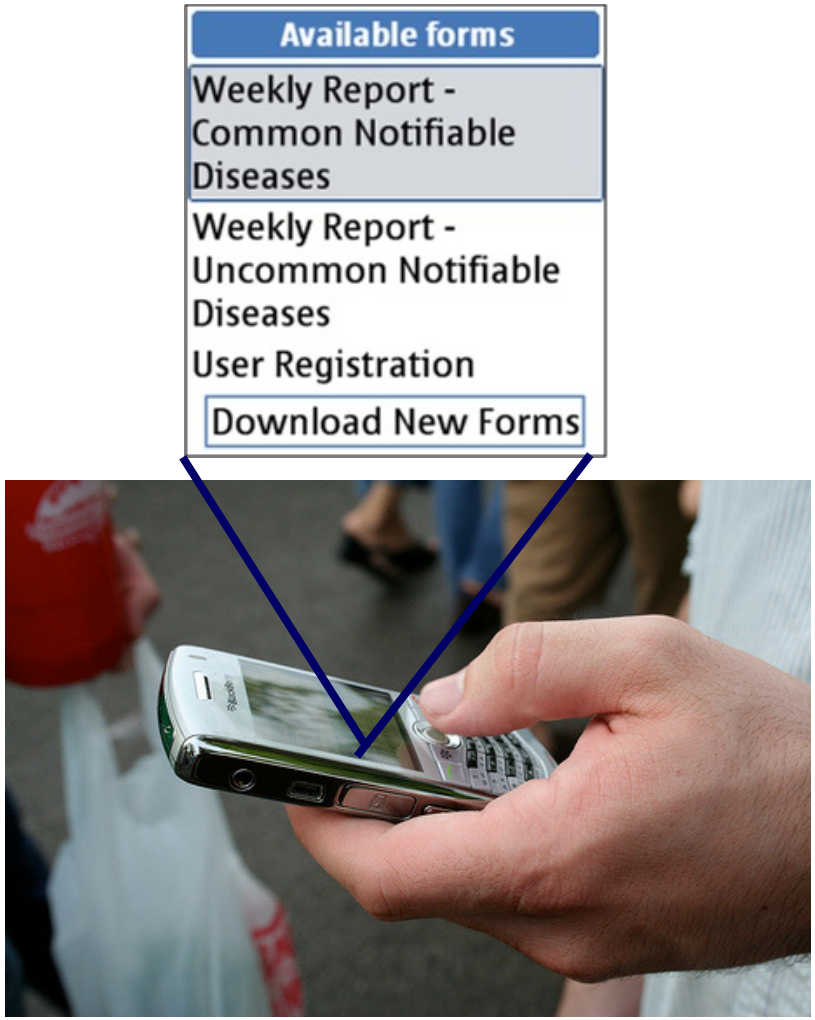
PCR/DNA fingerprinting

Internet

Next-Generation sequencing


## Point of surveillance testing

# Participatory Surveillance and Disease reporting

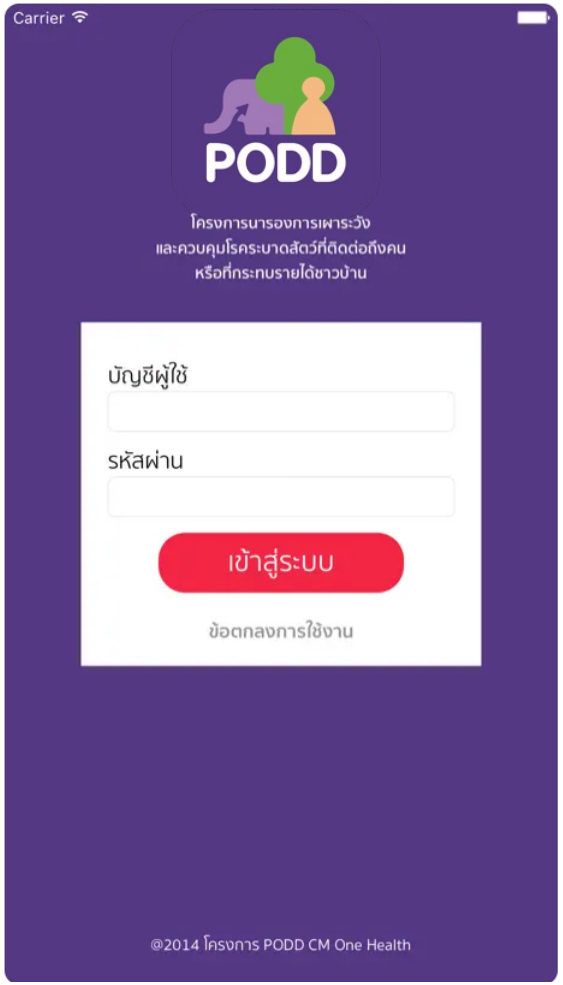


# Participatory Surveillance
# "Flu near you" USA


- **Data collection:** Smartphone and web applications for community members to report respiratory symptoms consistent with Influenza-like illness (ILI)
- **Laboratory testing:** None associated
- **Action:** Local, regional and national collation to signal any necessary action

# Digital mapping for action: Flu near you

# Participatory One Health Reporting, Thailand




- **Data collection:** Smartphone and web applications for community members to report unusual animal disease events or environmental hazards
- **Laboratory testing:** Local specimen collection and public health laboratory testing/isolation and sequencing
- **Action:** Local response from health experts in the community and/or send preventive materials such as vaccines.

# Community-based Surveillance

## Systematic review: drivers of success in 19 community-based surveillance activities:

1) Dedicated surveillance workers
2) Engaged community
3) Local ownership and trust
4) Integration with other services
5) Effective communication
6) Simple and adaptable case definitions
7) Adapted technology/quality assurance
8) Real time decision making and action

McGowan CR, et al. Community-based surveillance of infectious diseases: a systematic review of drivers of success. BMJ Global Health 2022;7:e009934. doi:10.1136/ bmjgh-2022-009934

# Community-based Surveillance

**Community-based surveillance:** detection and reporting and of public health events within communities by community members.

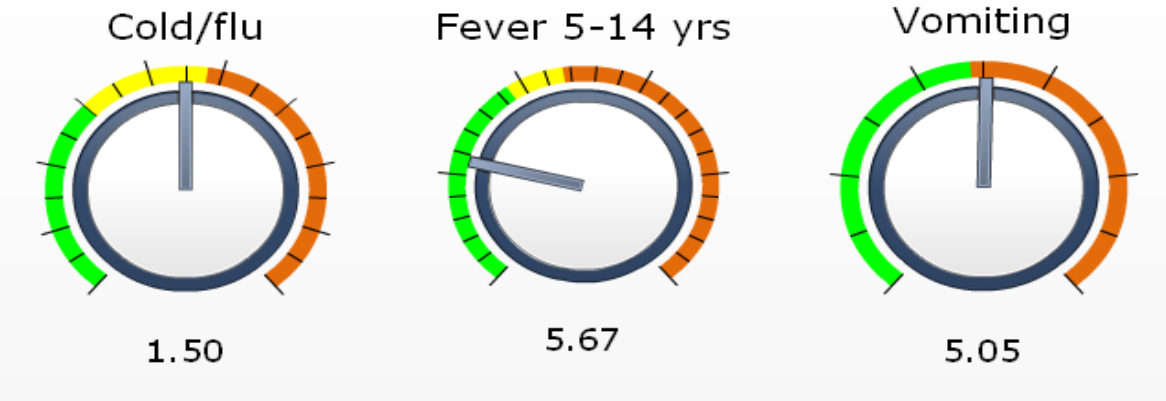
**Examples:**

- **Endemic disease surveillance:** avian influenza COVID-19, dengue, measles, rabies, TB, anthrax, diphtheria in Indonesia
- **Influenza-like illness (ILI) surveillance:** community-based reporting with self-testing with COVID or COVID/influenza/RSV Rapid Diagnostic Tests worldwide
- **Fever surveillance:** arbovirus/Zika testing, including pregnant women, in communities in Senegal and Uganda


*Byrne A, Nichol B (2020) A community-centred approach to global health security: implementation experience of community-based surveillance (CBS) for epidemic preparedness, Global Security: Health, Science and Policy, 5:1, 71- 84, 2020. DOI: 10.1080/23779497.2020.1819854*

# Automatic Digital Surveillance and Thresholds, UK

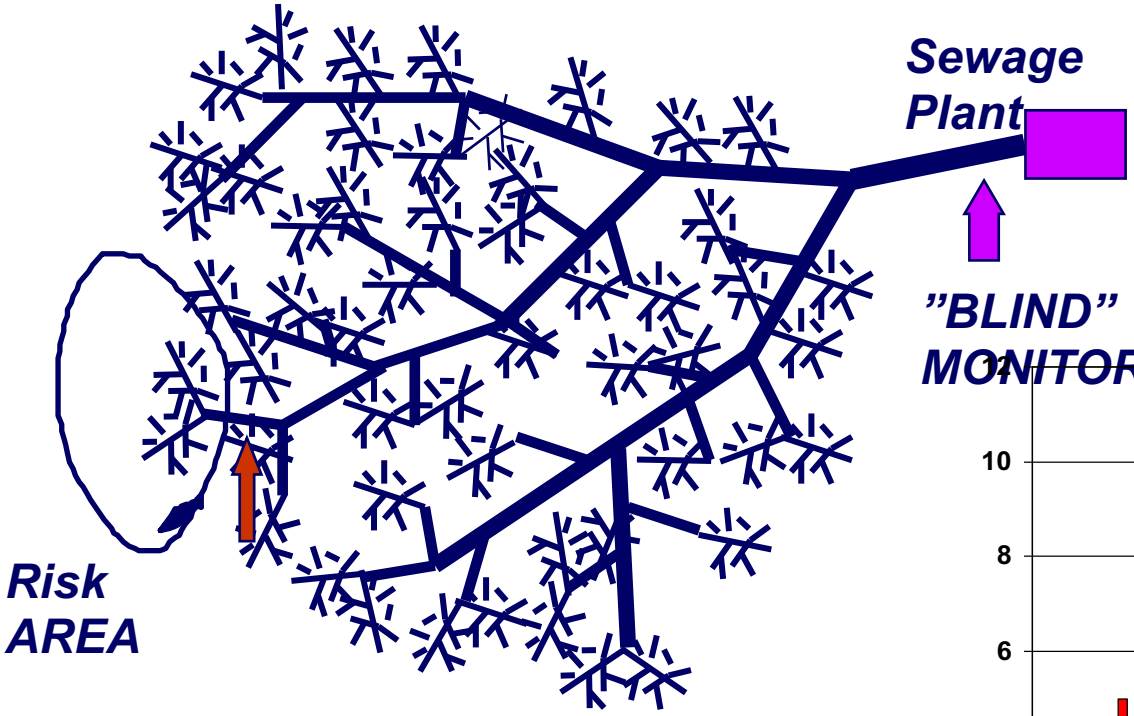
NHS Direct Syndromic Dashboard




- **Source:** Telephone health line manned by nurses and emergency dept records
- **Reporting:** Over 300 clinical algorithms used to assess patients symptoms
- **Collection:** Daily records automatically monitored for 10 syndromes including: cold/flu, cough, fever, diarrhoea, vomiting
- **Action:** standard investigation protocol implemented

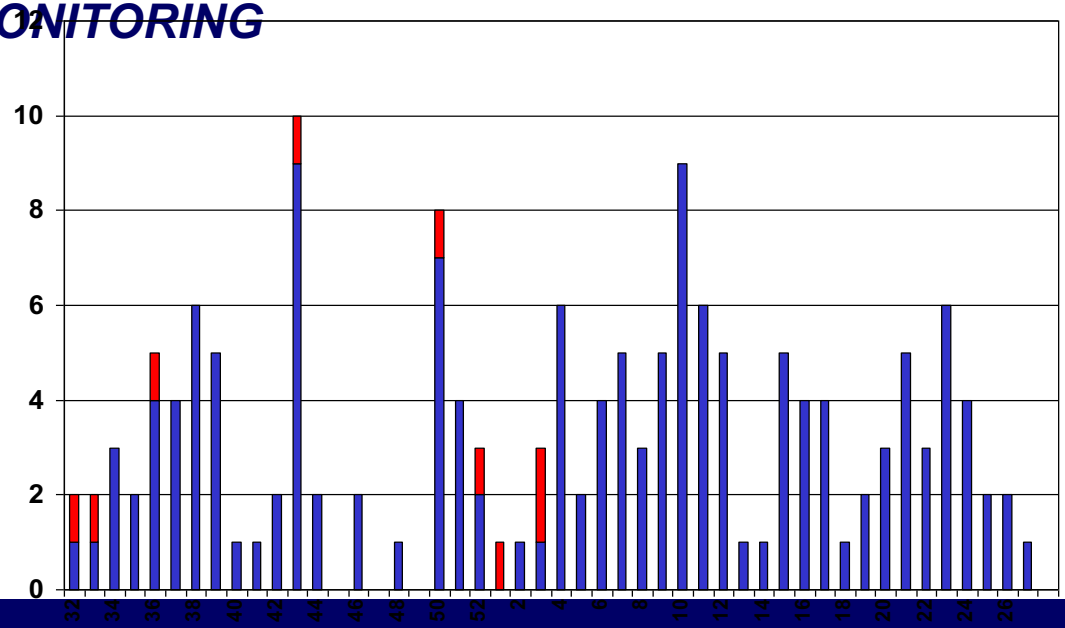
**Influenza and norovirus threshold key:**
**GREEN: Call numbers are within baseline levels**
**YELLOW: Call numbers are approaching early warning thresholds suggesting increasing community activity**
**ORANGE: Early warning thresholds have been breached indicating increased community activity**

# Environmental Polio Surveillance, Sewage Network, Egypt



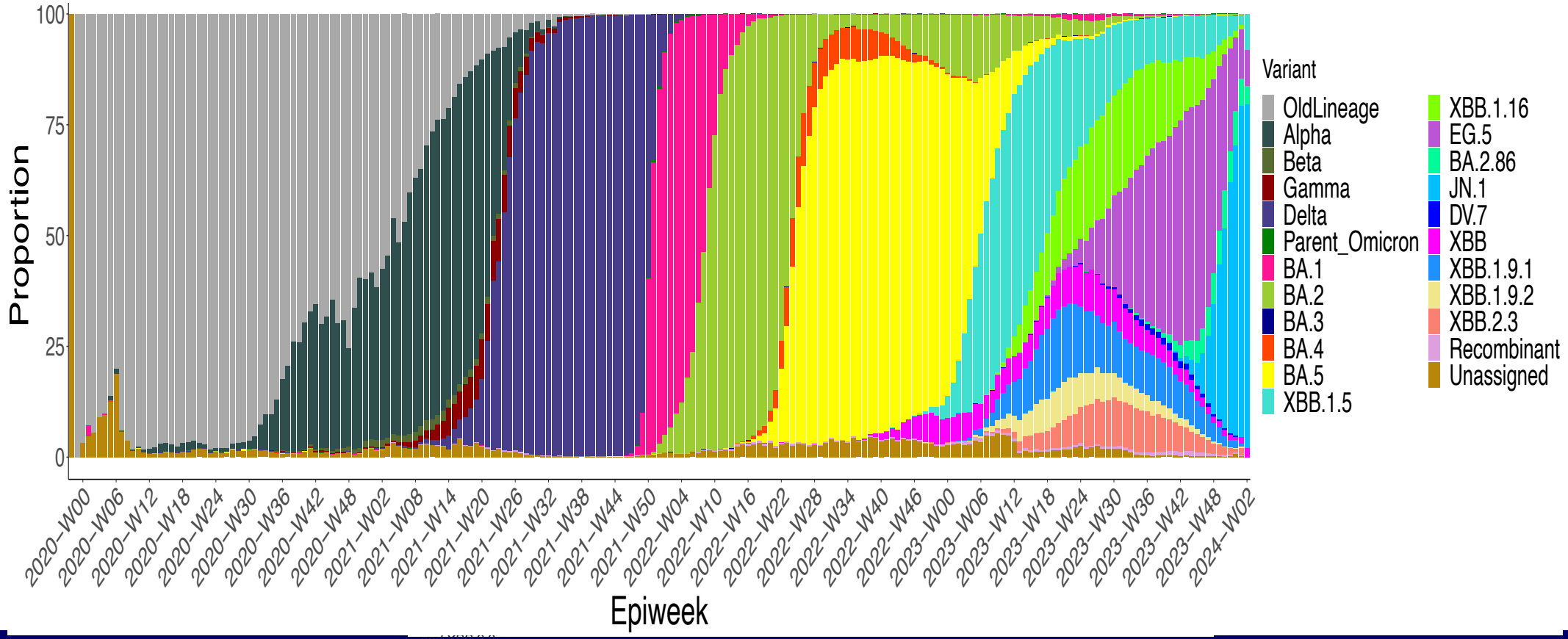

Wild poliovirus type 1

Sabin poliovirus type 1

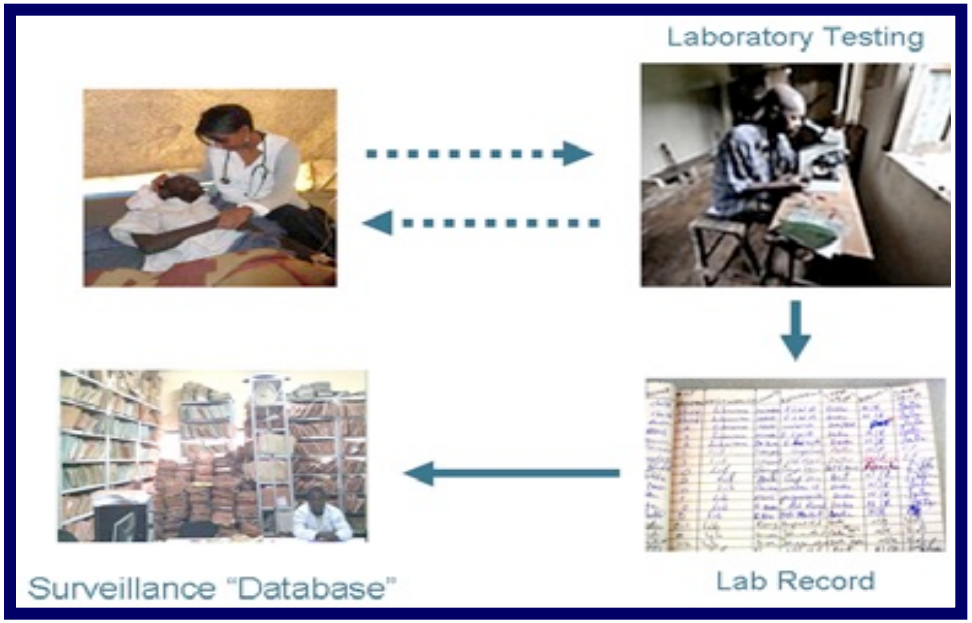


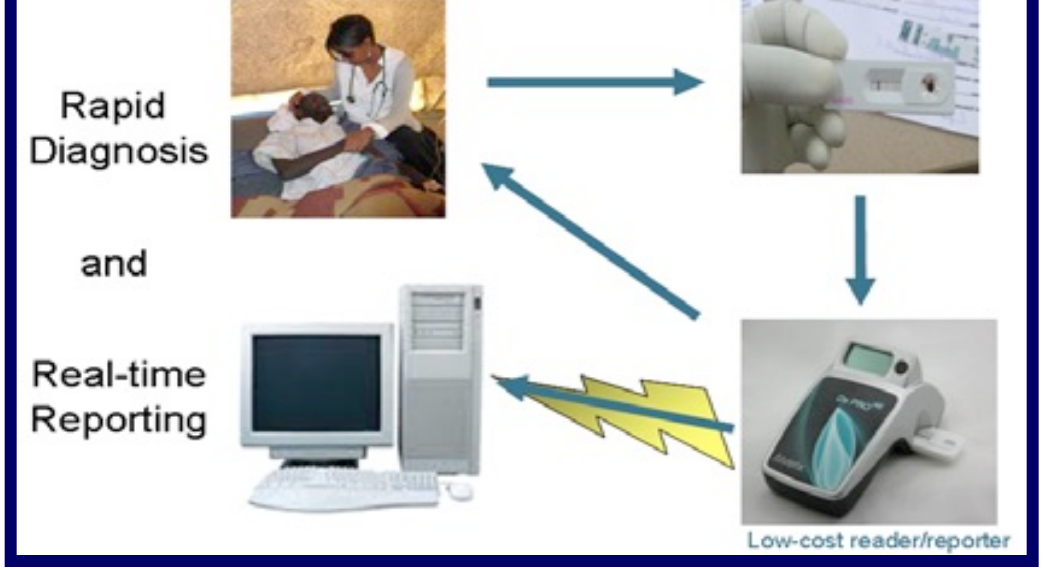
# SARS CoV2 Environmental Surveillance: Wastewater

- SARS-CoV-2 wastewater levels spiked across the world during November and December 2023, reaching the highest observed peaks in 2023 for many countries.
- There has since been a general downward trend in these SARS-CoV-2 wastewater levels globally.



# The Future is Here: Laboratory Diagnosis and Real-time Reporting



# Rapid POC tests to Ensure Equitable Access to Diagnostics

## 2003

A = Affordable

S = Sensitive

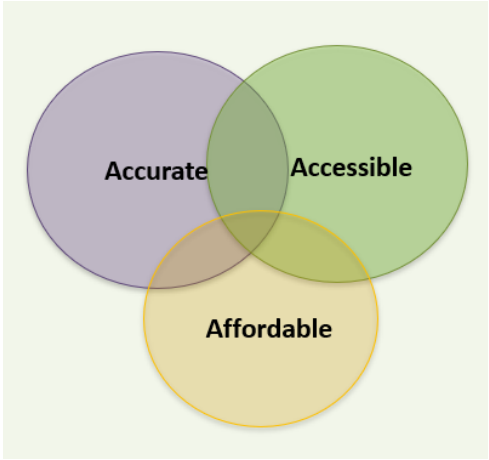
S = Specific

U = User-friendly

R = Rapid and robust

E = Equipment-free

D = Deliverable




## 2018

R = Real time connectivity

E = Ease of specimen collection

A = Affordable

S = Sensitive

S = Specific

U = User-friendly

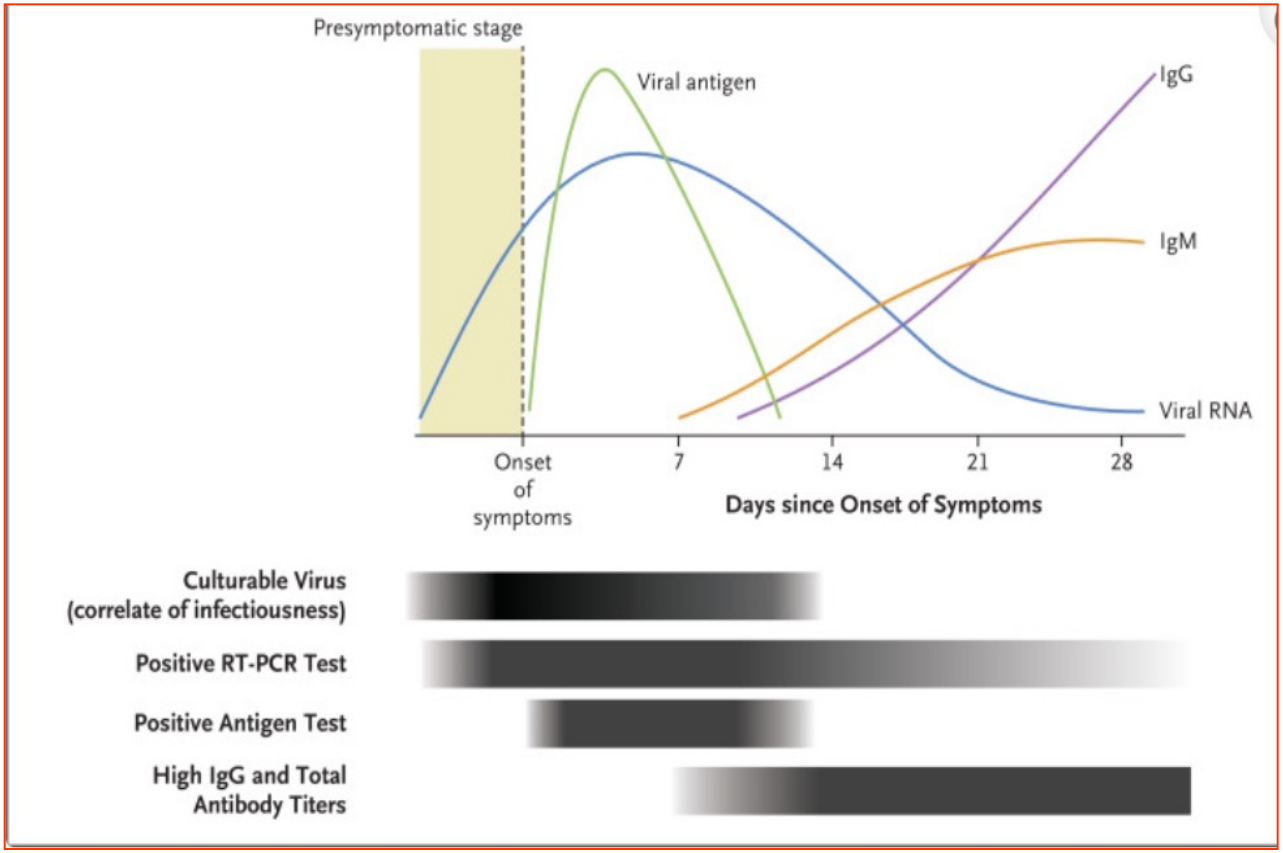
R = Rapid and robust

E = Equipment-free

D = Deliverable

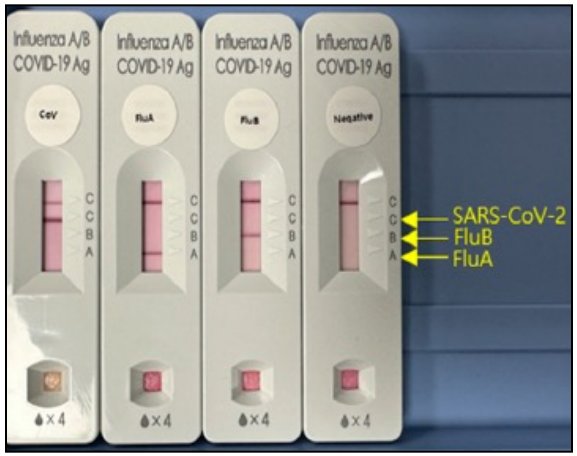
Mabey D, et al. Diagnostics for the developing world. Nature Rev Microbiol 2: 231-40, 2004.
Land KJ, et al. REASSURED diagnostics to inform disease control strategies, strengthen health systems and improve patient outcomes. Nat Microbiol. 4(1):46-54.2019. e-pub Dec 2018.

# Tests for Confirming Clinical Diagnosis and Surveillance




Drain PK. Rapid Diagnostic Testing for SARS-CoV-2. N Engl J Med. 2022 20;386(3):264-272.

Multiplex rapid antigen tests for use with ILI surveillance samples:



# Tests for Dengue Diagnosis and Surveillance

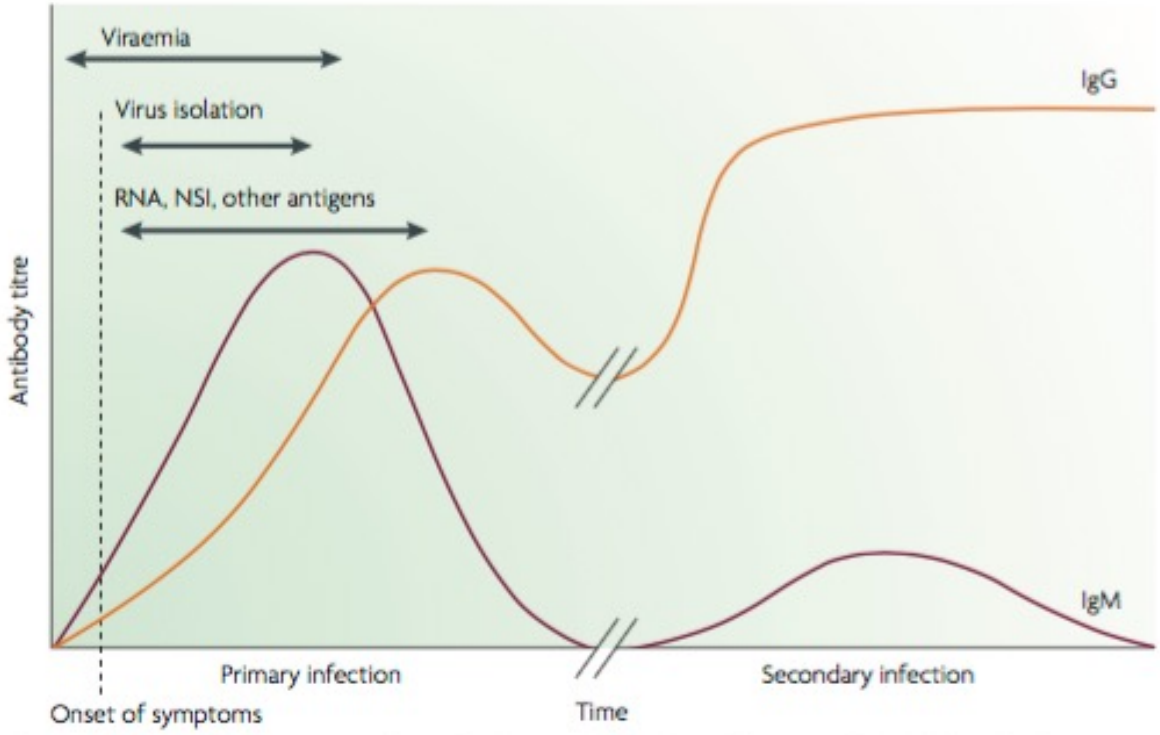



Figure 2 | **Major diagnostic markers for dengue infection.** The titre of the IgM and IgG response varies, depending on whether the infection is a primary or secondary infection.

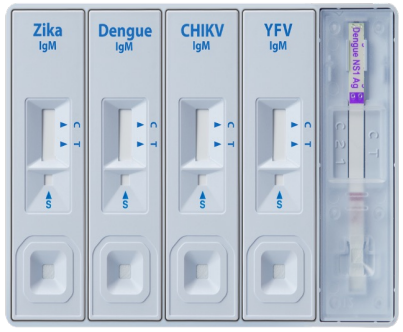
Peeling RW, et al.. Evaluation of diagnostic tests: dengue. Nat Rev Microbiol. 2010 Dec;8(12 Suppl):S30-8. doi: 10.1038/nrmicro2459. PMID: 21548185.

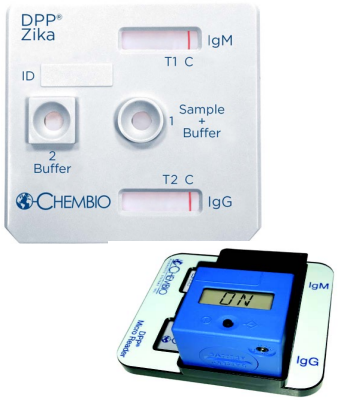
**For confirming clinical diagnosis:**

- Virus isolation
- Nucleic acid detection
- Antigen detection
- Seroconversion for IgM
- 4-fold rise in IgG titres
- IgM + NAT/NS1

**For surveillance**:

- Monitor increase in IgM+ cases
- Confirmation by nucleic acid tests



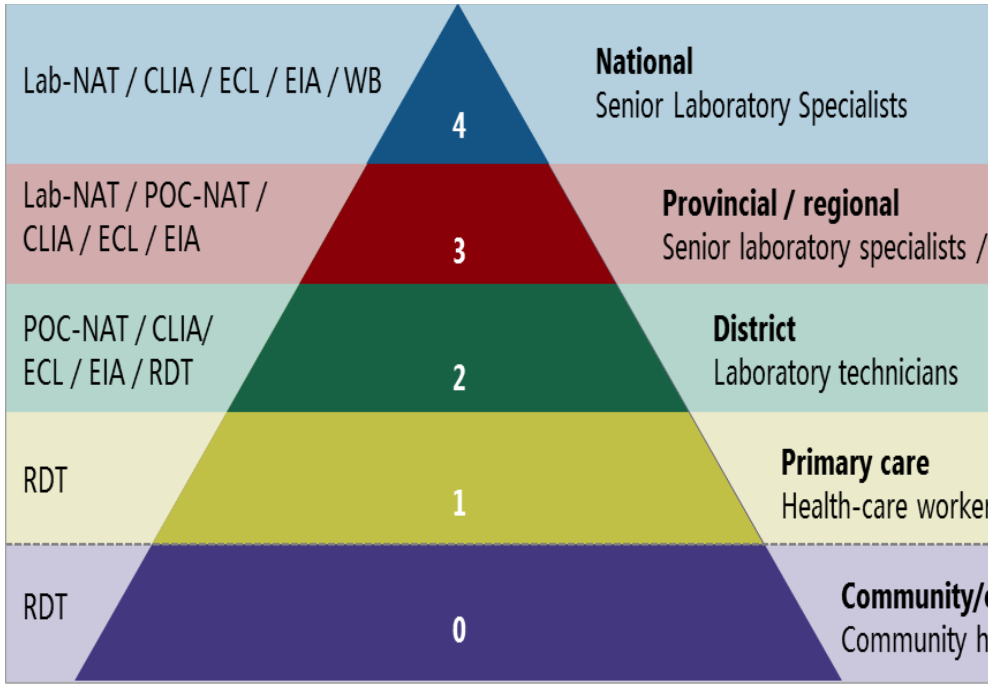



# Explosion of near-Point-of-Care Molecular Platforms

**Plug and play format:**

- 2-3 minutes hands-on time
- 5 – 75 minutes to result
- Data connectivity
- Multiplex testing complements syndromic surveillance to monitor trends and confirm cause of outbreak at source:
  - Respiratory panel
  - Gastroenteric panel
  - Fever panel
  - Neuro panel

# Real-time Surveillance




Source: WHO Hepatitis Testing Guidelines 2017

***NAT: Nucleic acid tests: Lab-NAT: laboratory-based;***
***POC-NAT: at point-of-care;***
***CLIA: chemiluminescence immunoassay;***
***ECL: electrochemiluminescence immunoassay;***
***EIA: enzyme immunoassay; RDT: rapid diagnostic test***

- **Goal: develop a connected surveillance system as the backbone of a healthcare system to monitor trends and provide early alerts of outbreaks**
- **How?**
  - **Ensure appropriate diagnostic technology at every level**
  - **Develop/strengthen community-based surveillance using syndromic reporting + rapid testing**
  - **Investments in:**
    - **People**: Lab + epidemiologists; field epi+lab teams; IT and informatics expertise
    - **real-time reporting** – lab information systems + RDTs with readers for data connectivity
    - **Artificial Intelligence and machine learning for algorithms to detect unusual trends, provide alerts of potential outbreaks and monitor effectiveness of interventions**

# Genomic Sequencing

Lab Instruments for sequencing
& fragment analyses

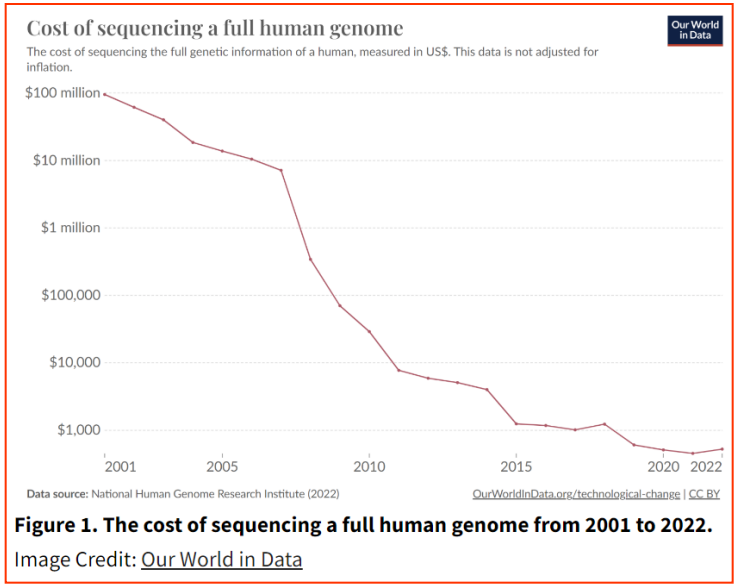
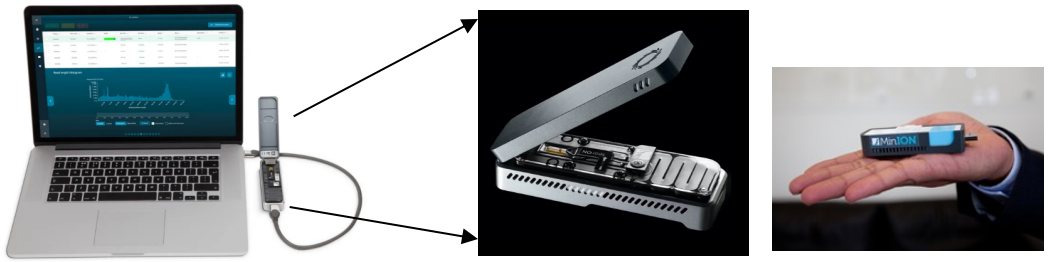
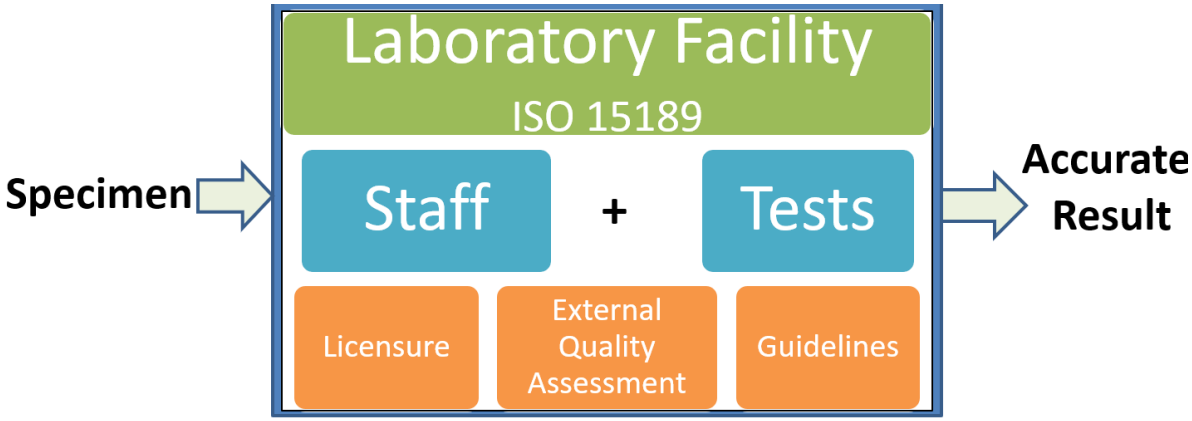



**Figure 1. The cost of sequencing a full human genome from 2001 to 2022.**
Image Credit: Our World in Data



**MinIon: Portable (87g); Real time data; unrestricted read length**

# Quality System for Laboratories

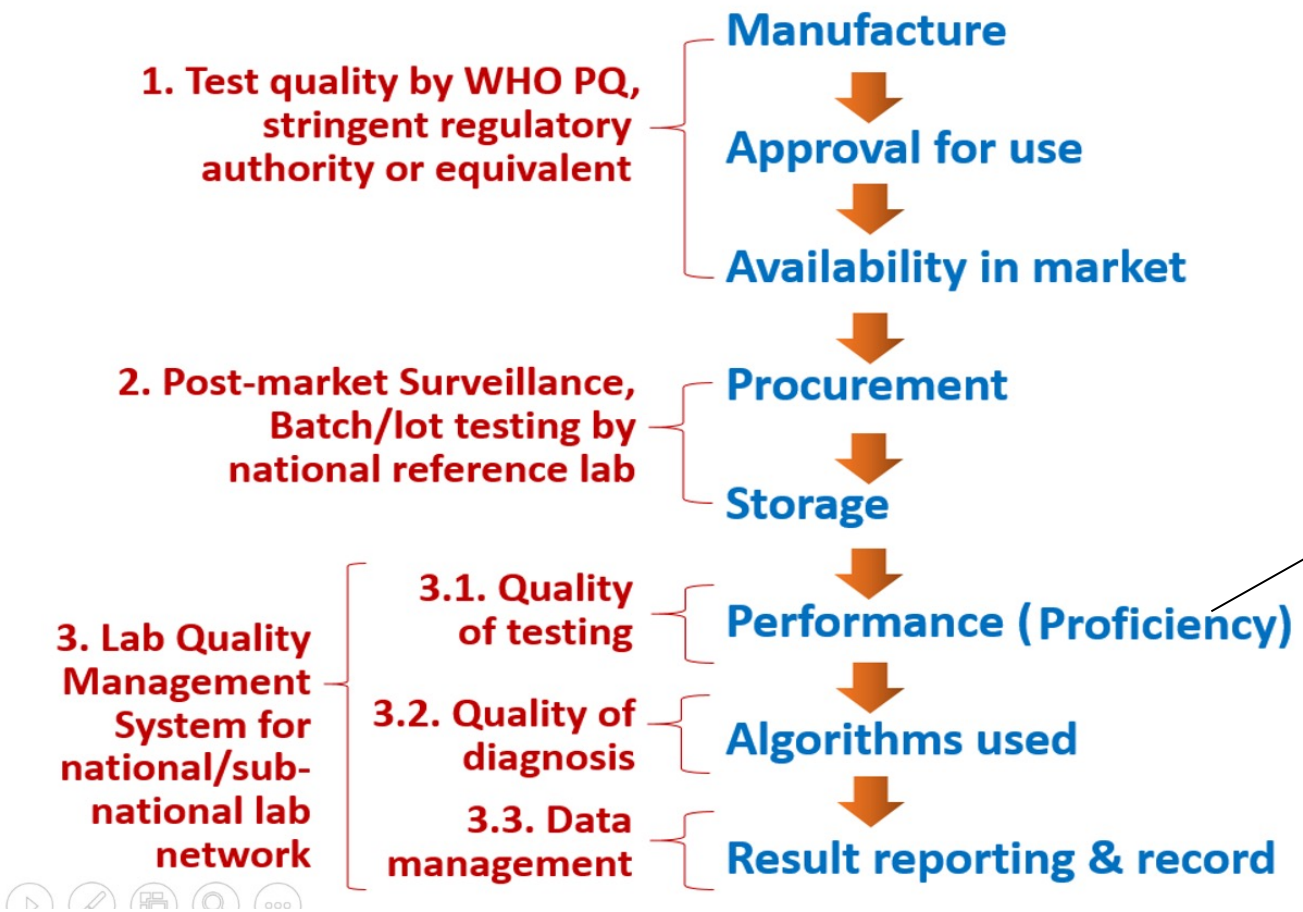



WHO's Stepwise Laboratory Quality Improvement Process Towards Accreditation (SLIPTA) Checklist:

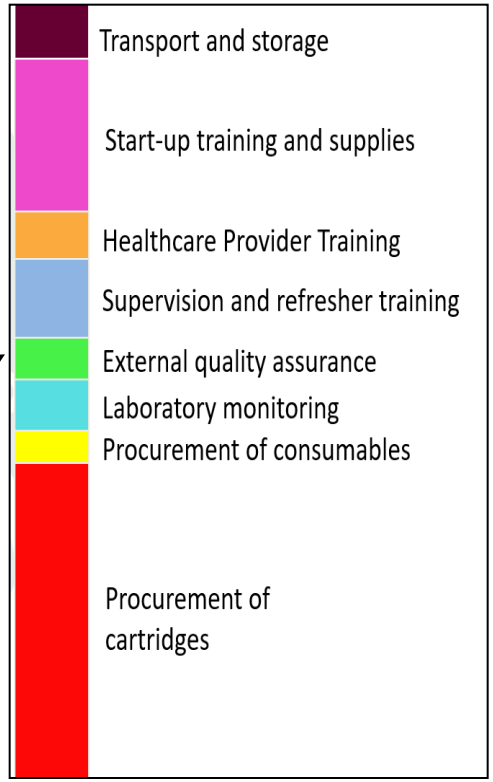
- to determine if a laboratory is providing accurate and reliable test results on a timely basis
- to determine if it is well-managed and adhering to good laboratory practices
- to identify areas for improvement
- as an input to generate laboratory-specific plans

*https://aslm.org/wp-content/uploads/2023/12/SLIPTA-Checklist-V3-2023-Refillable.pdf?x79169*

# The Diagnostics Quality Continuum




QA must be included in the budget for a POC Testing Programme:



# Review and Recommendations

# Review of organizational structure of public, private and community-based health laboratory facilities

- Uniform and standardised lists of diagnostic tests that often do not reflect local epidemiology and needs
- Diagnostic test formats are not tailored to laboratory skills
- Relationship of public and academic/private laboratories not clear
- Surge capacity for diagnostic testing not clear

# Recommendation 1: Organisation and Function

- Establish epidemiology units to facilitate geographic mapping of disease burden and ensure laboratory capacity appropriate for local needs
- National reference laboratory to oversee all laboratory and point-of-care (POC) diagnostic services to ensure tiered diagnostic testing service appropriate for capacity and human resources
- Include academic and private sector laboratories in pandemic planning for POC diagnostic centres when needed and include in pandemic exercises

# Supply Chain, Procurement and Quality Assurance

- Unreliable procurement and financing sometimes leads to ruptures of supplies and inconsistency in reagent availability
- Quality assurance is *ad hoc* with no uniform system adapted to the various tiers of diagnostic testing

# Recommendation 2:
# Supply Chain, Procurement and Quality Assurance

- Clarify funding for diagnostic testing in every tier in upcoming Labkesmas regulation
- Adapt and use WHO Laboratory Information Management System (LIMS) for timely alert for procurement and quality assurance
- Implement the WHO Stepwise Laboratory Quality Improvement Process Towards Accreditation (SLIPTA) Checklist to assess laboratory capacity and quality
- Develop and implement a regular and systematic quality assurance programme for laboratories and other sites of testing

# Structure and Governance in Expanding Diagnostic and Surveillance Capacity

- Confusion in laboratories of all tiers about expectations under transformation
- Private sector not included in sharing of surveillance and laboratory information through coordinating minister
- Public sector sharing of surveillance and laboratory data occurs between human, animal and environmental sectors shared on an One Health technical platform, but not through the coordinating minister
- Academic and private sector surveillance and laboratory data from human and veterinary sectors not shared with public sector

# Recommendation 3: Structure and Governance

- Review and clarify laboratory expectations and develop guidelines to meet the expectations
- Create ethical and secure data sharing policies, with safeguards, for surveillance and laboratory systems for humans, animals and the environment including the academic and private sectors – trust need to be built during inter-epidemic periods and not during public health emergencies
- Conduct regular risk assessment of disease threats in the public, academic and private human, animal and environmental sectors

# Strengthen Diagnostic and Surveillance Capacity across Public Health System

- Surveillance and diagnostic testing at Puskesmas level does not include animal and environmental sectors
- Outbreak response limited in effectiveness by government policies that discourage use of tests that fall outside policy
- Endemic disease reporting not adequate
- Laboratory information remains siloed despite SATU SUHAT that was developed to integrate information
- Diagnostic testing equipment for COVID-19 remains idle for various reasons and is not adapted for sustainable use

# Recommendation 4: Diagnostic and Surveillance Capacity

- Consider the use of new technologies such as apps as a means of reporting surveillance information and POC tests rather than laboratory infrastructure at Puskesmas level
- Create algorithms for diagnostic testing at all tiers, with emphasis on POC testing with data connectivity at community level– ensuring equitable access and real-time reporting to inform public health action without delay
- Link surveillance and laboratory data to digital mapping apps to better understand epidemiology and to creating dashboards for communications with the public
- Develop more permissive testing policies with input from epidemiologists and laboratory staff, especially for investigating potential outbreaks
- Conduct in-service training to provide epidemiology skills to laboratory staff including analysis skills and the use of SATU SEHAT
- Map and rationalise the use of all existing laboratory equipment
- Consider promoting and facilitating local manufacture of POC diagnostics

# Strengthen Diagnostic and Surveillance Capacity across Public Health System

- Red Cross study* demonstrated feasibility of community level surveillance - understanding needed on how to scale up
- Innovations such as POC diagnostics, digital mapping and surveillance dashboards do not exist
- Indonesia has a field epidemiology training programme for medical officers but not for laboratorians

*Byrne A et al. A community-centred approach to global health security. https://www.tandfonline.com/doi/epdf/10.1080/23779497.2020.1819854**?needAccess=true**

# Recommendation 5: Diagnostic and Surveillance Capacity

- Develop capacity to implement translational field research in order to better integrate newer surveillance and diagnostic testing capacities at the level of the Puskesmas and to replace laboratory infrastructure with flexible POC diagnosis and reporting at community level
- Develop and implement a field epidemiology training programme appropriate for laboratorians and build epi-lab teams for outbreak investigations
- Review and revise as necessary the field epidemiology training programme for medical officers to ensure it is fit for purpose in view of newer innovations in surveillance and diagnostic testing

# Laboratory research agenda

- It is not clear how necessary research is, or will be, conducted when novel pathogens are identified in order to ensure best possible outbreak control, including contact tracing
- It is not clear how laboratories participate, or will participate in drug and vaccine trials and other research activities during outbreaks

# Recommendation 6: Laboratory Research Agenda

- Provide resources to invest in open nucleic acid amplification technology platforms and laboratory technologies such as 16S ribosomal RNA gene amplicon sequencing for identification of unknown pathogens
- Develop capacity for wastewater environmental surveillance
- Link academic research institutes and public health laboratories and initiate collaborative research during inter-epidemic periods so that when unknown pathogens are suspected, collaborative research can be carried out without delay
- Ensure resources for laboratory research to provide data for policy and critical public health decision making

# Summary

- Following the above recommendations Indonesia can strengthen surveillance and diagnostic capacity using
  - participatory surveillance from communities upwards, alert the government of the need for additional support as required
  - community engagement in public health emergencies and equitable access to diagnostic testing at primary care level to strengthen the healthcare system at all levels, leaving no one behind
  - real-time understanding of disease events where and when they begin with digital mapping of laboratory data to facilitate rapid public health action