Serological studies, applicability in the surveillance, prevention and control of viral respiratory diseases

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Outline

1. Influenza
2. Serological surveillance
3. Serological study types
4. Serological assays
5. The usefulness of serological studies
6. Limitations of the serological studies
7. Future perspectives

1. Influenza

- Influenza virus type and subtypes circulate in alternation and evolve genetically and antigenically
- Influenza immunity in the population is dynamic and acquired after infection or vaccination
- Viral antigenic drift, natural waning immunity, immune imprinting and immunosenescence are major contributing factors to increasing infection susceptibility
- Influenza vacines are one of the most important measures to prevent influenza infection and mainly the severe disease

1. Influenza

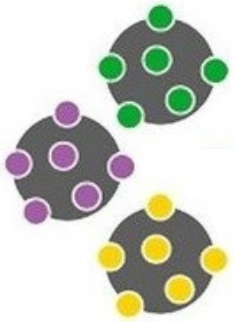
- Seroepidemiological studies are a tool to understand annual incidence, evaluate population susceptibility and the impact of vaccination programs

- Influenza serological studies are lacking at national and global level. Essential for vaccine composition recommendations and for preparedness and response plans for epidemics/pandemics

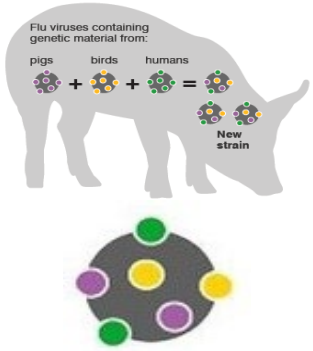
Aquired immunity after exposure

Seasonal Influenza

Cross-immunity



Influenza variants



Pandemic influenza

Immunity after vaccination

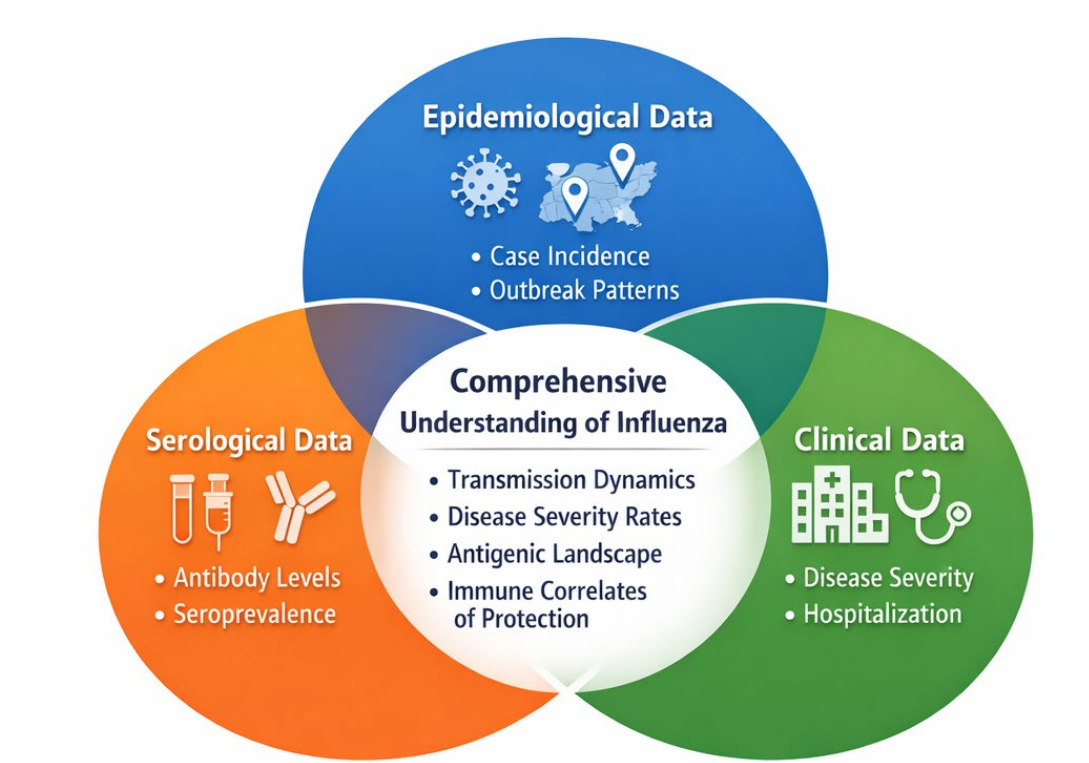
Influenza vaccine

2. Serological surveillance

- Serological surveillance refers to the use of biomarkers assays to monitor the distribution and determinants of infection or immunity in populations

- Provide insights about exposure to infectious diseases agents, immune responses and impact of vaccination programs

- Serological surveillance is a powerful tool to fill the gaps left by traditional disease surveillance methods



Integrating serological, epidemiological, and clinical data provides a ***complete picture*** of ***influenza infection risk and vaccine-induced protection.***

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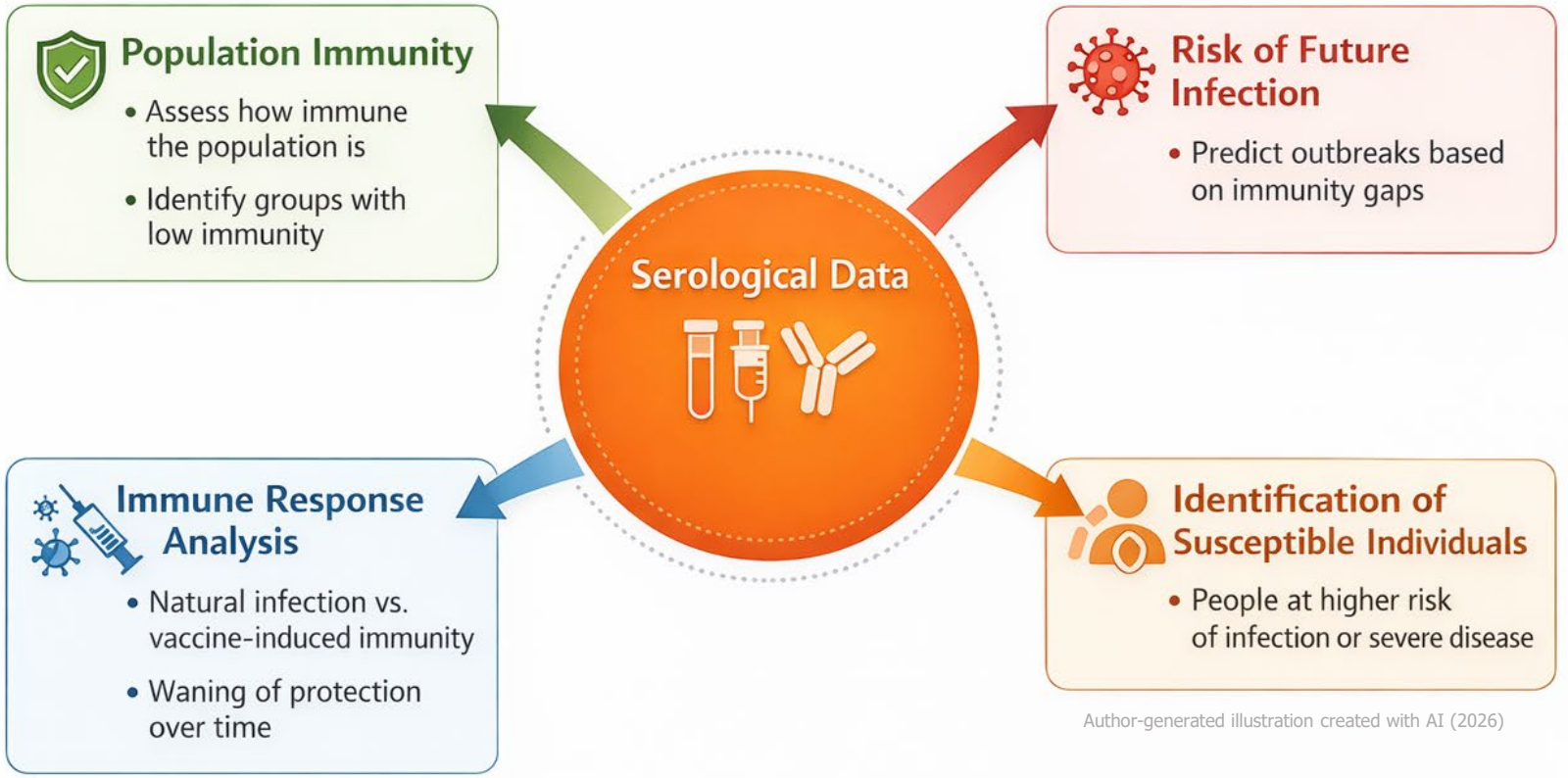
2. Serological surveillance

- **Serological data** plays an important role in the respiratory viruses surveillance



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- Serological data is crucial to planning and preparedness response to epidemics and pandemics

3. Serological study types

- Different serological study designs allow estimation of population exposure, immune dynamics, and recent transmission

Cross-sectional *

- One sampling **time point**
- Measures **seroprevalence**
- Estimates population **exposure**

*** repeated cross-sectional study**
Enables the study of immunology dynamic in a specific population

Longitudinal Cohort

- Same individuals sampled **multiple** times
- Measures antibody **dynamics** and **waning** immunity

Sero-incidence

- **Paired** samples before and after a period
- Detects **seroconversion**
- Estimates **recent infection** rates

4. Serological assays

- Serological studies, coupled with appropriate **serological assays**, are invaluable in understanding the spread of infectious diseases and guiding public health interventions

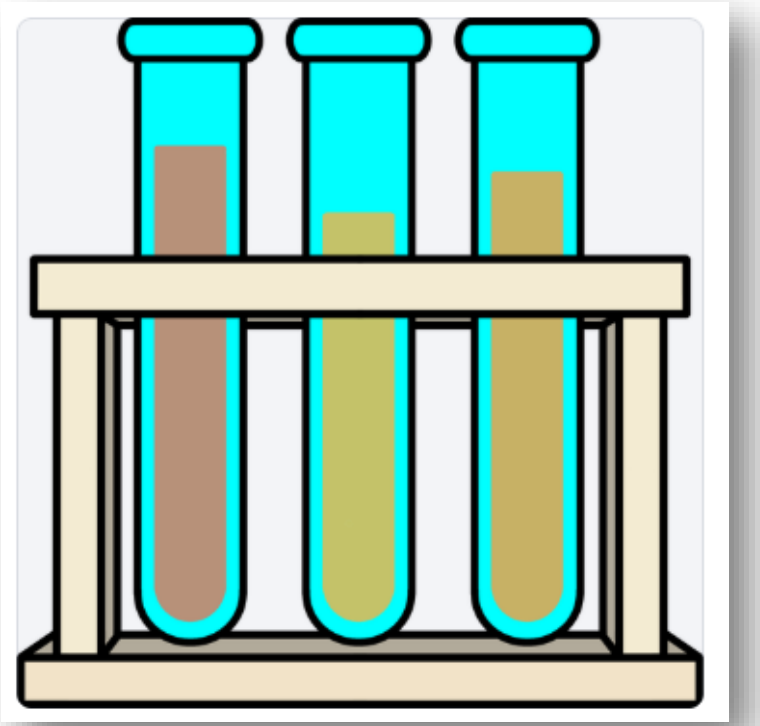
- A serological assay is a **laboratory test** that is used to detect and measure the presence of specific antibodies in the blood samples collected during the survey

- The **selection of sampling method and a suitable laboratory assay depends** on the **study's goals**, available **resources**, and the specific **epidemiological context**

4. Serological assays

Suitable test should meet the criteria:

- Simple
- Accurate (Sensitivity, Specificity)
- Reliability and ability to detect long-lasting antibodies
- Minimal interference from non-specific inhibitors
- Availability of reagents
- Safety of the test for the laboratory technician



4. Serological assays

Enzyme-linked immunosorbent assay (ELISA)

- Most commonly used test in diagnosis and serology to detect antibodies to a specific microorganism
- Detects antibodies by binding them to antigens coated on a plate and measuring the enzyme reaction that produces a detectable signal
- High sensitivity and specificity and allows quantitative measurements

Rapid Diagnostic Tests (RDTs)

- Lateral flow devices to detect antibodies
- Quick and easy to use, no need for sophisticated laboratory equipment
- Less sensitive
- Screening tool

4. Serological assays

Neutralization assays

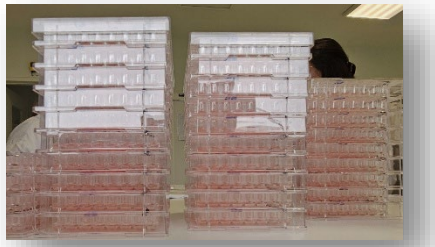
- Measure the ability of antibodies to neutralize pathogens, preventing infection in cell cultures
- Determining protective immunity
- Technically demanding, time-consuming
- Requires high biosafety level facilities for some pathogens

Microsphere Immunoassays

- Enables the development of broadly reactive multiplex assays
- Requires specialized equipment
- Trained Human resources

4. Serological assays

Hemagglutination inhibition assay (HAI)



Recommended for the detection of antibodies against influenza viruses

Advantages

- International standard method
- Simple and inexpensive
- High throughput
- Historical comparability
- Used in vaccine evaluation studies
- Antibody titers used as correlates of protection

Disadvantages

- Lower sensitivity compared to NT assays
- Limited to detect antibodies against hemagglutinin
- Requires well-standardized reagents (virus, red-blood cells)
- Described variability inter-laboratories

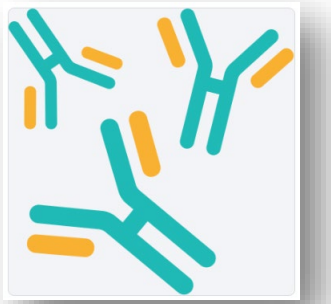
4. Serological assays

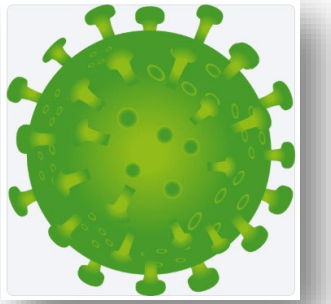
Hemagglutination inhibition assay (HAI)

Recommended for the detection of antibodies against influenza viruses

Limitations

- Cross-reactivity of antibodies between related influenza strains
- Unable to distinguish between infection and vaccination produced antibodies
- Lower sensitivity for some influenza viruses, e.g. avian influenza



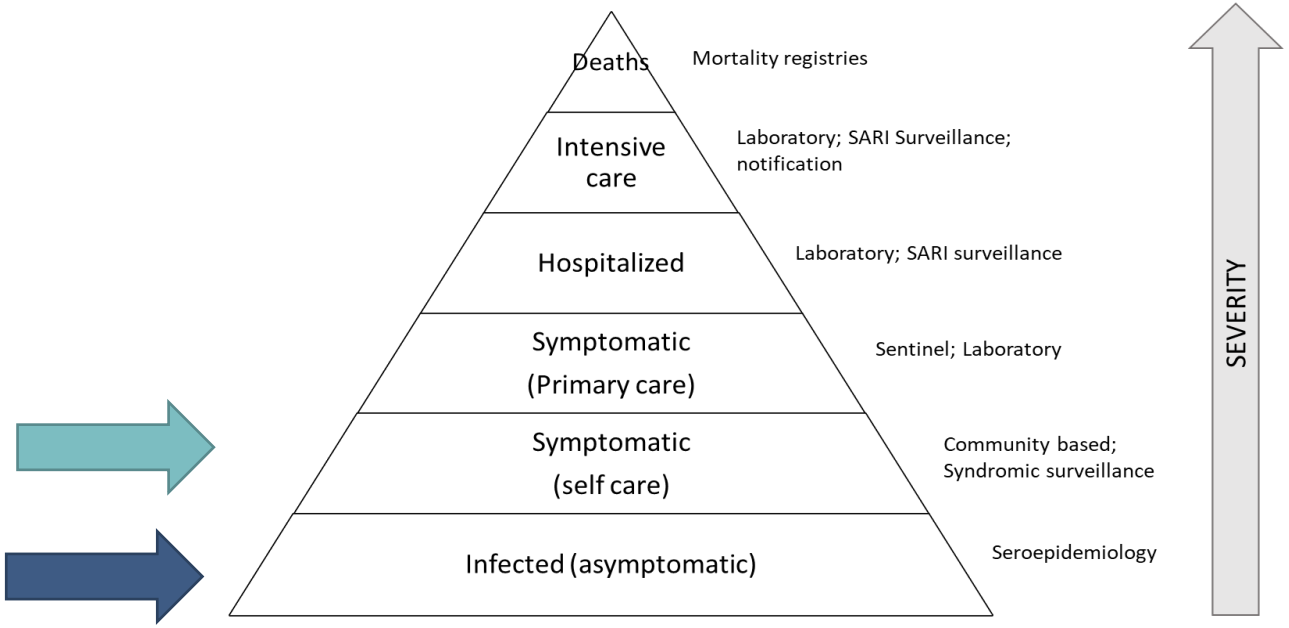


5. The usefulness of serological studies

Epidemiological surveillance

- The seroepidemiological studies are the unique component of the surveillance capable to **identify the asymptomatic infections** and the **healthy carriers** of pathogens, that are not captured in any surveillance system

Seroepidemiology



5. The usefulness of serological studies

Epidemiological surveillance

Contributes to:

- complete picture of the disease burden
- understand the dynamics of the disease transmission in the population
- monitors the effectiveness of the preventive measures

- Infection
- Antibody production
- Population immunity
- Public health measures

5. The usefulness of serological studies

Vaccination programs

- Improve **vaccine design** and formulation and the selection of viruses recommended for influenza vaccine composition
- Evaluate the immunity **response to vaccines**
- Monitoring **vaccination programs** (immune response, waning, booster doses)
- Contributing vaccination programs improvement

5. The usefulness of serological studies

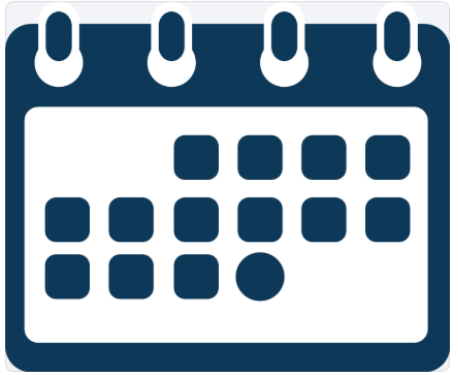
Emergent diseases

- Are part of the international framework for **preparedness and response** to future pandemics
- Measure the seroprevalence of antibodies against a **new pathogen** (capturing the fraction of asymptomatic and subclinical infections)
- Determine **cross-reactive antibodies**
- Determine the proportion of the **population susceptible** to the infection

5. The usefulness of serological studies

Planning and preparedness response

- Seroepidemiological data with economic analyses will facilitate the understanding of the **costs**, **benefits** and overall **impact of public health interventions**
- Estimates of the susceptible population, enabling **modelling and epidemiological studies**
- Lead to a more efficient use of resources, improved health outcomes, and **better preparedness** for future public health challenges
- **Strengthen** existing infectious disease surveillance strategies



6. Limitations of the serological studies

Influenza

- **Waning immunity:** past infections may not be detected
- **Cross-reactivity:** antibodies can react with different drift influenza virus
- **Difficult to distinguish vaccine and post-infection antibodies:** antibodies against hemagglutinin can be produced after vaccination and/or infection
- **Sampling bias:** non-representative samples may not reflect the general population
- **Timing for sample collection:** sera collection during influenza season or vaccination campaign affect results
- **Limited information on cellular immunity:** serosurveys commonly measure antibodies

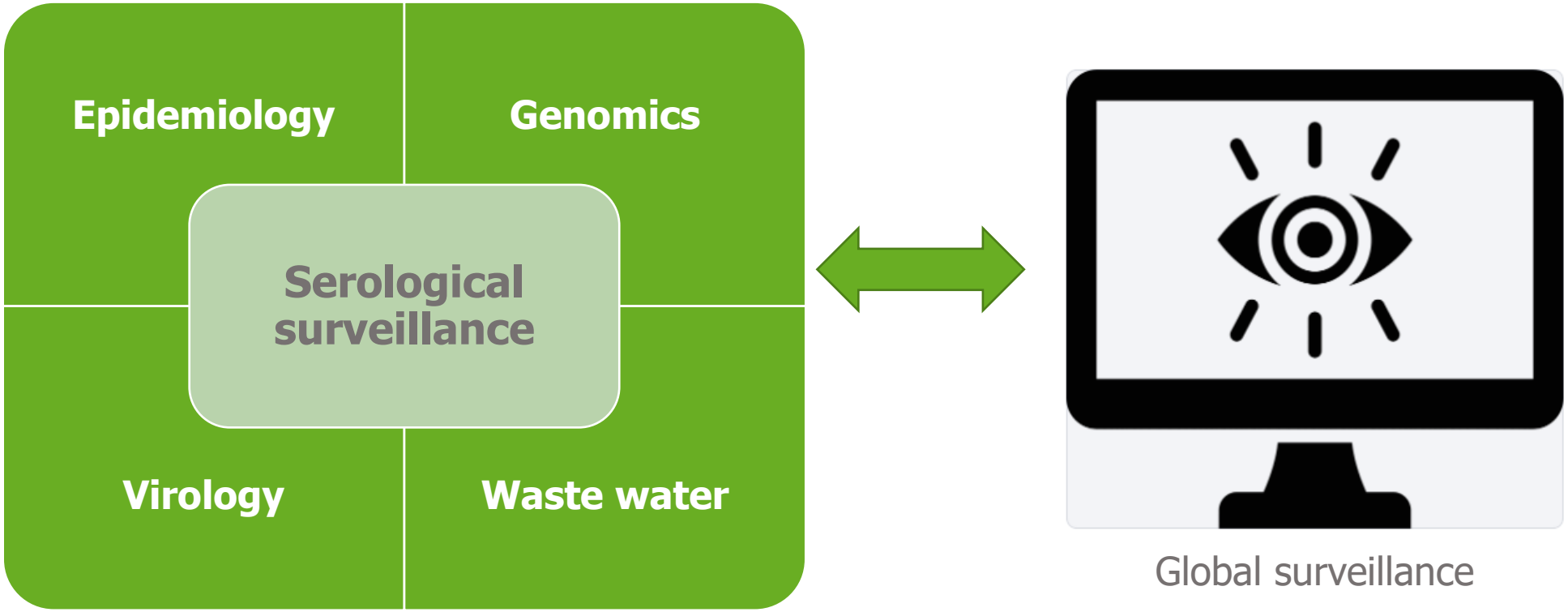
7. Future perspectives

Influenza

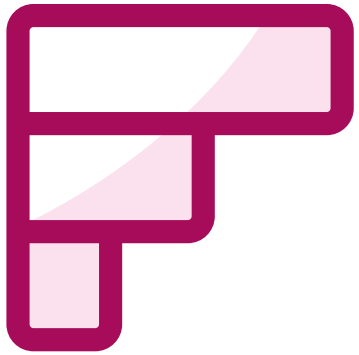
- **Integrated serology** in the surveillance programs: early detection of susceptible, monitoring vaccine coverage and efficacy, better monitor respiratory viruses circulation
- **Advanced serological technologies:** multiplex assays, high-throughput platforms and automation
- **Boarder population immunity studies:** dynamic monitoring of immunity in the population, antibody waning and stronger link to vaccine effectiveness evaluation (emergent viruses)
- **Forecasting outbreaks and epidemics:** influenza virus type/subtypes with transmission advantage in specific populations or geographic locations

7. Future perspectives

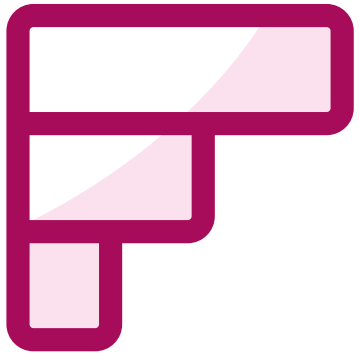
Serological surveillance plays an important role in future infectious disease monitoring by providing critical insights into population immunity and guiding prevention and control strategies



Slido questions



In your country/institution, are serological data currently used for public health decision-making?



What do you see as the biggest limitation of influenza serology?