# Public health surveillance for COVID-19

Interim guidance

22 July 2022

World Health Organization

## Key points

Surveillance for COVID-19 remains critical to ending the COVID-19 emergency worldwide and informing public health actions to limit the spread of SARS-CoV-2 and reduce morbidity, mortality and impact.

**The World Health Organization (WHO) continues to recommend maintaining and strengthening surveillance to achieve the core surveillance objectives for COVID-19. This should include:**

- **early warning** for changes in epidemiological patterns
- **monitoring trends** in morbidity and mortality
- **monitoring burden of disease on health care capacity** (health and care workers, hospitalizations and intensive care unit admissions)
- **incorporating strategic and geographically representative genomic surveillance** to monitor circulation of known variants of concern (VOCs) and allow for early detection of new variants of concern, circulation of SARS-CoV-2 in potential animal reservoirs and changes in virological patterns.

**In addition, WHO continues to recommend Member States with the capacity to carry out enhanced surveillance activities and conduct special studies to:**

- **describe and monitor SARS-CoV-2 infection in high-risk groups** who continue to be at the highest risk of exposure or severe disease
- **characterize new variants,** including aspects of their severity, transmissibility, immune escape and the impact of countermeasures
- **better understand post COVID-19 condition (long COVID**), including the role of immunity and risk factors.

**WHO recommends that the following remain priority groups and settings for SARS-CoV-2 surveillance:**

- **priority groups:** Individuals older than 60 years, individuals with immunocompromising diseases or taking immunosuppressive medications, people with multiple co-morbidities, pregnant women and unvaccinated individuals
- **priority settings:** environments where there is a higher chance that people belonging to priority groups might stay for extended periods of time in close proximity with each other, such as in closed settings, long-term care facilities and nursing homes.

**COVID-19 surveillance reporting variables from Member States to WHO include:**

- **daily cases and deaths**, as per International Health Regulations (IHR 2005) requirements
- **required weekly reporting** to WHO of detailed surveillance variables
    - age and sex of probable and confirmed cases and deaths
    - cases and deaths among health and care workers
    - number of new cases admitted for hospitalization and to an intensive care unit (ICU)
    - number of persons tested with a nucleic acid amplification test (NAAT) and other testing methods.
- **variants of concern (VOCs) and variants of interest (VOIs)**: date of detection of first case and weekly relative prevalence (based on representative sampling)
- **vaccination**: doses administered; number of persons vaccinated with a primary series and booster.

**What is new in this version:**

- updated WHO case definitions (see the Annex), contact definitions, priority groups and settings in line with the latest contact tracing and quarantine guidance
- updates of core and enhanced surveillance objectives and methods in various settings, including environmental and animal surveillance
- updated guidance on surveillance of SARS-CoV-2 variants, including the integration of sampling for genomic surveillance in SARS-CoV-2 testing strategies
- updates of COVID-19 surveillance reporting requirements to WHO, which includes the addition of new ICU admissions for COVID-19 treatment.

# Introduction

The global goals to end the COVID-19 emergency are to reduce SARS-CoV-2 transmission and the impact of COVID-19 disease. Surveillance remains fundamental to understanding the evolution of the virus, the risk factors for severe disease and the impact of vaccination and public health and social measures.

This document, which updates the guidance published on 14 February 2022, provides guidance to World Health Organization (WHO) Member States on the continued implementation and strengthening of surveillance for COVID-19 disease and the SARS-CoV-2 virus that causes it and reporting requirements for WHO. The updated guidance reflects adjustments to surveillance activities Member States should perform as the pandemic continues. It should be read in conjunction with other WHO COVID-19 guidance materials, including recommended preparedness, readiness and response activities(1), contact tracing(2) for COVID-19, clinical management for COVID-19 (3) and the SARS-CoV-2 laboratory(4) and sequencing guidance(5).

The document outlines the current and continued needs for surveillance during the acute phase of the pandemic, which are critical to address COVID-19 within this context. It is not meant to describe long-term surveillance strategies for COVID-19 beyond the acute phase. The main intended audience of this document is public health surveillance technical officers, but it should be helpful for information purposes for all public health authorities and practitioners.

While this guidance is specific to the current setting of the acute COVID-19 emergency, WHO is working with Member States to strengthen COVID-19 surveillance for the longer term while also integrating SARS-CoV-2 testing into existing respiratory disease surveillance systems. This document will be further updated if there are major changes in the surveillance requirements during the remainder of the acute phase of the pandemic. Updated information and other guidance on COVID-19 can be found on WHO's website .

# Methodology

The recommendations in this document are based on existing WHO guidance, which are referenced throughout, and have been updated to align recommendations with the latest published tools and incorporate updated scientific evidence. Literature reviews were conducted to identify new published studies that provide evidence to underpin the document's recommendations. They included studies in the following areas:

- signs and symptoms in people with COVID-19
- chest imaging for detection of COVID-19
- sensitivity and specificity for early warning of signals of increases of transmission/severity
- testing strategies for the best early warning outcome in the overall population and in targeted population and settings, including genomic surveillance
- trend monitoring
- genomic surveillance signals
- environmental surveillance: signals and predictive value.

Additional references were provided by technical advisors from various WHO departments including, but not limited to, Serosurveillance, Laboratory and Diagnostics, Clinical Management and Immunization. Existing guidance documents from WHO and other partners (European Centre for Disease Prevention and Control, United States Centers for Disease Control and Prevention) were also used as resources.

In addition, a survey was conducted on the variables required to be reported to WHO and acceptability and feasibility of reporting for Member States. Further, a series of informal consultations on surveillance methods were conducted in April 2022 with Regional Offices and Member States; 42 Member States from all six WHO Regions attended the consultations, and information on the availability of variables was retrieved from 166 out of 194 WHO Member States.

The WHO Epidemiology Technical advisory group, the WHO Infection Prevention and Control (IPC) and Contact Tracing Guideline Development Groups were consulted in the development and review of this document. This interim guidance was additionally reviewed by WHO Regional Office surveillance technical teams, which assessed the feasibility and acceptability of the latest recommendations.

# 1. Recommended COVID-19 surveillance for Member States

## 1.1. Aims and objectives

WHO continues to recommend maintaining and strengthening surveillance to achieve the core surveillance objectives for COVID-19, including:

- **early warning** for changes in epidemiological patterns
- **monitoring trends** in morbidity and mortality
- **monitoring burden of disease** (health and care workers, hospitalizations, intensive care unit admissions)
- **incorporating strategic and geographically representative genomic surveillance** to monitor circulation of known variants of concern (VOCs) and allow early detection of new variants of concern, circulation of SARS-CoV-2 in potential animal reservoirs and changes in virological patterns.

In addition, WHO continues to recommend Member States with the capacity to carry out enhanced surveillance activities and conduct special studies to:

- **describe and monitor SARS-CoV-2 infection in high-risk groups** who continue to be at the highest risk of exposure or severe disease
- **characterize new variants, including aspects of** their severity, transmissibility, immune escape and the impact of countermeasures
- **better understand post COVID-19 condition (long COVID), including the** role of immune status and risk factors
- estimate **vaccine effectiveness** and the level of population immunity.

**WHO recommends that the following remain priority groups and settings for SARS-CoV-2 surveillance.**

- **Priority groups:** individuals older than 60 years, individuals with immunocompromising diseases or taking immunosuppressive medications, people with multiple co-morbidities, pregnant women and those informed by a medical professional that they are at high risk for severe disease and unvaccinated individuals.
- **Priority settings:** environments where there is a higher chance that people belonging to priority groups might stay for extended periods of time in close proximity with each other, such as long-term care facilities and nursing homes.

It is important to maintain routine syndromic surveillance for other infectious diseases, especially those caused by respiratory pathogens (such as influenza and respiratory syncytial virus) through surveillance for influenza-like-illness (ILI), severe acute respiratory infection (SARI) and acute respiratory infections (ARI), with sampling and laboratory testing of all or a subset of cases through sentinel surveillance sites. Universal/national reporting of clusters of unusual or unexplained respiratory syndromes is also vital. Both are critical for understanding trends in other diseases with similar presentations to guide appropriate public health preparedness and clinical management. WHO is working on recommendations to integrate SARS-CoV-2 surveillance and diagnosis within existing respiratory disease surveillance systems, such as those for influenza, respiratory syncytial virus (RSV) and MERS-CoV.

As vaccination is deployed, surveillance enhances understanding of the impact of vaccination on transmission dynamics and monitoring of vaccine effectiveness at a population level (see Vaccine guidance(6)).

Response measures (such as public health and social measures) are adjusted at sub-national levels, as informed by epidemiological and health system indicators. Countries are encouraged to monitor the data at appropriate sub-national levels to inform risk assessment, response decisions and readiness planning; but WHO does not require reporting of sub-national data.

## 1.2. Diagnostic tools and detection strategies

**Confirmation of infection**

Data on the number of individuals tested for SARS-CoV-2 should continue to be collected from all relevant laboratories and/or testing sites within the health system. Nucleic acid amplification test (NAAT) testing is the reference standard method to identify SARS-CoV-2 infection, but antigen-based rapid diagnostic tests (Ag-RDTs) can also be used to confirm SARS-CoV-2 infection. The number of tests conducted and infections confirmed by each diagnostic method should be recorded and reported. Knowing the testing denominator can indicate the level of surveillance activity, and the proportion of positive tests can indicate the intensity of transmission. It is also important to capture information on:

- testing eligibility criteria and changes in the testing strategy to facilitate interpretation of testing and positivity rates
- the total number of individuals tested for SARS-CoV-2 (this is distinct from the number of tests conducted, which may not be an accurate denominator owing to the possibility of repeat testing of a single individual).

As COVID-19 has become less severe, testing strategies are steering away from exhaustive detection of all cases but should be maintained at a level ensuring sufficient sensitivity to detect unusual increases in incidence and timely and sensitive detection of variants.

**The minimum testing rate that should be maintained is one person tested per 1000 population per week**, as advised by WHO since May 2020 and recently corroborated by modelling studies(7)**.**

**Nucleic acid amplification tests (NAAT)**

In the initial stages of the epidemic, nucleic acid amplification tests (NAAT) such as real-time the polymerase chain reaction test (RT-qPCR) were the only WHO-recommended assays for confirmation of a case. RT-qPCR and other NAAT assays can be manual or have varying degrees of automation that simplify use. For the purposes of surveillance, however, all NAAT tests are considered equal. More information can be found in Diagnostic testing for SARS-CoV-2(8).

**Antigen-detecting rapid diagnostic tests (Ag-RDTs)**

In addition to NAAT tests, which remain the reference standard, Ag-RDTs can serve as a complementary method for diagnostic confirmation given certain circumstances, as detailed in the case definition. The minimum performance requirements for Ag-RDTs is ≥ 80% sensitivity and ≥ 97% specificity, as established through a formal process of target product profile (TPPs) development for priority SARS-CoV-2 diagnostics.

This technology for SARS-CoV-2 detection is much simpler and faster to perform than nucleic acid amplification tests like RT-qPCR and can be conducted outside of clinical and laboratory settings, by trained individuals (9) or by the patient or care-giver, as part of self-testing (10). Although these Ag-RDTs are less sensitive than NAAT, they offer rapid, inexpensive, and early detection of the most infectious SARS-CoV-2 infections in places where NAAT testing is not available or results are not timely. However, when there is no transmission or low transmission, the positive predictive value of Ag-RDTs will be low, and NAATs are preferable as first-line testing or for confirmation of Ag-RDT positive results. Self-tests using saliva are not included for these testing strategies because evidence on performance is still needed.

Two types of antigen-detection Rapid Diagnostic Tests (Ag-RDT) are available:

**- Professional use SARS-CoV-2 antigen-RDT:** WHO emergency use listing (EUL)-approved Ag-RDT, in which sample collection, test performance and result interpretation are done **by a trained operator**

**- Self-test SARS-CoV-2 antigen-RDT:** WHO EUL-approved Ag-RDT in which sample collection, test performance and result interpretation are done **by patients themselves or by a care giver who is not a trained operator**

Based on all reviewed evidence, self-testing achieves accuracy that is similar to professional testing with Ag-RDTs. Compared to existing or no testing options, SARS-CoV-2 self-testing has the potential to increase access, reduce time to receiving results and taking post-test actions, achieve good uptake, inform individual risk-based decision making and enable diagnosis of cases that may otherwise have been missed.

- *Diagnosis*

When used for diagnosis, self-tests will be more likely to detect current infection when performed within the first 5-7 days of the disease course. Where there is ongoing community transmission, and testing is targeted towards individuals with symptoms and/or recent exposures (such as contacts or health and care workers), COVID-19 self-testing can be considered for **diagnostic purposes**, without a requirement for further confirmatory testing.

- *Screening*

Self-testing for screening purposes can be considered among individuals without symptoms or known exposure to SARS-CoV-2 irrespective of intensity of community transmission. For this application, a negative self-result could enable participation in an activity and, depending on the epidemiological situation, a positive self-test result may be followed by confirmatory testing.

Further information is available in Antigen detection in the diagnosis of SARS-CoV-2 infection using rapid immunoassays(11), use of antigen detection rapid diagnostic testing(12), and Use of SARS-CoV-2 antigen-detection rapid diagnostic tests for COVID-19 self-testing(10)

**Other considerations on testing**

Guidance on testing strategies has been published here(13) (see **Table 1** for key points relevant to surveillance).

- Individuals meeting the suspected case definition for SARS-CoV-2 infection should be tested, regardless of vaccination status or disease history.
- If resources are constrained, and it is not possible to test all individuals meeting the case definition, the following groups should be prioritized for testing:
    - individuals who are at risk of developing severe disease (see definitions above)
    - health and care workers
    - inpatients in health facilities
    - the first symptomatic individual or subset of symptomatic individuals in a closed setting (e.g. long-term care facilities) in the context of a suspected outbreak.
    - individuals who have regular contact with those who are at risk of developing severe disease (see definitions above) in settings including households, health care facilities and long-term care facilities.

Routine testing of asymptomatic individuals with NAAT or Ag-RDTs is currently recommended only for specific groups, including contacts of confirmed or probable cases of SARS-CoV-2 infection, and frequently exposed groups, such as health and care workers and long-term care facility workers. Widespread screening of asymptomatic individuals is not currently recommended, owing to the significant costs associated with it and the lack of data on its operational effectiveness.

Mutation-detecting NAAT assays may be used as a screening tool for SARS-CoV-2 variants, but the presence of a specific variant should be confirmed through sequencing. Such tests should be appropriately validated for this purpose.

The network of SARS-CoV-2 testing facilities should leverage and build on existing capacities and capabilities and be able to integrate new diagnostic technologies and adapt capacity according to the epidemiological situation, available resources and country-specific context.

**Table 1 Prioritization for testing where testing and response capacity are outstretched**

| Situation | Alternative measures |
|---|---|
| Individual meeting case definition for suspected SARS-CoV-2 infection but with mild symptoms and no risk factors | Test when possible. If Ag-RDT or NAAT is not available, register as a suspected case and home isolate, as per WHO guidance. Prioritize testing of persons from vulnerable populations (e.g. health and care workers) as per definitions above. |
| Individual meeting case definition for COVID-19, requiring admission to health care facility | Strongly recommended to test using Ag-RDT or NAAT, where available. If testing is not possible, implement isolation measures to prevent nosocomial transmission. |
| Individual meeting case definition for COVID-19, with no known COVID-19 contact, having regular contact with populations at high risk for severe disease | Recommended to test using Ag-RDT or NAAT. |
| Symptomatic health worker with no known SARS-CoV-2 contact | Strongly recommended to test using Ag-RDT or NAAT. |
| Increased number of suspected cases in a specific group (potential cluster) | Test a subset of the cases using Ag-RDT or NAAT. Consider all other symptomatic individuals as probable cases and isolate, as per WHO guidance. |
| Symptomatic individuals in closed settings, including schools, hospitals, long-term living facilities | Test a subset of the cases using Ag-RDT or NAAT. Consider all other symptomatic individuals as probable cases and isolate, as per WHO guidance. |
| Recovering patient | Not necessary to test. |

| Situation | Alternative measures |
|---|---|
| Asymptomatic contacts of confirmed or probable cases, including health and care workers | Quarantine as per WHO guidance with testing, where possible, to shorten quarantine. If contacts become symptomatic, assume COVID-19 and isolate, as per WHO guidance. |

**Testing individuals with immunity for SARS-CoV-2**
Any individuals meeting the suspected case definition, regardless of vaccination status or previous infection with SARS-CoV-2, should be tested, if testing is indicated. Further details can be found here(13).

**Antibody detection (serology)**

Serological assays that detect antibodies produced by the human body in response to infection with the SARS-CoV-2 or COVID-19 vaccination can be useful in various settings. WHO has developed standardized seroepidemiology protocols to support national public health and social measures, promote the international comparability of research and address gaps in current knowledge of COVID-19. More information can be found here (14).

Serosurveillance studies can be used to support the investigation of an ongoing outbreak and to support the retrospective assessment of the attack rate or the size of an outbreak. As SARS-CoV-2 is a novel pathogen, understanding of the antibody responses it engenders is still emerging. Antibody detection tests should therefore be used with caution and not as a means to test for acute infections or for clinical management. The role of non-quantitative assays for antibody detection in epidemiologic surveys is being studied.

Immune seroconversion is determined by testing for the presence (and concentration) of antibodies directed against various SARS-CoV-2 proteins early in the course of disease (acute phase – first few days after onset of symptoms) and again weeks later, after symptoms have resolved (convalescent phase). A significant rise in antibody from baseline to the convalescent phase allows retrospective case confirmation. Result interpretation would depend on several factors, such as previous infection- or vaccine-derived immunity and the type of serological test performed: for anti-N (nucleocapsid) or anti-S (spike) neutralizing antibodies.

More information can be found in Diagnostic testing for SARS-CoV-2 (8).

## 1.3. Core surveillance for COVID-19: Methods and settings

Core surveillance objectives are :

- **early warning** for change in epidemiological patterns
- **monitoring trends** in morbidity and mortality
- **monitoring burden of disease on health care capacity** (infections in health and care workers, hospitalizations, intensive care unit admissions)
- **genomic surveillance**: circulation of variants of concern (VOCs), circulation in potential animal reservoirs, change in virological patterns.

Evidence and data to support these core surveillance objectives can be found in a wide range of data sources, point of care, health systems and other indirect sources (Table 2) and should be triangulated if possible.

**Table 2 Examples of core surveillance methods for SARS-CoV-2 in various settings**

| | Core Surveillance Objective | | | |
|---|---|---|---|---|
| **Surveillance data source/ system/setting** | **Early warning** | **Morbidity and mortality trend monitoring** | **Health care capacity** | **Genomic surveillance** |
| **Community** | X | X | | |
| **Primary Care sites** | X | X | X | |
| **Pharmacies** | X | X | | |
| **Laboratories** | X | X | | X |
| **Hospitals** | X | X | X | |
| **Private clinics** | | X | X | |
| **Financial/billing datasets** | | X | | |
| **Civil registration and vital statistics** | | X | | |
| **Sentinel ILI/ARI/ SARI sites** | | X | X | X |
| **Closed settings*** | X | X | X | X |
| **Humanitarian settings** | X | X | X | X |
| **Travelers at points of entry** | X | | | X |
| **International conveyance wastewater** | X | | | X |
| **Environmental surveillance of community wastewater** | X | | | X |
| **Human-animal interface** | X | | | X |

*Including but not limited to long-term care facilities, prisons and dormitories.

**Closed settings**

People who live in closed environments such as prisons, residential facilities, retirement communities and care homes for persons with disabilities can be especially vulnerable to COVID-19. The reasons include the probability that transmission may be higher than in the general population or because residents have health conditions or predisposing factors that increase the risk of severe illness and death. Dedicated enhanced surveillance for some high-risk groups residing or working in closed settings is necessary to ensure the prompt detection of cases and clusters faster than through primary-care or hospital-based surveillance. Enhanced surveillance in closed settings includes the use of active case finding through frequent screening for signs and symptoms for COVID-19; and zero reporting (the reporting of zero cases when none are detected) for all individuals in high-risk groups under surveillance.

**Humanitarian settings**

There are several strategies for the detection of SARS-CoV-2 infection in refugee camps and among displaced populations and in other humanitarian or low-resource settings. Event-based surveillance can help pick up early warnings and alerts. Where Early Warning, Alert and Response (EWAR) or Community Based Surveillance (CBS) systems are in place, COVID-19 disease should be integrated into them and active case finding can be conducted where feasible. In health care facilities, syndromic surveillance may be put in place.

Testing strategies should target suspected cases following WHO case definitions. Further prioritization can depend on the transmission levels, “high-risk” groups and resources available. Further information can be found in the Interagency Guidance on scaling-up COVID-19 outbreak readiness and response operations in humanitarian situations (15). Additional guidance for humanitarian operations, camps and other fragile settings can be found here (16).

### 1.3.1. Early warning

The objective of an early warning system is to strike a balance between sensitivity and specificity:

- sensitivity to any signal indicative of increased risk (transmissibility, severity)
- specificity: investigation for additional evidence to confirm the risk and driving factors including immune escape and transmission factors
- shortest time frame possible between the detection of the signal and confirmation/dismissal of the alert.

This implies

- triangulation of signals from multiple sources
- strong, rapid response and investigation resources and procedures, as well as coordination between stakeholders.

Early warning active surveillance methods according to site and context are summarized in Table 3.

**Table 3: Early warning active surveillance methods for SARS-CoV-2 in various settings**

| | **Early warning active surveillance methods** | | | | |
|---|---|---|---|---|---|
| **System Site/ Context** | **Mandatory notifiable disease screening and reporting** | **Cluster investigations** | **Community-based surveillance** | **Environmental surveillance** | **Pharmaceutical vigilance** |
| **Community** | | X | X | X | |
| **Primary care sites** | X | X | | | X |
| **Pharmacies** | | | | | X |
| **Hospitals** | X | X | | | X |
| **Laboratories** | X | | | | |
| **Sentinel ILI/ARI/ SARI sites** | X | | | | X |
| **Closed settings*** | X | X | X | X | X |
| **Humanitarian settings** | X | X | X | X | X |
| **Travelers at points of entry** | X | X | | X | |
| **International conveyance wastewater** | | X | | X | |

*Including but not limited to long-term care facilities, prisons and dormitories.

**Community-based surveillance**

Where possible, individuals meeting the case definition for a suspected case should be able to access evaluation and testing, ideally at the primary care level. If testing capacity is scarce, the probable case definition described above can be used, without testing, to initiate response activities.

Cases identified through travel-related testing should be included in the data reported. In low-resource settings, travel-related tests samples may represent a large proportion of tests performed, which may bias the representativeness of reported cases. If resources are limited, it is recommended to deprioritize travel-related testing.

**Event Based Surveillance**

The capacity to rapidly detect any changes in the overall COVID-19 situation can be further strengthened through robust event-based surveillance (EBS) mechanisms. EBS complements conventional public health surveillance efforts by capturing unstructured information from formal and informal channels, such as online content, radio broadcasts and print media, communities, health workers and laboratory workers. Successful EBS implementation requires dedicated human resources and clear processes to sift through large volumes of information to filter, triage, verify, compare, assess and communicate relevant content. Many web-based systems have been developed over the years to support EBS activities, and many converge through the WHO-led Epidemic Intelligence from Open Sources (17) (EIOS) initiative. It is equally important to monitor for other potential non-COVID-19 events that may emerge in parallel, having further effects on lives and compromising COVID-19 response efforts. Further guidance on EBS is available in the WHO Guide to establishing Event Based Surveillance (18) and from the Africa Centres for Disease Control and Prevention, here (19).

**Health care-associated infections**

In countries with mandatory reporting systems for health care-associated infections, SARS-CoV-2 infection should be included as a priority condition for reporting within these systems, in addition to being counted within general COVID-19 surveillance. All cases and clusters in health care settings should be investigated and documented for their source and transmission patterns to allow rapid control. Specific reporting of the number of COVID-19 cases and deaths (including asymptomatic SARS-CoV-2 infections) in health and care workers should be implemented and reported to the national surveillance system, in line with the latest reporting format. Additional resources on COVID-19 among health and care workers in a health care setting can be accessed here (20), here (21) and here (22).

### 1.3.2. Monitoring trends in COVID-19 morbidity and mortality

The aim of this activity is to produce reliable and stable time series for relevant epidemiological indicators to analyse patterns and identify timely departures in trends. The key principles are stability, regularity and reliability of data. Weekly analysis and reporting are recommended. The surveillance indicators and methods for trend monitoring according to site and context presented in Table 4.

**Table 4: Monitoring trends in various settings**

| | Surveillance indicators/methods for trend monitoring | | | |
|---|---|---|---|---|
| **System site/ Context** | **Mandatory notifiable disease routine reporting** | **Hospitalization/ICU admissions** | **Routine mortality surveillance** | **Routine environmental surveillance** |
| **Community** | | | X | X |
| **Primary care sites** | X | | | |
| **Hospitals** | X | X | X | |
| **Sentinel ILI/ARI/ SARI sites** | X | | | |
| **Laboratories** | X | | | |
| **Closed settings*** | X | | X | X |
| **Humanitarian settings** | X | | X | X |
| **Civil registration and vital statistics** | | | X | |
| **Financial/billing datasets** | | X | | |

*Including but not limited to long-term care facilities, prisons and dormitories.

## *Morbidity*

Surveillance in primary care settings is needed to detect cases and clusters in the community. Where possible, testing should be available at primary care clinics. Rapid data reporting and analysis are critical to detect new cases and clusters and to initiate appropriate control measures. Zero reporting – including by sites at the primary care level – is crucial to verifying that the surveillance system is continuously functioning and for monitoring virus circulation. Given competing priorities for resources, however, it may not be practical for all primary care settings to conduct zero reporting, in which case a subset (e.g. sentinel sites, see below) can be selected to do so.

At the primary care level, private facilities and laboratories provide a large proportion of the tests performed and should be included in detection strategies and reporting systems.

Patients with probable or confirmed COVID-19 admitted to hospitals should be notified to national public health authorities in a timely manner. Some essential data, such as outcome, may not be immediately available but should not delay notification to public health authorities.

**Sentinel syndromic surveillance**

Sentinel syndromic surveillance is a complementary approach to the other forms of surveillance listed in this document. The advantage of using a sentinel surveillance system is that a systematic, standardized approach to testing is used based on syndromic case definitions and are not affected by changes in testing strategies that could have an impact on the other COVID-19 surveillance approaches.

Countries that conduct primary care or hospital-based sentinel surveillance for influenza-like-illness (ILI), acute respiratory infection (ARI), severe acute respiratory infection (SARI) or pneumonia should continue this syndromic surveillance and collection of respiratory specimens through sentinel networks using existing case definitions. Laboratories should continue virologic testing of routine sentinel site samples for influenza in addition to testing samples for SARS-CoV-2. Multiplex assays have been developed for combined testing for influenza and SARS-CoV-2. Countries are encouraged to conduct year-round sentinel surveillance for acute respiratory syndromes along with testing for SARS-CoV-2.

Within the existing surveillance systems, the patients selected for additional testing for SARS-CoV-2 should preferably be representative of the population and include all ages and sex. If possible, continue to collect samples from both ILI (outpatient) and SARI (inpatient) sentinel sites to represent both mild and severe illness. Based on the local situation, resources and epidemiology, countries may wish to prioritize sampling among inpatients (SARI or pneumonia cases) to understand SARS-CoV-2 circulation in patients with more severe disease. Further guidance on sampling for testing in sentinel sites can be found in Global Epidemiological Surveillance Standards for Influenza (23).

SARS-CoV-2 infections identified through sentinel surveillance should be reported as part of overall national SARS-CoV-2 infection/COVID-19 case counts, as well as through relevant sentinel-site channels.

Additional guidance on sentinel site surveillance for COVID-19 is found in the interim guidance for maintaining surveillance of influenza and monitoring of COVID-19 (24).

**Environmental surveillance**

Routine clinical SARS-CoV-2 surveillance programs have been augmented with community-level environmental surveillance (ES) in an increasing number of settings globally. The most experience has been gained with the sampling of sewage to capture SARS-CoV-2 genetic material shed in faeces and respiratory secretions that are discharged into sewage.

A number of scenarios have emerged in which ES has been used to detect unrecognized transmission and provide an additional source of information to support decision-making about whether to adjust public health and social measures. These include:

- early warning (3-7 days) of increasing trends in cases (moderate- to high-prevalence settings).
- overcoming complacency for clinical testing by publicizing presence or increase of ES SARS-CoV-2 signals in a specific geographic area (low- to moderate-prevalence settings)
- cost-effective targeting of clinical testing resources to areas with higher ES signals (spatially discrete, low to moderate prevalence settings)

- informing early and targeted restrictions in pockets of re-emergence to help reduce the extent and economic impact or restrictions (spatially discrete, low-prevalence settings)
- targeted surveillance for early warning of circulation in high-risk contexts such as managed isolation facilities, aged care facilities, prisons, informal settlements, refugee and displaced person settings; transport vessels at borders such as planes and ships; events and gatherings; and isolated communities
- identification of known variants (where presence of variants is uncertain), identification and tracking emergence of novel variants using whole genome sequencing (moderate- to high-prevalence settings).

Wherever ES has been used, its application has been adjunct to, and not in place of, clinical surveillance. Clarity on coordination, data sharing and interpretation of results between entities responsible for ES and public health (PH) surveillance is critical to make effective use of ES data in COVID-19 response strategies. Methods for sampling, analysis and interpretation of data are evolving. Several protocols exist but there is as yet no internationally agreed protocol for ES of SARS-COV-2.

Applications to date have been most successful in settings with high sewerage coverage. Pilot testing in settings with low sewerage coverage and predominantly on-site sanitation systems have deployed sampling strategies and capacities from the polio ES programs.

Additional information can be found in the interim guidance Environmental surveillance for SARS-COV-2 to complement public health surveillance (25).

### *Mortality*

There are three main approaches for estimating COVID-19-attributable mortality and excess mortality due to indirect effects on health systems.

- **Civil registration and vital statistics.** Formal death certification, including cause of death attributable to COVID-19, should be done as routinely required by civil registration systems. Countries should also monitor deaths resulting from non-specific respiratory causes such as unspecified pneumonia, which may represent undiagnosed COVID-19. In addition, vital statistics should monitor excess all-cause mortality over time, as changes may be related to the COVID-19 pandemic's effects on health systems.
- **Ad hoc surveys**. Where civil registration and vital statistics systems are limited or non-existent, rapid mortality surveillance may be considered. Further guidance can be found in the document Revealing the toll of COVID-19 (26), and on the webpage The true death toll of COVID (27).
- **Using COVID-19 surveillance data**. The number of COVID-19 deaths occurring in hospitals should be reported at least weekly, as should the number of COVID-19 deaths occurring in the community, including in long-term-care facilities. For both hospital and community COVID-19 deaths, the age, sex and location of death should be recorded. Surveillance data can be used to model excess mortality.

To ascertain that the cause of death from COVID-19 for deaths occurring outside of health care settings, see the WHO Verbal Autopsy tool (28), which now includes COVID-19.

#### 1.3.3.Health care facility occupancy- burden on health care capacity

Monitoring of the impact of COVID-19 on health care response capacity to admit and care for severe cases should become a staple monitoring item and part of the COVID-19 surveillance package.

Health care capacity data, such as bed occupancy, seldom follow the same data flow as patient surveillance data, especially in hospital settings. Acquiring these data in a stable and timely manner can require adjustments in dataflow systems. Private health facilities should contribute to bed capacity/occupancy surveillance systems.

Settings where SARI sentinel sites are already actively reporting should be included in health care capacity monitoring. Health care capacity trends should be monitored closely with other indicators to anticipate overwhelmed capacity, identify alert thresholds for surge measures and escalate potential public health and social measures (PHSM) in a timely manner to allow for rapid adaptation of resources.

**Table 5: Health care capacity indicators and sources**

| System Site/ Context | Health care capacity indicators | | |
|---|---|---|---|
| | Health care worker absenteeism | Number (or percent) of beds dedicated/available for COVID treatment | Oxygen supply |
| **Primary Care sites** | X | | |
| **Pharmacies** | X | | |
| **Hospitals** | X | X | X |
| **ICU** | X | X | X |
| **Private clinics** | X | X | X |
| **Sentinel SARI sites** | X | X | X |
| **Closed settings*** | X | | |
| **Humanitarian settings** | X | | X |

*Including but not limited to long-term care facilities, prisons and dormitories.

### 1.3.4. Genomic surveillance

Genomic surveillance should be integrated into overall COVID-19 detection, testing and reporting strategies, and sampling for genomic sequencing should be defined as a subset of all testing measures. This should include collecting secondary samples for sequencing purpose from individuals who have tested positive with Ag-RDT.

*Sampling considerations*

**The turnaround time from sample collection to genomic result has an impact on the sensitivity of variant detection**. The longer the turnaround time, the larger the sample required to detect a variant at a given prevalence.

**Frequent sampling to produce a time series** should be prioritized, rather than seeking to obtain a large quantity of samples at a given time. It is therefore preferable to have small but stable sampling from a fixed Global Influenza Surveillance and Response System (GISRS) sentinel site, National Influenza Centre or teaching hospital than to have large but variable batches of samples of uneven geographical origin that will render time series and trends difficult to analyse. This consideration is especially important for countries that send samples overseas for genomic sequencing.

*Randomized representative sampling*

Randomized representative sampling can be defined as a selection of a subset of a given target population that is representative of the target population situation. Samples should be obtained across a distribution of age, sex, clinical spectrum and geographical location at minimum. Routine randomized representative sampling for genomic sequencing should be included in testing strategies, with a clear methodology, data flow and workflow defined to randomly select samples from testing sites and channel them for sequencing. Samples should be obtained regularly from the community as opposed to focusing only on sequencing travelers' samples.

**Variable Sample sizes**

Various sample size calculators (29,30) can help to refine the number of specimens from a representative sample that need to undergo genomic sequencing to detect with a specified level of confidence variants circulating at low levels. Given that sequencing capacity is highly variable across countries, and achievable sample sizes may be highly dependent on capacity, it is possible to use these same sample size calculators to 'back-calculate' the level of confidence and precision in available sequence data.

The European Centre for Disease Prevention and Control (ECDC) has released detailed guidance on sample size calculations to detect and monitor the proportion of variants circulating at low levels and includes tables showing the required sample size under various situations and given certain parameters. Considerations when identifying a sample include:

- level of precision/sensitivity to detect
- level of confidence required (e.g. 95% confidence)
- level of transmission within the country (a larger sample will be required when the incidence is high and there are many people with SARS-CoV-2 infection).

The unit of sampling frequency (regular, routine sampling weekly, every two weeks, or every month) should also be considered, because the relative prevalence of variant lineages can change rapidly. Turnaround time between sampling and results need to be taken into account in the sampling frequency, as does the desired sensitivity.

Countries decide the desired sensitivity to detect variants circulating at low levels, changes in the relative prevalence of variant lineages and the level of confidence of the surveillance findings. In general, for public health purposes, the sensitivity to detect variants circulating at low levels may be the primary driver of sample size decisions because the public health significance of detecting a variant that was not detected before may be higher than detecting a modest change in the relative prevalence of a given lineage. Additionally, estimates of the sample size needed to monitor relative prevalence are more complex in settings with multiple different lineages in simultaneous circulation. The size of the sample should be calculated to fit detection and monitoring of the variant with the smallest prevalence.

**A minimum sampling rate of 1 person tested per 1000 population per week should be maintained**, as advised by WHO since May 2020 and recently corroborated by modelling studies(7)**.**

**Table 6**: **Sample sizes required to detect a significant change (at 95% confidence) of relative prevalence**

| Weekly number of SARS-CoV-2 detections | Sample size based on the difference in the proportion of a certain variant, from one week to another | |
|---|---|---|
| | **From 2.5% to 5%** | **From 2.5% to 10%** |
| >100,000 | 725 | 129 |
| 10,001-100,000 | 705-720 | 129 |
| 5,001-10,000 | 676 | 128 |
| 2,501-5,000 | 634 | 126 |
| 1,001-2,500 | 563 | 123 |
| 500-1,000 | 421 | 115 |
| <500 | 296 | 103 |

Sampling methods should be adapted to sampling site storage capacity, transport logistics and sample processing turnaround time. Systematic/consecutive sampling, as opposed to random sampling, can have logistical consequences on sample storage and workflow. The distribution of socio-demographic and clinical severity criteria among sequenced samples should be compared with those of all reported cases as a validation of the quality of representative sampling.

- **Fixed sample sizes**

In countries with minimal laboratory capacity, sequencing a minimum of 15 specimens per week from sentinel sites provides a baseline on which to build (WHO GISRS 2021). The Africa Centres for Disease Control and Prevention (Africa CDC) and the Pathogen Genome Initiative (PGI) network aim to collect a random sample of at least 50 positive specimens from each African country per week, with the goal of establishing a sustainable, routine sampling frame(31). By contrast, the WHO Regional Office for the Americas/Pan American Health Organization (PAHO) recommends that countries sequence at least 50 positive specimens a month. This is roughly equivalent to detection of at least one sample of a variant that has 5% prevalence for the determined sampling period. If the sample size is fixed, the confidence level of failing to detect a specific variant can be 'back-calculated' (29).

- **Denominator for relative prevalence calculation**

The denominator used to calculate the relative prevalence of a given variant based on randomized representative sampling should be consistent with respect to time and sampling methodology.

Mistakes leading to mis-calculation of relative prevalence have included:

- inclusion of samples selected through targeted sampling, including PCR and molecular screening
- different time frames between samples, such as when numerators include the results of samples analysed in the past, and the denominator includes samples sent for analysis in the current week.

*Targeted sampling*

Some variants have phenotypic characteristics of potential concern because of their ability to spread more easily from person to person; cause more severe disease; or dampen the impact of available PHSMs, diagnostics, therapeutics or vaccines. Targeted sequencing of specimens with a higher pre-test probability of being a VOI or VOC might be beneficial in addition to the above strategies. Number of samples sequenced from such specimens should be focused on the first few cases, or the few cases with most recent onset of symptoms, should be targeted for sampling. A subset of cases is sufficient for sampling for sequencing, at the discretion of the investigators, in regard to relevant factors: exposure, transmission chain, severity, outcome, vaccination status, immunological capacity etc

Potential triggers for targeted sequencing include:

- specimen-level characteristics, such as genomic sequencing results from screening assays such as PCR-based single nucleotide polymorphism (SNP) detection assays
- environmental characteristics, such as evidence of variant sequences from wastewater surveillance.

Phenotypic characteristics identifiable by clinicians and public health agencies may be used to prioritize specimens for genomic sequencing. These include specimens from:

- cases of SARS-CoV-2 infection in people who have been vaccinated and have severe disease
- cases of SARS-CoV-2 infection in people who have been previously infected
- cases where there is unexpected discordance between diagnostic tests, such as in clusters of individuals testing positive by rapid antigen test but negative by RT-PCR; characteristic and recurrent drop-out in a single gene target in a multi-target PCR assay; or where sample compartment test results are discrepant (e.g. upper versus lower respiratory tract)
- patient groups, such as immunocompromised patients, with underlying conditions that increase the likelihood of prolonged viral replication and shedding (32–34)
- case clusters with unusual clinical presentations (e.g. unusually severe disease, unusual symptoms)
- case clusters suggestive of zoonotic transmission (e.g. among people working with animals susceptible to SARS-CoV-2 infection)
- cases with unexpectedly poor response to therapeutics.

Alternatively, targeting based on epidemiologic characteristics such as travel history – particularly recent travel to an area with a high incidence of a known VOC – might be used to prioritize specimens (35).

**Outbreak and unusual clusters**

Weekly monitoring of epidemiological indicators at a high geographical granularity allows for timely detection of any departure from trends or unexpected signals. Event-based surveillance may also detect unusual clusters and super-spreading events. This allows for early targeting of investigation and sampling for sequencing.

**Table 7 Examples of disease surveillance indicators and alert triggers**

| Indicators | Alert trigger |
|---|---|
| **Cases** | Increase / departure from trend |
| **Age-disaggregated cases** | Increase in specific age groups (under 18, under 60; to be determined locally) |
| **Cases among health and care workers** | Increase / departure from trend |
| **Case fatality ratio** | Increase / departure from trend |
| **Age disaggregated deaths** | Increase in specific age groups |
| **Hospitalizations/ICU admissions or bed occupancy rate** | Increase in specific age groups |
| **Test positivity rate** | Increase / departure from trend |

These triggers and thresholds should be adapted to local situations, investigation capacity and desired sensitivity.

If routine surveillance systems are not in place to monitor hospital or ICU admissions or bed capacity, demand for oxygen and ventilators may indicate a surge in severe illness, which may or may not be driven by an emerging variant with increased virulence. Such indicators can be followed with joint monitoring from pharmaceutical and biomedical supplies providers.

Similarly, increases in transmission beyond which might be expected given population levels of immunity also warrant further investigation. For example, high levels of community transmission in areas where vaccination coverage is high or there are high levels of past infection may indicate the presence of a variant able to evade the immune response, as has occurred with the Omicron VOC. Please see the WHO guidance on vaccine effectiveness in the context of new SARS-CoV-2 variants (36).

Trends in mortality at the lowest available administrative level can reveal an increase in death rate in particular populations, and the case fatality ratio (CFR) may be estimated if case-based surveillance data covering the same time period and geographic region are also available (see Case Fatality Ratio scientific brief (37)). Increases in CFR may warrant further investigation through genomic characterization, although trends in mortality are unlikely to reveal a variant with higher severity unless there is a drastic change in CFR. The observation that mortality is higher than expected for a given incidence might also be an indicator for increased disease severity.

- **Environmental Surveillance and genomic surveillance**

Detection of variant sequences in wastewater can flag the circulation of a variant and assist in targeting further investigations and sequencing in a given geographical area, such as an informal settlement, or a setting, such as a prison, long-term care facility or passenger ship, where randomized sequencing might be a challenge.

- **Human-animal interface**

Genomic surveillance of potential zoonotic transmission in humans, as well as monitoring of outbreaks in animal rearing locations and sampling in wildlife, should be staple components of human-animal interface genomic surveillance strategies (see Considerations on monitoring SARS-CoV-2 in animals (38). SARS-CoV-2 detection in wastewater originating from animal rearing facilities can also be used as a signal of virus circulation in a potential animal reservoir.

**Table 8 Examples of genomic surveillance methods in various settings**

| | Methods for genomic surveillance | | | |
|---|---|---|---|---|
| **Context** | **Routine representative sampling** | **Targeted (immuno-compromised, travellers)** | **Outbreak and unusual clusters** | **Environmental genomic surveillance** |
| **Community** | X | | X | X |
| **Primary care sites** | X | X | X | |
| **Hospitals** | X | X | X | |
| **Sentinel ILI/ARI/ SARI sites** | X | X | | |
| **Closed settings*** | X | X | X | X |
| **Humanitarian settings** | X | X | X | X |
| **Travelers at points of entry** | | X | | X |
| **International conveyance wastewater** | | | | X |
| **Human-animal interface** | X | X | X | X |

*Including but not limited to long-term care facilities, prisons and dormitories.

# 2. Enhanced public health surveillance methods

**Objectives**

- **Describe and monitor groups at highest risk** of exposure or severe disease.
- **Characterize variant** severity, transmissibility and immune evasion.
- **Assess post COVID-19 condition** by quantifying its occurrence and assessing the role of immune status and risk factors.
- **Estimate vaccine effectiveness and the level of population immunity.**

These objectives require more stringent methodologies to collect health information in controlled settings and populations on a longer-term basis and thus require more resources. The aim of these studies is to provide more granular, reliable data to assess risk factors for infection, severity, transmissibility, immune evasion, post COVID-19 condition and other disease characteristics. Various methodologies can be used: observational, case control, cohort and test-negative design.

**Table 9: Examples of special studies and enhanced surveillance for SARS-CoV-2**

| | Special studies and enhanced surveillance for SARS-CoV-2 | | | | |
|---|---|---|---|---|---|
| **Site/ context** | **Clinical progression surveillance** | **Case control including health workers** | **Vaccine effectiveness** | **Long-term observational cohort studies** | **Transmission** |
| **Community/ participatory surveillance** | X | | X | X | X |
| **Primary care sites** | X | X | X | | |
| **Hospitals** | X | | X | X | |
| **Sentinel ILI/ARI/ SARI sites** | X | X | X | | |
| **Closed settings*** | | X | X | X | X |
| **Humanitarian settings** | | | X | | X |
| **Human-animal interface** | | | | | X |

*Including but not limited to long-term care facilities, prisons and dormitories.

## 2.1. Special studies

**COVID-19 prevalence studies**

With the reduction in widespread testing, it has become increasingly difficult to ensure representativeness of surveillance data. Controlled, point-in-time testing with a regular frequency on a representative subset of a target population can help better assess the relative completeness of incidence data obtained through reported cases and accurately monitor the active transmission of the disease in the community. Countries may consider this approach as a relatively cost-effective way to maintain monitoring of incidence trends in the absence of exhaustive testing. Examples of results can be found from the United Kingdom Coronavirus Infection Survey (39) for which the protocol can be found here (40) .

**UNITY studies: early investigation protocols**

WHO, in collaboration with technical partners, has developed several standardized generic epidemiological investigation protocols, collectively named UNITY studies. These studies aim to support national public health and social measures, promote the international comparability of research and address gaps in current knowledge regarding the COVID-19 pandemic.

- **First Few X (FFX) cases**

The primary objectives of an FFX investigation among cases and close contacts are to provide descriptions or estimates of:

- clinical presentation of SARS-CoV-2 infection and course of associated disease
- secondary infection rate (SIR) and secondary clinical attack rate of SARS-CoV-2 infection among close contacts

- serial interval of SARS-CoV-2 infection
- symptomatic proportion of COVID-19 cases (through contact tracing and laboratory testing)
- identification of possible routes of transmission.

This protocol is particularly useful for the characterization of emerging variants.

The investigation can continue for as long as is determined feasible by the implementing country. The impact of emerging variants on ongoing studies will need to be assessed on a case-by-case basis. In the context of emerging variants, laboratory-confirmed cases could be enrolled retrospectively once whole genome sequencing results are available and a variant sequence is confirmed. Alternatively, they could be identified on the basis of a characteristic diagnostic test result, such as S gene target failures defined as signals for an emerging variant on a multiplex diagnostic assay or a variant-specific RT-PCR, if available. Alternatively, cases could be enrolled without knowing the lineage of the virus and allocated to a variant cohort once whole genome sequencing results are available. The protocol for this approach can be found here (41).

- **Household transmission studies**

A household transmission investigation is a case-ascertained prospective study of all identified household contacts of an individual with laboratory-confirmed SARS-CoV-2 infection. The primary objectives of a household transmission study are to provide key data on:

- proportion of asymptomatic cases and symptomatic cases
- incubation period of COVID-19 and the duration of infectiousness and of detectable shedding
- serial interval of SARS-CoV-2 infection
- reproduction numbers: *R*0 and *R* of SARS-CoV-2
- clinical risk factors for COVID-19 and the clinical course and severity of disease
- high-risk population subgroups
- secondary infection rate and secondary clinical attack rate of SARS-CoV-2 infection among household contacts
- patterns of health care-seeking behaviour.

Duration of data collection between inclusion and the end of the publicly available study protocols is 28 days, but initial results can be produced in a few days to weeks. The initial stages of the survey design and implementation can take some time and are resource intensive. Countries are encouraged to establish surge capacity for these household surveys in advance of variant detection. The protocol can be found here (42).

- **Assessment of risk factors for COVID-19 in health workers**

**Protocol for a prospective study of a cohort of health workers:** This protocol has been designed to investigate the extent of SARS-CoV-2 infection and risk factors for infection among health workers. Follow-up and testing of respiratory specimens and serum of health workers within a facility in which an individual with a confirmed case of SARS-CoV-2 infection is receiving care can provide useful information on transmissibility and routes of transmission and are important for limiting amplification events in health care facilities. The protocol can be accessed here (22).

**Protocol for a case-control study:** This protocol, which aims to assess risk factors for COVID-19 in health workers, consists of a nested case-control study of health workers involved in the care of any confirmed cases of SARS-CoV-2 infection. The study is based on the use of incidence density sampling. It is to be initiated as soon as a case of SARS-CoV-2 infection is confirmed among health workers in a health care setting. Health workers with confirmed SARS-CoV-2 infection will be recruited as cases. Health workers exposed to SARS-CoV-2-infected patients in the same setting but who do not themselves become infected will be recruited as controls, with a target of at least two to four controls for every case. The protocol can be accessed here (43)

## 2.2. Enhanced clinical metadata

**WHO clinical data platform**

WHO has created a global clinical platform of patient-level anonymized clinical data. The platform is a secure, limited-access, password-protected platform hosted on REDCap, a secure web application for building and managing online surveys and databases.

The objectives of the platform are to:

- describe the clinical characteristics of COVID-19
- assess the variations in clinical characteristics of COVID-19
- identify the association of clinical characteristics of COVID-19 with outcomes
- describe the temporal trends in clinical characteristics of COVID-19.

WHO has developed three clinical characterization case report forms (CRFs) to standardize data collection of clinical features of COVID-19 among hospitalized patients and among patients experiencing post COVID-19 condition. The three different CRFs are: core, multi-inflammatory syndrome in children (MIS-C) and post COVID-19 condition.

More information can be found on the WHO Clinical data platform (44).

## 2.3. Serological surveys

Population-based serological surveys and the use of serology in specific settings/populations can help provide estimates of the proportion of a population that has been infected by SARS-CoV-2 virus as measured by antibodies and assess the extent of infection and proportion of unrecognized infections (e.g. asymptomatic or subclinical infections). Age and sex disaggregation of serosurveillance data should be compared with that of the disease surveillance system to determine the sensitivity of the surveillance system.

At this stage, for countries undertaking serosurveillance for SARS-CoV-2, the following primary objectives are recommended:

- to measure the **seroprevalence of antibodies to SARS-CoV-2 in the general population by sex, age group, and vaccination status** to ascertain cumulative population immunity
- to estimate the **fraction of asymptomatic, pre-symptomatic or subclinical infections in the population, including by sex and age group.**

Serological assays can differentiate between infection and vaccine-acquired immunity because anti-N (nucleocapsid) and anti-S (spike) neutralizing antibodies can be used as proxies to distinguish infection versus vaccine-derived immunity. This is only true, however, for samples from people vaccinated with vaccines exclusively targeting SARS-CoV-2 spike proteins.

Serological surveillance can also provide an opportunity to inform or evaluate **secondary objectives**, such as:

- to determine **risk factors for infection** by comparing the exposures of infected and non-infected individuals
- to contribute to an improved estimation of the **infection fatality rate**
- to contribute to an improved understanding of **antibody kinetics at the level of populations** following SARS-CoV-2 infection
- to contribute to a **greater understanding of the immunity** derived from vaccination versus that from infection
- to estimate **uptake of vaccination against SARS-CoV-2** in the population by sex, age and priority target groups.

Countries considering serological surveillance for SARS-CoV-2 infection can choose one of two methods for obtaining samples. Participants may be recruited through a random selection process such as from population-based household surveys or based on convenience (for example, by collecting residual sera of attendees at health care facilities or blood donors). The following three study designs are recommended:

- one-time cross-sectional seroprevalence survey
- repeated cross-sectional seroprevalence survey in the same geographic area (but not sampling the same individuals)
- longitudinal investigation with serial sampling from the same individuals each time.

WHO has developed standardized seroepidemiology protocols to support national public health and social measures, promote the international comparability of research and address gaps in current knowledge of COVID-19. More information can be found here (14). A WHO generic protocol "Population-based age-stratified seroepidemiological investigation protocol for coronavirus 2019 (COVID-19) infection" is available here (45). In light of vaccine roll-out, this protocol is being adapted to include estimation of vaccine uptake and other indicators such as case fatality ratio and proportion of asymptomatic infections stratified by vaccination status.

## 2.4. Vaccination effectiveness and impact

Given the many vaccines used by different countries worldwide and the surveillance being conducted to guide the response to COVID-19, countries should conduct basic surveillance to help understand vaccine impact in their context. Data to support monitoring of vaccine impact should, as much as possible, leverage existing systems already in place for COVID-19 surveillance.

Objectives include:
-**Characterizing the epidemiologic context to guide vaccine rollout.** Based on surveillance data, countries should determine where (geographically and/or by sub-population) the COVID-19 burden remains high and use this information to guide phased vaccine introduction.
- **Understanding vaccine effectiveness (VE) and the impact of vaccination.** One option to monitor VE over time is to nest vaccine effectiveness studies in existing surveillance systems. Surveillance systems would need to be reinforced to ensure that there is no selection bias in the population included in the VE study, and that vaccination, outcome and confounding factors/effect modifiers are well documented. Ideally, this is best done through sentinel site surveillance and can be efficiently added to influenza sentinel site surveillance, such as in influenza-like illness sites and acute respiratory infection and SARI sites (46), by adding questions related to vaccination and SARS-CoV-2 testing and the genomic sequence of the SARS-CoV-2 strain. Other potential sentinel surveillance sites include acute febrile illness sentinel sites or COVID-19 diagnostic centres. In all settings, case definitions must be adhered to strictly, and reliable high-quality data must be collected. It is valuable to collect data from a variety of sentinel sites that cover both outpatient and inpatient services to help understand the impact of a vaccine on the severity of disease.
- **Understand long-term immunity, duration of immunity and the potential need for booster doses due to waning immunity.** This is a medium- to longer-term objective that can be achieved via a combination of sentinel site surveillance and research studies.

Further guidance can be found in the WHO documents Guidance on developing a national deployment and vaccination plan for COVID-19 vaccines, Monitoring COVID-19 vaccination: Considerations for the collection and use of vaccination data and Guidance on conducting vaccine effectiveness evaluations in the setting of new SARS-CoV-2 variants: Interim guidance, 22 July 2021. Addendum to Evaluation of COVID-19 vaccine effectiveness.

## 2.5. Surveillance of Reinfection

Where resources were sufficient, large population-based observational study designs have proven to be valuable tools to estimate reinfection rates (47). A baseline approach to establish actual reinfection rates can be conducted through longitudinal studies involving large cohorts, where sample size will depend on evidence generated from prior epidemiological data. The SIREN study in the United Kingdom (48) is an example of a prospective cohort study on reinfections that allowed for estimation of the protective effect of previous infection.

Prospectively monitoring confirmed cases of SARS-CoV-2 infection, coupled with genomic and immunological surveillance, provides the opportunity for paired samples and the use of comparable molecular testing for both episodes. It also provides valuable real-time information to health authorities to assist in effectively establishing reinfection rates and enhancing epidemiological surveillance, including contact tracing and vaccination monitoring. Serial sampling and testing of convalescent cases will enhance the understanding of SARS-CoV-2 reinfections and better define host immunity dynamics in relation to SARS-CoV-2 genomic diversity at population levels in different age cohorts and among individuals with different immunological profiles.

Immunological assessments

Virus neutralization titres are expected to increase between the first and second infections, and serological investigations(14) could be a useful strategy to incorporate into confirmatory investigations, once the markers and titres are better understood. Trends in detection and persistence of antibodies, with a focus on neutralizing antibodies and other immunological markers – including markers for cellular immunity – could lead to better understanding of immunological dynamics in case of reinfection.

## 2.6. Participatory surveillance/self-reporting

Participatory disease surveillance enables members of the public to voluntarily self-report signs or symptoms, usually through dedicated smartphone applications, without laboratory testing or assessment by a health care provider. Participatory surveillance gives timely and detailed information on signs and symptoms (49) and evolution of physiopathology during the illness episode and allows long-term follow up of sequelae. One example of a large ongoing study is the ZOE COVID study, which collects data reported through a self-reporting app (50). Data collected from participatory surveillance can also give indications of changes in health care-seeking behaviour, which are important to understand when interpreting facility-based surveillance data (51).

# 3. Data collection

## 3.1. Case-based data set

Reporting of individual case report forms is no longer required by WHO at the global level. On a voluntary basis, Member States may wish to continue to submit case report forms in consultation with their WHO Regional Offices. Data-sharing policies regarding case-based data and analysis strategy and output sharing will be managed by the relevant Regional Office.

An updated version of the Surveillance Case Report Form template, including vaccination status, can be found online. Although WHO has recommended ceasing case-based reporting for surveillance, the Organization encourages countries to participate in the reporting of clinical data on COVID-19 patients using the dedicated tools available here (independent of surveillance reporting).

## 3.2. Variables for national surveillance: weekly aggregate surveillance:

As part of national surveillance, countries are encouraged to collect and monitor weekly trends for their own use. This is distinct from the core weekly aggregated data set recommended to be reported to WHO, as described below in section 4.2. The following items – as best suited to countries' local demographic and health situation, health system and surveillance dataflow – should be considered for inclusion.

**Transmission**

- **ILI/ARI/SARI and pneumonia trends** from influenza sentinel sites, GISRS networks and national influenza centres
- **Testing**:
  - testing strategies: screening, targeting of testing for high-risk populations, sampling for sequencing
  - testing activities, including monitoring of self-tests use and results reporting
  - test positivity rate
  - sampling for sequencing integrated to testing strategies: geographical and demographic coverage of sampling
- **Health workers**: frequent monitoring of transmission in populations with high occupational risk of exposure
- **Reinfection**: incidence, mean time between episodes, vaccine status of reinfections
- **Human-animal interface**: detection and circulation of SARS-CoV-2 animal handlers
- **Wildlife and farm-reared animals**: detection and circulation of SARS-CoV-2.

**Severity**

- **Admissions to hospital and ICU** for COVID-19 treatment
- **Severity ratios**: ICU/hospitalization ratio
- **Vaccination status** of hospitalized and ICU admissions for COVID-19
- **Case fatality rates** for hospitalization and ICU admissions.

**Impact**

- **Health care resources**, including bed occupancy, health worker absenteeism, continuity of care for other emergency and non-emergency medical care
- **Post COVID-19 condition**: incidence, length of condition, risk factors
- **Excess mortality** from all causes and due to COVID-19.

# 4. Reporting COVID-19 surveillance data to WHO

## 4.1. International Health Regulations (IHR 2005)

WHO requests that Member States report daily counts of cases and deaths and weekly aggregate counts of cases and deaths at different levels of aggregation (geographical and demographical as most relevant to the situation), as per IHR requirements(52).

Daily counts of SARS-CoV-2 infections/COVID-19 cases and deaths are compiled by WHO Regional Offices, which in turn receive data either directly from Member States or through extraction from official government public sources

(e.g. Ministry of Health websites). Member States are thus encouraged to continue making these daily counts publicly available. Whatever surveillance strategy is employed – exhaustive testing of suspected SARS-CoV-2 infections, or only a subset – the resulting data are requested to be reported. WHO tallies and reports the number of confirmed infections and deaths in its situation reports, global dashboard (covid19.who.int) and elsewhere.

Counts are based on WHO case definitions (53) unless otherwise stated. All data represent date of reporting rather than date of symptom onset. They are subject to continuous verification and may change based on retrospective updates to accurately reflect trends or changes in country case definitions or reporting practices.

Counts of new infections and new deaths are calculated by subtracting previous cumulative total counts from the current count. Owing to differences in reporting methods, cut-off times, retrospective data consolidation and reporting delays, the number of new infections may not always reflect daily totals published by individual countries, territories or areas. Further information on the data collected and displayed can be found in the global dashboard (covid19.who.int).

## 4.2. Weekly aggregated reporting to WHO

The aim of ongoing weekly aggregate reporting is to obtain further information on global COVID-19 trends for enhanced analysis. WHO recommends to aggregate on the date of reporting to the health system. The following data set should be considered as the core list of surveillance indicators to be included in routine weekly reporting to WHO. WHO recommends to aggregate on date of reporting to the health system:

- number of confirmed cases
- number of probable cases
- number of confirmed deaths
- number of probable deaths
- number of new admissions to hospital for COVID-19 treatment (combined confirmed and probable)
- number of new admissions to ICU for COVID-19 treatment (combined confirmed and probable)
- number of health and care workers infected (combined confirmed + probable) as a subset of total case count
- number of health and care workers who died from COVID-19 (combined confirmed + probable) as a subset of total death count
- number of persons tested (NAAT or Ag-RDT)
- number of persons tested by NAAT
- combined confirmed + probable cases by age group (see below) and sex
- combined confirmed + probable deaths by age group (see below) and sex.

The following age categories (in years) are requested: 0-4, 5-9, 10-14, 15-19, 20-29, 30-39, 40-49, 50-59, 60-64, 65-69, 70-74, 75-79, 80 and over.

**The deadline for Member State submission** of weekly data for each epidemiologic week is **Thursday of the following week**.
Member States are requested to **submit weekly data** even when **no new cases were reported** during the week (**zero reporting**).

Weekly aggregated reporting data can be reported via Excel using the form "Global Surveillance of COVID-19: WHO process for reporting aggregated data- V2 (54)". A data dictionary is included. Members States can also report via existing Regional platforms or the dedicated weekly surveillance submission platform, which is available for Member States to self-report their weekly data directly to WHO (for further information or to obtain login credentials, please email covidsurveillance@who.int).

**Country metadata**
Member States are requested to provide additional surveillance metadata to WHO to facilitate interpretation of submitted surveillance data:

- definition of epidemiologic period/week in used in country (e.g. "Monday to Sunday")
- case definitions used by the country, and the date these definitions came into effect
- surveillance/detection strategy or strategies in place in the country, and the date these strategies came into effect (articulating the surveillance strategy is particularly important where surveillance does not seek to capture all cases, such as when it is limited to sentinel sites)

- testing strategy or strategies in place in the country and the date these strategies came into effect
- situation reports whenever they are issued.

Changes in definitions or criteria have an impact on case ascertainment and, consequently, on multiple epidemiologic parameters, such as the epidemic curve and calculation of the case fatality ratio. Metadata should be submitted using the dedicated mailbox for COVID-19 surveillance (covidsurveillance@who.int) or through respective WHO Regional Offices.

Countries are also encouraged to monitor the quality of COVID-19 surveillance by monitoring such performance indicators as timeliness, completeness and representativeness of surveillance data.

## 4.3. DHIS2 health data toolkit packages

The COVID-19 DHIS2 digital data package includes standard metadata aligned with this guidance and implementation guidance to enable rapid deployment in countries. Features include case-based surveillance, contact tracing, aggregate surveillance and vaccination surveillance. Guidance for these packages may be found here (55).

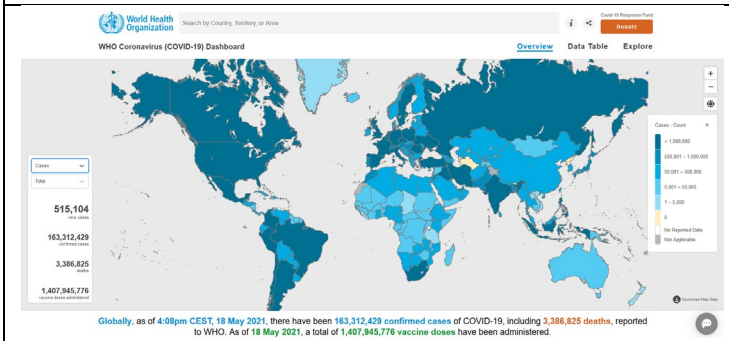
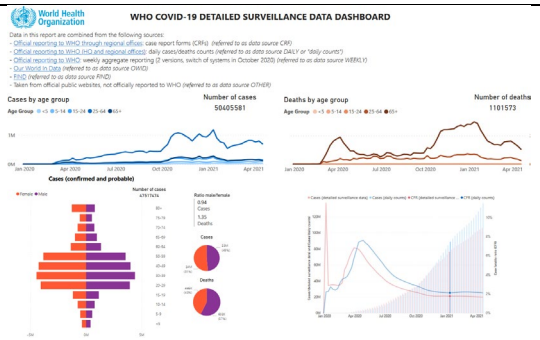
## 4.4. Reporting of COVID-19 through the Global Influenza Surveillance and Response System (GISRS)

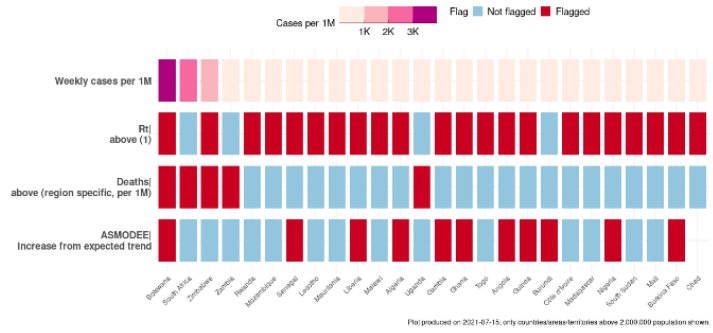
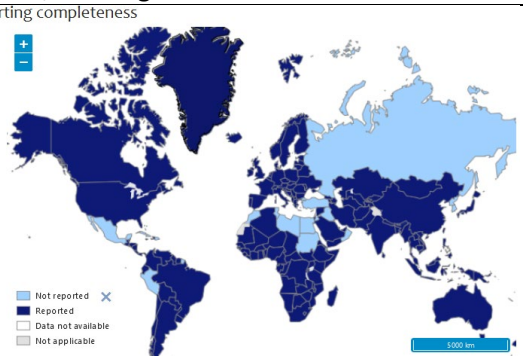
WHO has been monitoring influenza trends and virology through the Global Influenza Surveillance and Response System (GISRS) for 70 years. This system gathers information on ILI, ARI, SARI and pneumonia cases and mortality, mainly through sentinel surveillance. Countries are encouraged to maintain and strengthen existing sentinel syndromic surveillance and to test samples collected for influenza surveillance for SARS-CoV-2. Data from sentinel syndromic surveillance and from laboratory testing for influenza and SARS-CoV-2 (numbers tested and numbers positive) identified at GISRS sites should be reported to WHO via existing reporting platforms and existing formats and frequencies, both through the GISRS system and aggregate reporting for COVID-19 (as outlined above). Further information about reporting to GISRS can be found at Operational considerations for COVID-19 surveillance using GISRS (56).

## 4.5. Data analysis, display and outputs

WHO uses reported data to create a number of internal and public goods to provide information for evidence-based operational decision-making. Major uses are outlined in the figures below.

**Table 10 : WHO global COVID-19 epidemiological data outputs**

| Daily aggregated data | Detailed surveillance data |
|---|---|
| Cumulative and new cases and deaths from WHO regional dashboards and Regional Offices<br>Used for daily presentation, WHO dashboard, situation reports, detailed analysis | Detailed disaggregation of Covid-19 cases and deaths: age, sex, health workers<br>Detailed surveillance dashboard, used for analysis and situation reports at Headquarters and Regional and Country Offices |
|  <br>Link to Dashboard |  <br>Link to Dashboard |

| Data analysis features | Vaccination data |
|---|---|
| In-depth analysis features of trends in cases, deaths and testing and flagging of alarming trends, with variable thresholds | Data from Regional Offices and augmented by publicly available sources.<br>Displaying countries having started vaccination, doses administered, coverage. |
|  <br>Link to dashboard |  <br>Link to Dashboard |

## 4.6. Monitoring and evaluation framework

The COVID-19 Strategic Response and Preparedness Plan for 2022(57) (SPRP) includes surveillance as a strategic element of preparedness and response. For further guidance on surveillance indicators, see the SPRP monitoring and evaluation framework.

## 4.7. Vaccination

- **Monitoring of vaccine deployment**

WHO is monitoring vaccine deployment through vaccination data published online and provided officially through WHO Regional Offices. WHO recommends reporting the following variables, which are displayed through the WHO global COVID-19 dashboard.

**Table 11: Variables for aggregate reporting of vaccination deployment**

| Variable | Frequency |
|---|---|
| Start date of vaccination (for each vaccine) | Once |
| Authorizations for vaccine products, deployment of authorized products | Ad hoc |
| Target groups | Ad hoc |
| Total number of vaccine doses administered | Weekly |
| People vaccinated with at least one dose | Weekly |
| Daily doses administered | Weekly |
| People vaccinated (completion of primary series) | Weekly |

WHO is also monitoring vaccine deployment monthly via the Electronic Joint Reporting Forms (eJRF). For more information, refer to the WHO vaccination monitoring guidance (6).

## 4.8. Publication of COVID-19 surveillance data

Many countries' public health authorities maintain public dashboards with key metrics on COVID-19 epidemiological surveillance.

To facilitate data reporting standardization and avoid duplicating COVID-19 surveillance data reporting efforts, the following data standards are encouraged.

- Variables included in the data set should be aligned with weekly aggregated data (Annex section 5.2).
- Weekly data trends, including the latest weekly reporting for each variable, should be accessible (in addition to cumulative figures).
- Retrospective weekly data for each variable should be available.

An example of publication standards can be found on the WHO detailed dashboard.

# Annex : definitions for surveillance

## Case definition

The case definitions for suspected, probable and confirmed cases below have been slightly modified since the 14 February 2022 version of this interim guidance. Chest imaging criteria were removed from the probable case definition following findings from Cochrane review(58), that established the low sensitivity of these criteria.

Countries may need to adapt these case definitions depending on their local epidemiological situation and other factors. All countries are encouraged to publish adapted definitions online and in regular situation reports and to document periodic updates to definitions that may affect the interpretation of surveillance data.

### Suspected case of SARS-CoV-2 infection (3 options, A through C)

**A.** A person who meets the clinical **OR** epidemiological criteria:

Clinical criteria:

1. Acute onset of fever AND cough (influenza-like illness)
   **OR**
2. Acute onset of ANY THREE OR MORE of the following signs or symptoms: fever, cough, general weakness/fatigue[1], headache, myalgia, sore throat, coryza, dyspnoea, nausea, diarrhoea, anorexia.

**OR**

Epidemiological criteria:

1. Contact of a probable or confirmed case or linked to a **COVID-19 cluster**[2]

**B.** A patient with severe acute respiratory illness (SARI: acute respiratory infection with history of fever or measured fever of ≥ 38 C°; and cough; with onset within the last 10 days; and who requires hospitalization).

**C.** A person

With no clinical signs or symptoms, **NOR** meeting epidemiologic criteria
With a **positive professional use or self-test** SARS-CoV-2 antigen-RDT[3]

### Probable case of SARS-CoV-2 infection (2 options, A through B)

**A.** A patient who meets clinical criteria above **AND** is a contact of a probable or confirmed case or is linked to a COVID-19 cluster [2]

**B.** Death, not otherwise explained, in an adult with respiratory distress preceding death **AND** who was a contact of a probable or confirmed case or linked to a COVID-19 cluster[2]

### Confirmed case of SARS-CoV-2 infection (2 options, A through B)

**A.** A person with a positive nucleic acid amplification test (NAAT), **regardless of** clinical criteria **OR** epidemiological criteria

**B.** A person

Meeting clinical criteria **AND/OR** epidemiological criteria (See suspect case A)
With a **positive professional use or self-test** SARS-CoV-2 Antigen-RDT[3]

Note: Clinical and public health judgment should be used to determine the need for further investigation in patients who do not strictly meet the clinical or epidemiological criteria. Surveillance case definitions should not be used as the sole basis for guiding clinical management.

[1] Signs separated with slash (/) are to be counted as one sign.

[2] A group of symptomatic individuals linked by time, geographic location and common exposures, containing at least **one NAAT-confirmed** case or at least **two** epidemiologically linked, symptomatic (meeting clinical criteria of suspect case definition A or B) persons with **positive Ag-RDTs performed by a trained operator OR as a self-test** (based on ≥97% specificity of test and desired >99.9% probability of at least one positive result being a true positive).

[3] Antigen-detection rapid diagnostic tests (Ag-RDT) are available for use by trained professionals or for self-testing by individuals:

- **Professional use SARS-CoV-2 antigen-RDT:** WHO EUL approved Ag-RDT, in which sample collection, test performance and result interpretation are done by a trained operator.
- **Self-test SARS-CoV-2 antigen-RDT:** WHO EUL approved Ag-RDT in which sample collection, test performance and result interpretation are done by individuals by themselves.

## Community Based Surveillance: case definition

Individuals in the community can play an important role in the surveillance of COVID-19. Community-based surveillance (CBS) – the systematic detection and reporting of events of public health significance within a community, by community members – may serve to bridge the gap between the community and the health system, especially in settings where access to health care is scarce, such as fragile settings and humanitarian settings. In CBS, alerts generated by trained volunteers are reported to health authorities for verification and response through established surveillance and referral mechanisms. More guidance on establishing CBS is available from the International Federation of Red Cross and Red Crescent Societies, here (59).

**Table 12 : Community case definitions**

| Health risk | Suggested community definition | Related diseases |
|---|---|---|
| Cough and difficulty breathing | Fever with dry cough or difficulty breathing | COVID-19<br>Acute respiratory infections (ARIs)<br>Tuberculosis |

## High-risk populations

**Risk factors for severe disease and death**

- Age more than 60 years (increasing with age).
- Smoking
- Underlying conditions: diabetes, hypertension, cardiac disease, chronic lung disease, cerebrovascular disease, dementia, mental disorders, chronic kidney disease, immunosuppression, HIV, obesity and cancer.

In pregnancy, increasing maternal age, high body mass index, non-white ethnicity (in specific settings), chronic conditions and pregnancy-specific conditions such as gestational diabetes and pre-eclampsia can be associated with adverse effects.

Other risk factors associated with higher risk of severity and death include higher sequential organ failure assessment (SOFA) score and D-dimer >1 µg/L (indicative of a possible blood clotting condition) on admission.

Further details on risk factors can be found in COVID-19 Clinical management: living guidance (60).

**High-risk communities**

These populations include:

- people aged ≥ 60 years and/or with underlying conditions that increase the risk of severe disease
- disadvantaged groups such as refugees, internally displaced people, migrants and other marginalized communities; those in high density/low resource settings (such as camps, informal settlements, slums and places of detention) and lower-income groups
- Health workers, defined by WHO as all people engaged in actions with the primary intent of enhancing health, including care workers, who often have roles in the provision of care in long-term care facilities and in community settings.

See IASC guidance (15) and Public health and social measures for COVID-19 preparedness and response in low capacity and humanitarian settings (61) for further details.

## Definition of a contact

The following definition of a contact has been updated on 6 July 2022.
A SARS-CoV-2 contact is a person who has had any one of the following exposures to a probable or a confirmed case of SARS-CoV-2 infection:

- face-to-face contact with a probable or confirmed case within 1 metre and for at least 15 minutes, or
- direct physical contact with a probable or confirmed case, or
- direct care for a patient with probable or confirmed COVID-19 disease without the use of recommended personal protective equipment (PPE)[23] or,
- other situations as determined by local health authorities based on local risk assessments.

Exposure must have occurred during the infectious period of the case, which is defined as follows.

- Exposure to a symptomatic case: 2 days before and 10 days after symptom onset of the case, plus 3 days without symptoms or 3 days with improving symptoms, for a minimum period of 13 days after symptoms onset.
- Exposure to an asymptomatic case: 2 days before and 10 days after the date on which the sample that led to confirmation was taken.

No significant differences in viral load have been reported between symptomatic and asymptomatic cases(62,63). At present, no infective SARS- CoV-2 viral load has been established for humans (64), and contacts of an asymptomatic case should be managed in the same way as those of a symptomatic case.

**Priority groups are people that have higher chances of developing severe disease** if infected through a contact with a case. They include (but are not limited to): Individuals older than 60 years, individuals with immunocompromising diseases or taking immunosuppressive medications, people with multiple co-morbidities, pregnant women and those informed by a medical professional that they are at high risk.

**Unvaccinated or partially vaccinated contacts, especially if belonging to the above high-risk groups**, are more likely to experience severe disease, requiring hospitalisation, and/or resulting in death when compared with vaccinated contacts(65), therefore, they should receive special attention from contact tracing activities. It is worth noting that the vaccination status or the presence of underlying conditions in a contact might not always be known to the index case or the contact tracer. It is therefore imperative that public messaging target these high-risk individuals, making them aware of their increased risk of severe disease when exposed to a case and be advised to get vaccinated (or, where partially vaccinated, to complete the primary vaccination series and recommend booster doses). Contacts at high risk for severe disease ('priority groups', as defined above), independent of their vaccination status, should remain the priority for contact tracing in order to reduce the morbidity and mortality due to COVID-19.

**Priority settings** are environments where there is a higher chance that people belonging to the priority groups might stay for extended periods of time in close proximity with each other, and therefore have a higher chance of becoming infected, and developing severe disease if they develop COVID-19 after contact with a case. Examples of high priority settings are health care facilities including nursing homes and long-term care facilities. This can also include households with members of high priority groups.

**Priority situations** are circumstances such as the emergence of a new variant for which characteristics of immune escape and disease severity are unknown, or any other circumstances determined by public health authorities as priority.

**All symptomatic contacts should be able to be tested**, either through facility-offered PCR or Ag-RDT test, or through Ag-RDT self-test. If contacts test positive with any of the above methods, then they are to be considered a confirmed SARS-CoV-2 case and undergo isolation according to recommendations in place.

## Definition of COVID-19 death for surveillance purposes

The definition of COVID-19 death below has not been changed since the 16 December 2020 update.

A COVID-19 death is defined for surveillance purposes as a death resulting from a clinically compatible illness in a probable or confirmed COVID-19 case, unless there is a clear alternative cause of death that cannot be related to COVID-19 disease (e.g. trauma). There should be no period of complete recovery between the illness and death.

It is recognized that in extremely high transmission contexts, some decedents will test positive for SARS-CoV-2 infection incidentally. This points to the importance of accurately assessing whether the clinical features of the death are compatible with COVID-19.
Stillborn infants testing positive for SARS-CoV-2 should not have their deaths recorded in cases or deaths, in line with stillbirth recording standards for other pathogens.

For further guidance on COVID-19 as the cause of death, see Medical certification, ICD mortality coding, and reporting mortality associated with COVID-19 (66).

## Variant definitions

These are working definitions and may be updated regularly. More information on variants of interest and variants of concern can be found here(67).

**Variant of Interest (VOI)**
A SARS-CoV-2 variant:

- with genetic changes that are predicted or known to affect virus characteristics such as transmissibility, disease severity, immune escape, diagnostic or therapeutic escape; AND
- identified to cause significant community transmission or multiple COVID-19 clusters, in multiple countries with increasing relative prevalence alongside increasing number of cases over time, or other apparent epidemiological impacts to suggest an emerging risk to global public health.

Note that a VOI may additionally be designated as “previously circulating”.

**Variant of Concern (VOC)**
A SARS-CoV-2 variant that meets the definition of a VOI (see above) and, through a comparative assessment, has been demonstrated to be associated with one or more of the following changes at a degree of global public health significance:

- increase in transmissibility or detrimental change in COVID-19 epidemiology; OR
- increase in virulence or change in clinical disease presentation; OR
- decrease in effectiveness of public health and social measures or available diagnostics, vaccines, therapeutics.

Note that a VOC may additionally be designated as “previously circulating”.

**Subvariants under monitoring**

A variant that, according to phylogenetic analysis, belongs to a currently circulating VOC
AND
shows signals of transmission advantage compared to other circulating VOC lineages
AND
has additional amino acid changes that are known or suspected to confer the observed change in epidemiology and fitness advantage as compared to other circulating variants.

**Variant under monitoring (VUM)**
A SARS-CoV-2 variant with genetic changes that are suspected to affect virus characteristics with some indication that it may pose a future risk, but evidence of phenotypic or epidemiological impact is currently unclear, requiring enhanced monitoring and repeat assessment pending new evidence.

## Reinfection: standard evidence for investigation

**Suspected reinfection case**
Confirmed or probable COVID-19 case (following WHO case definition), with **a history of a primary** confirmed, or probable **COVID-19 infection**, with at least 90 days between the episodes.
**Probable reinfection case:**
- Positive NAAT and/or Ag-RDT results for both episodes fitting the WHO Case Definition, with episodes occurring at least 90 days apart, based on the sampling date.
OR
- Genomic evidence for the second episode is available and includes lineage that was not submitted to SARS-CoV-2 genomic databases at the time of first infection.
**Genetic evidence of confirmed reinfection:**
Samples available for both primary and secondary episodes allowing for full genomic sequencing, whereby samples must be shown to be phylogenetically distinct from one another. Evidence should be generated at clade/lineage, as defined by genomic classification of SARS-CoV-2 between the first and second infection.

If evidence of different clades is demonstrated in episodes less than 90 days apart, this also constitutes evidence of confirmed reinfection.

If there are more than two nucleotide differences for every month separating the samples between the sequences for first and second infections, i.e., exceeding the expected single nucleotide variation, these would be considered as different lineages/clades.

The 90-day cut off should ideally be determined between onset dates (for probable cases), or sampling dates (for confirmed cases) of primary and secondary episodes.

For further guidance on genomic information classification and lineage, please see the WHO guidance on genomic sequencing (5).

**Investigation process and items for case definition**

The following items for a standardized and harmonized investigation for SARS-CoV-2 reinfection should be considered:

- Suspected reinfection case definition for screening purposes

The definition provided above is designed to accommodate a common screening algorithm for clinical and public health purposes, either by retrospectively reviewing health records to identify potential reinfections or prospectively to provide data to clinicians and health authorities on the incidence of reinfection cases. A follow-up investigation is warranted to confirm reinfection status for suspected or probable cases of reinfection.

- Infection episodes

Infection and reinfection episodes should be investigated and confirmed as per the WHO case definition. Cases can be confirmed through NAAT or Ag-RDTP. The current reinfection definition is intended for all patients, including immunocompromised patients, who may be transmitting the virus over a longer period of time.

- Clinical evidence of disease

The clinical phenotype of reinfections has not been characterized, and it is not known whether there is an impact on clinical severity when compared with an initial infection with SARS-CoV-2. Molecular detection should follow the standard WHO Covid-19 case definition criteria (53). Clinical management should not be different based on the number of infections suspected or reported by the patient and should follow the clinical management guidance (60).

- Interval between episodes

Prolonged duration of virus shedding (up to 90 days) has been reported to be associated with persistent infections and may be misinterpreted as reinfection. Such cases should be further assessed through real-time PCR (RT-qPCR), sequencing, serological testing and clinical evaluation. A time interval of less than 45 days makes reinfection considerably less likely, although not impossible. Conversely, persistent primary infections of up to 100 days have also been documented in immunocompromised hosts but are not considered common among immunocompetent individuals. Recent evidence(68) suggests that reinfections with Omicron can occur within a shorter interval, but more evidence is needed to confirm the timeframe.

**WHO advises adoption of a standard of a minimum interval of 90 days between primary and secondary infection.**

- Molecular laboratory tests

For NAAT tests, owing to the variability across molecular platforms, Ct values should be considered with care and may not have clinical relevance (see Genomic sequencing of SARS-CoV-2: a guide to implementation for maximum impact on public health (5)).
Whole genome sequence analysis of the virus from both episodes could provide insight into the evolution between clades from both episodes; the expected single nucleotide variation (SNV) rate is two nucleotides per month (69).

- Accounting for vaccination

The vaccination status of subjects should be recorded in the context of testing for antibodies against SARS-CoV-2. Following the worldwide deployment of vaccination, the development of immunological and molecular technology will allow in future for clear differentiation between serological evidence of previous infection and vaccine-induced immunity. At the time of publication, such tests existed but were not widely available. At present, it is not recommended to differentiate infection-derived immunity from vaccine-derived immunity for surveillance purposes. Nevertheless, it is advised to collect the vaccination status of reinfection cases, as displayed in the recommended data set.

**Reporting**

Although WHO does not require reporting of reinfection cases, Member States are advised to monitor reinfection status in close linkage with clinical, epidemiological, and sequencing data for surveillance of new variants and vaccine coverage monitoring.

## Definitions for hospitalization and ICU admission

Hospitalization is defined as admission as an inpatient for a length of over 12 hours of time, or overnight.

Admission to intensive care for COVID-19 treatment is monitored to capture severity of COVID-19 disease and its impact on intensive care unit (ICU) capacity.

- **New admission to ICU Unit**. An ICU is defined as *"an organized system for the provision of care to critically ill patients that provides intensive and specialized medical and nursing care, an enhanced capacity for monitoring, and multiple modalities of physiologic organ support to sustain life during a period of life-threatening organ system insufficiency".*

Given the wide range of health systems and case management worldwide, ICU admission can include, beyond strictly counting admissions to intensive care units, patients with COVID-19 placed on advanced respiratory support measures such as mechanical ventilation or extracorporeal membrane oxygenation (ECMO) in other parts of the hospital.

## Vaccine status and breakthrough infections

Vaccines should be approved by a stringent regulatory authority or listed under WHO Emergency Use Listing.

For surveillance perspectives**, a person is defined as vaccinated when they have completed the primary vaccination series,** regardless of additional doses/booster. If possible, data collection should allow stratification by time since the last vaccination (last dose received, including booster doses): < 3 months, 3-5 months, ≥6 months. At individual level the terminology should focus on whether individuals are up-to-date with recommended respective schedules, including additional doses and boosters.

For the Janssen vaccine, as per the latest SAGE recommendation from December 2021,(70) countries can choose to use Ad26.COV2.S as a schedule with a single or two doses.

Cases and infections are expected in vaccinated persons, albeit in a predictable proportion, in relation to vaccine efficacy values. The following definitions should be used to characterize infections and cases in vaccinated persons.

- **Asymptomatic breakthrough infection:** detection of SARS-CoV-2 RNA or antigen in a respiratory specimen collected from a person without COVID-19-like symptoms ≥ 14 days after they have completed all recommended doses of the vaccine series.
- **Symptomatic breakthrough case:** detection of SARS-CoV-2 RNA or antigen in a respiratory specimen collected from a person with COVID-19-like symptoms ≥ 14 days after they have completed all recommended doses of the vaccine series.

NB: COVID-19-like symptoms should fit those listed in the COVID-19 case definition.

## Post COVID-19 Condition

According to the WHO clinical case definition, available here (71), post COVID-19 condition occurs in individuals with a history of probable or confirmed SARS-CoV-2 infection, usually 3 months from the onset of COVID-19, with symptoms that last for at least 2 months and cannot be explained by an alternative diagnosis.

Common symptoms include fatigue, shortness of breath and cognitive dysfunction, but others are described in the document and generally have an impact on everyday functioning. Symptoms may be new onset, following initial recovery from an acute COVID-19 episode, or persist from the initial illness. Symptoms may also fluctuate or relapse over time. A separate definition may be applicable for children.

# Selected references


1. Critical preparedness, readiness and response actions for COVID-19 [Internet]. [cited 2021 Nov 9]. Available from: https://www.who.int/publications/i/item/critical-preparedness-readiness-and-response-actions-for-covid-19
2. Contact tracing in the context of COVID-19 [Internet]. [cited 2021 Jul 16]. Available from: https://www.who.int/publications/i/item/contact-tracing-in-the-context-of-covid-19
3. Living guidance for clinical management of COVID-19 [Internet]. [cited 2021 Dec 15]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-clinical-2021-2
4. Recommendations for national SARS-CoV-2 testing strategies and diagnostic capacities [Internet]. [cited 2021 Dec 15]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-lab-testing-2021.1-eng
5. Genomic sequencing of SARS-CoV-2: a guide to implementation for maximum impact on public health [Internet]. [cited 2021 Nov 9]. Available from: https://www.who.int/publications/i/item/9789240018440
6. Monitoring COVID-19 vaccination: Considerations for the collection and use of vaccination data [Internet]. [cited 2021 Nov 15]. Available from: https://www.who.int/publications/i/item/monitoring-covid-19-vaccination-interim-guidance
7. Low Testing Rates Limit the Ability of Genomic Surveillance Programs to Monitor SARS-CoV-2 Variants: A Mathematical Modelling Study by Alvin X. Han, Amy Toporowski, Jilian Sacks, Mark Perkins, Sylvie Briand, Maria Van Kerkhove, Emma Hannay, Sergio Carmona, Bill Rodriguez, Edyth Parker, Brooke E Nichols, Colin Russell :: SSRN [Internet]. [cited 2022 May 27]. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4115475
8. Diagnostic testing for SARS-CoV-2 [Internet]. [cited 2021 Apr 21]. Available from: https://www.who.int/publications/i/item/diagnostic-testing-for-sars-cov-2
9. The SARS-CoV-2 Antigen RDT Training Package | HSLP [Internet]. [cited 2021 Dec 15]. Available from: https://extranet.who.int/hslp/content/sars-cov-2-antigen-rapid-diagnostic-test-training-package
10. Use of SARS-CoV-2 antigen-detection rapid diagnostic tests for COVID-19 self-testing [Internet]. [cited 2022 Apr 11]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-Ag-RDTs-Self_testing-2022.1
11. Antigen-detection in the diagnosis of SARS-CoV-2 infection using rapid immunoassays [Internet]. [cited 2021 Apr 21]. Available from: https://www.who.int/publications/i/item/antigen-detection-in-the-diagnosis-of-sars-cov-2infection-using-rapid-immunoassays
12. Use of antigen detection rapid diagnostic testing [Internet]. [cited 2021 Dec 15]. Available from: https://www.who.int/multi-media/details/use-of-antigen-detection-rapid-diagnostic-testing
13. Recommendations for national SARS-CoV-2 testing strategies and diagnostic capacities [Internet]. [cited 2021 Nov 9]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-lab-testing-2021.1-eng
14. Unity Studies: Early Investigation Protocols [Internet]. [cited 2021 Apr 21]. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/early-investigations
15. Scaling up COVID-19 Outbreak Readiness and Response in Camps and Camp Based Settings (jointly developed by IASC / IFRC / IOM / UNHCR / WHO) [Internet]. [cited 2021 Nov 9]. Available from: https://www.who.int/publications/m/item/scaling-up-covid-19-outbreak-readiness-and-response-in-camps-and-camp-based-settings-(jointly-developed-by-iasc-ifrc-iom-unhcr-who)
16. Preparedness, prevention and control of coronavirus disease (COVID-19) for refugees and migrants in non-camp settings [Internet]. [cited 2021 Nov 15]. Available from: https://www.who.int/publications/i/item/preparedness-prevention-and-control-of-coronavirus-disease-(covid-19)-for-refugees-and-migrants-in-non-camp-settings
17. Early detection, verification, assessment and communication [Internet]. [cited 2021 Nov 15]. Available from: https://www.who.int/initiatives/eios
18. World Health Organization. Regional Office for the Western Pacific. A Guide to establishing event-based surveillance. 2008;22.
19. Africa CDC Event-based Surveillance Framework – Africa CDC [Internet]. [cited 2021 Nov 15]. Available from: https://africacdc.org/download/africa-cdc-event-based-surveillance-framework/
20. Surveillance protocol for SARS-CoV-2 infection among health workers [Internet]. [cited 2021 Nov 11]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-HCW_Surveillance_Protocol-2020.1
21. Cohort study to measure COVID-19 vaccine effectiveness among health workers in the WHO European Region: guidance document [Internet]. [cited 2021 Dec 7]. Available from: https://apps.who.int/iris/handle/10665/340217?search-result=true&query=WHO%2FEURO%3A2021-2141-41896-57484&scope=&rpp=10&sort_by=score&order=desc
22. Protocol for assessment of potential risk factors for 2019-novel coronavirus (COVID-19) infection among health care workers in a health care setting [Internet]. [cited 2021 Nov 11]. Available from: https://www.who.int/publications/i/item/protocol-for-assessment-of-potential-risk-factors-for-2019-novel-coronavirus-(2019-ncov)-infection-among-health-care-workers-in-a-health-care-setting
23. Global epidemiological surveillance standards for influenza [Internet]. [cited 2021 Nov 11]. Available from: https://www.who.int/publications/i/item/9789241506601
24. Corrigenda – Maintaining surveillance of influenza and monitoring SARS-CoV-2 [Internet]. [cited 2021 Nov 8]. Available from: https://www.who.int/publications/m/item/corrigenda
25. Environmental surveillance for SARS-COV-2 to complement public health surveillance – Interim Guidance [Internet]. [cited 2022 Apr 20]. Available from: https://www.who.int/publications/i/item/WHO-HEP-ECH-WSH-2022.1
26. Revealing the toll of COVID-19 [Internet]. [cited 2021 Nov 15]. Available from: https://www.who.int/publications/i/item/revealing-the-toll-of-covid-19
27. The true death toll of COVID-19: estimating global excess mortality [Internet]. [cited 2021 Nov 15]. Available from: https://www.who.int/data/stories/the-true-death-toll-of-covid-19-estimating-global-excess-mortality
28. Verbal autopsy standard [Internet]. [cited 2021 Nov 15]. Available from: https://www.who.int/standards/classifications/other-classifications/verbal-autopsy-standards-ascertaining-and-attributing-causes-of-death-tool

29. Influenza Virologic Surveillance Right Size Sample Size Calculators [Internet]. [cited 2021 Apr 21]. Available from: https://www.aphl.org/programs/infectious_disease/influenza/Influenza-Virologic-Surveillance-Right-Size-Roadmap/Pages/Influenza-Sample-Size-Calculators.aspx
30. Variant Detection Calculator [Internet]. [cited 2021 Apr 21]. Available from: https://covid-19.tacc.utexas.edu/dashboards/variants/
31. Makoni M. Africa's $100-million Pathogen Genomics Initiative. The Lancet Microbe [Internet]. 2020 Dec 1 [cited 2021 Apr 21];1(8):e318. Available from: www.thelancet.com/microbe
32. Khatamzas E, Rehn A, Muenchhoff M, Hellmuth J, Gaitzsch E, Weiglein T, et al. Emergence of multiple SARS-CoV-2 mutations in an immunocompromised host. medRxiv [Internet]. 2021 Jan 15 [cited 2021 Apr 21];2021.01.10.20248871. Available from: https://doi.org/10.1101/2021.01.10.20248871
33. Choi B, Choudhary MC, Regan J, Sparks JA, Padera RF, Qiu X, et al. Persistence and Evolution of SARS-CoV-2 in an Immunocompromised Host. N Engl J Med [Internet]. 2020 Dec 3 [cited 2021 Apr 21];383(23):2291–3. Available from: http://www.nejm.org/doi/10.1056/NEJMc2031364
34. Avanzato VA, Matson MJ, Seifert SN, Pryce R, Williamson BN, Anzick SL, et al. Case Study: Prolonged Infectious SARS-CoV-2 Shedding from an Asymptomatic Immunocompromised Individual with Cancer. Cell. 2020 Dec 23;183(7):1901-1912.e9.
35. COVID-19 diagnostic testing in the context of international travel Scientific brief [Internet]. 2020 [cited 2021 Apr 21]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-Surveillance_Case_Definition-
36. Guidance on conducting vaccine effectiveness evaluations in the setting of new SARS-CoV-2 variants: Interim guidance, 22 July 2021. Addendum to Evaluation of COVID-19 vaccine effectiveness [Internet]. [cited 2022 Apr 13]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-vaccine_effectiveness-variants-2021.1
37. Estimating mortality from COVID-19: Scientific brief, 4 August 2020 [Internet]. [cited 2022 Jul 4]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-Sci-Brief-Mortality-2020.1
38. Considerations on monitoring SARS-CoV-2 in animals.
39. Coronavirus (COVID-19) Infection Survey: methods and further information - Office for National Statistics [Internet]. [cited 2022 May 18]. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/methodologies/covid19infectionsurveypilotmethodsandfurtherinformation#test-sensitivity-and-specificity
40. Nuffield Department of Medicine. COVID-19 Infection Survey [Internet]. [cited 2022 May 18]. Available from: https://www.ndm.ox.ac.uk/covid-19/covid-19-infection-survey/protocol-and-information-sheets
41. The first few X cases and contacts (FFX) investigation protocol for coronavirus disease 2019 (COVID-19), version 2.2 [Internet]. [cited 2022 Apr 13]. Available from: https://www.who.int/publications/i/item/the-first-few-x-cases-and-contacts-(-ffx)-investigation-protocol-for-coronavirus-disease-2019-(-covid-19)-version-2.2
42. Household transmission investigation protocol for 2019-novel coronavirus (COVID-19) infection [Internet]. [cited 2022 Apr 13]. Available from: https://www.who.int/publications/i/item/household-transmission-investigation-protocol-for-2019-novel-coronavirus-(2019-ncov)-infection
43. Assessment of risk factors for coronavirus disease 2019 (COVID-19) in health workers: protocol for a case-control study [Internet]. [cited 2022 Apr 13]. Available from: https://www.who.int/publications/i/item/assessment-of-risk-factors-for-coronavirus-disease-2019-(covid-19)-in-health-workers-protocol-for-a-case-control-study
44. The WHO Global Clinical Platform for COVID-19 [Internet]. [cited 2022 Apr 13]. Available from: https://www.who.int/teams/health-care-readiness/covid-19/data-platform
45. Population-based age-stratified seroepidemiological investigation protocol for coronavirus 2019 (COVID-19) infection [Internet]. [cited 2021 Nov 15]. Available from: https://www.who.int/emergencies/diseases/novel-
46. Estimating COVID-19 vaccine effectiveness against severe acute respiratory infections (SARI) hospitalisations associated with laboratory-confirmed SARS-CoV-2: an evaluation using the test-negative design: guidance document [Internet]. [cited 2022 Feb 11]. Available from: https://apps.who.int/iris/handle/10665/341111
47. Abu-Raddad LJ, Chemaitelly H, Malek JA, Ahmed AA, Mohamoud YA, Younuskunju S, et al. Assessment of the Risk of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Reinfection in an Intense Reexposure Setting. Clin Infect Dis [Internet]. 2020 Dec 14 [cited 2021 May 7]; Available from: https://academic.oup.com/cid/advance-article/doi/10.1093/cid/ciaa1846/6033728
48. Hall VJ, Foulkes S, Charlett A, Atti A, Monk EJM, Simmons R, et al. SARS-CoV-2 infection rates of antibody-positive compared with antibody-negative health-care workers in England: a large, multicentre, prospective cohort study (SIREN). Lancet [Internet]. 2021 Apr 17 [cited 2021 May 7];397(10283):1459–69. Available from: https://doi.org/10.1016/
49. How Omicron Symptoms Differ From Delta, Past COVID-19 Variants: Charts [Internet]. [cited 2022 Apr 13]. Available from: https://www.businessinsider.com/omicron-common-symptoms-vs-other-variants-charts-2022-1?r=US&IR=T
50. ZOE COVID Study [Internet]. [cited 2022 Apr 13]. Available from: https://covid.joinzoe.com/
51. Menni C, Valdes AM, Freidin MB, Sudre CH, Nguyen LH, Drew DA, et al. Real-time tracking of self-reported symptoms to predict potential COVID-19. Nat Med [Internet]. 2020 Jul 1 [cited 2021 Jun 11];26(7):1037–40. Available from: https://doi.org/10.1038/s41591-020-0916-2
52. International Health Regulations (2005) Third Edition [Internet]. [cited 2021 Jul 16]. Available from: https://www.who.int/publications/i/item/9789241580496
53. WHO COVID-19 Case definition [Internet]. [cited 2021 Apr 21]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-Surveillance_Case_Definition-2020.2
54. Global surveillance of COVID-19: WHO process for weekly reporting aggregated data [Internet]. [cited 2021 Nov 8]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-surveillance-aggr-CRF-2020.3
55. Covid Surveillance - DHIS2 [Internet]. [cited 2021 Nov 15]. Available from: https://dhis2.org/covid-surveillance/
56. Operational considerations for COVID-19 surveillance using GISRS: interim guidance [Internet]. [cited 2021 Nov 15]. Available from: https://www.who.int/publications/i/item/operational-considerations-for-covid-19-surveillance-using-gisrs-interim-guidance
57. Strategic preparedness, readiness and response plan to end the global COVID-19 emergency in 2022 [Internet]. [cited 2022 Apr 19]. Available from: https://www.who.int/publications/i/item/WHO-WHE-SPP-2022.1

58. Ebrahimzadeh S, Islam N, Dawit H, Salameh J-P, Kazi S, Fabiano N, et al. Thoracic imaging tests for the diagnosis of COVID-19. Cochrane Database Syst Rev [Internet]. 2022 May 16 [cited 2022 May 25];2022(5). Available from: http://doi.wiley.com/10.1002/14651858.CD013639.pub5
59. Resources [Internet]. [cited 2022 Apr 11]. Available from: https://www.cbsrc.org/resources
60. COVID-19 Clinical management: living guidance [Internet]. [cited 2021 Nov 9]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-clinical-2021-1
61. Public health and social measures for COVID-19 preparedness and response in low capacity and humanitarian settings [Internet]. [cited 2021 Nov 9]. Available from: https://www.who.int/publications/m/item/public-health-and-social-measures-for-covid-19-preparedness-and-response-in-low-capacity-and-humanitarian-settings
62. Zuin M, Gentili V, Cervellati C, Rizzo R, Zuliani G. Viral Load Difference between Symptomatic and Asymptomatic COVID-19 Patients: Systematic Review and Meta-Analysis. Infect Dis Rep [Internet]. 2021 [cited 2022 Apr 11];13(3):645–53. Available from: https://pubmed.ncbi.nlm.nih.gov/34287354/
63. Ra SH, Lim JS, Kim GU, Kim MJ, Jung J, Kim SH. Upper respiratory viral load in asymptomatic individuals and mildly symptomatic patients with SARS-CoV-2 infection. Thorax [Internet]. 2021 Jan 1 [cited 2022 Apr 11];76(1):61–3. Available from: https://pubmed.ncbi.nlm.nih.gov/32963115/
64. Karimzadeh S, Bhopal R, Huy NT. Review of infective dose, routes of transmission and outcome of COVID-19 caused by the SARS-COV-2: comparison with other respiratory viruses. Epidemiol Infect [Internet]. 2021 [cited 2022 Apr 11];149. Available from: https://pubmed.ncbi.nlm.nih.gov/33849679/
65. Scobie HM, Johnson AG, Suthar AB, Severson R, Alden NB, Balter S, et al. Monitoring Incidence of COVID-19 Cases, Hospitalizations, and Deaths, by Vaccination Status - 13 U.S. Jurisdictions, April 4-July 17, 2021. MMWR Morb Mortal Wkly Rep [Internet]. 2021 Sep 17 [cited 2022 Apr 11];70(37):1284–90. Available from: https://pubmed.ncbi.nlm.nih.gov/34529637/
66. Medical certification, ICD mortality coding, and reporting mortality associated with COVID-19 [Internet]. [cited 2021 Nov 8]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-mortality-reporting-2020-1
67. Tracking SARS-CoV-2 variants [Internet]. [cited 2021 Jun 3]. Available from: https://www.who.int/en/activities/tracking-SARS-CoV-2-variants/
68. Reinfection with different subtypes of Omicron is possible [Internet]. [cited 2022 May 27]. Available from: https://en.ssi.dk/news/news/2022/reinfection-with-different-subtypes-of-omicron-is-possible
69. Bandoy DJDR, Weimer BC. Analysis of SARS-CoV-2 genomic epidemiology reveals disease transmission coupled to variant emergence and allelic variation. Sci Rep [Internet]. 2021 Dec 1 [cited 2021 May 7];11(1):7380. Available from: https://www.nature.com/articles/s41598-021-86265-4
70. Interim recommendations for the use of the Janssen Ad26.COV2.S (COVID-19) vaccine [Internet]. [cited 2022 Jun 22]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-vaccines-SAGE-recommendation-Ad26.COV2.S-2021.1
71. WOrld Health Organisation. A clinical Case definition of Post Covid-19 Condition by a DELPHI consensus [Internet]. 2021 [cited 2021 Nov 9]. Available from: moz-extension://6aec06a7-94b7-4699-8677-04292e68a848/enhanced-reader.html?openApp&pdf=https%3A%2F%2Fapps.who.int%2Firis%2Fbitstream%2Fhandle%2F10665%2F345824%2FWHO-2019-nCoV-Post-COVID-19-condition-Clinical-case-definition-2021.1-eng.pdf


## Acknowledgements


From the World Health Organization: Maya Allan, Armanath Bapu, Isabelle Bergeri, Martha Gacic-Dobo, Masaya Kato, Biaukula Viema Lewagalu, Piers Mook, Minal Patel, Boris Pavlin, Richard Pebody, Tika Ram, Janet Diaz, Kathleen Strong, Katelijn Vandemaele, Lidia Redondo, Angel Rodriguez, Paula Couto, Hassan Mahmoud, Basma Mostafa Abdelgawad, Zyleen Kassamali, Silviu Ciobanu, Mohamed Basant, Maria Van Kherkhove, Jilian Sacks, Ayse Acma, Chavan Laxmikant, Craig Schultz

Expert groups : Contact tracing GDG, Epidemiology Technical Advisory Group


## Declaration of interests

Declarations of interest were collected for all GDG members at the beginning of the guidance update process and renewed at the beginning of every meeting. The WHO steering committee reviewed all declarations and found no conflict of interest sufficient to preclude any GDG member from participating fully in the development of the guideline.

Funding: WHO Internal Funds

WHO continues to monitor the situation closely for any changes that may affect this interim guidance. Should any factors change, WHO will issue a further update. Otherwise, this interim guidance document will expire two years after the date of publication.



WHO reference number: WHO/2019-nCoV/SurveillanceGuidance/2022.2