

COVID-19 Laboratory Testing Guide

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What is COVID-19?

COVID-19 (coronavirus disease 2019) is the disease resulting from infection with a newly emerged coronavirus named SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2).¹ Coronaviruses are a family of RNA viruses usually found in animals. Mutations in the virus can result in human infection and subsequent spread.²

SARS-CoV-2 is closely related to the SARS virus identified in 2003 (SARS-CoV) and (to a lesser degree) the MERS-CoV virus from 2012. All three can produce a severe respiratory syndrome and associated mortality.²⁻⁴ While both SARS-CoV and the MERS-CoV viruses seem to have a higher comparative rate of mortality (especially MERS-CoV), the newly emerged SARS-CoV-2 appears much more infectious, with significant human-to-human transmission.⁵⁻⁷ Asymptomatic individuals may transmit the virus, challenging infection control.^{8,9} Its rapid spread has produced a true global pandemic.

Diagnosis of COVID-19:

Diagnosis cannot be made solely on signs or symptoms as these overlap with other respiratory illness, so confirmation of the presence of the virus is essential. Table 1 describes the range and percent of symptoms seen in confirmed COVID-19 infections.

Sign or symptom	% of patients
Fever	83–99
Cough	59–82
Fatigue	44–70
Anorexia	40–84
Sputum production	28–33
Shortness of breath	31–40
Myalgia (muscle aches)	11–35

Table 1. Range and percent of symptoms seen in confirmed COVID-19 infections.¹³

In some populations, a loss of taste or smell is also a widely reported symptom.¹⁰ Molecular testing specific for the SARS-CoV-2 RNA is used to confirm presence of the virus, and serology testing can identify antibodies to the virus.^{11,12} In addition, antibody testing is a promising approach to assess prevalence of infection and potentially identify immunity. It remains to be confirmed whether antibodies to SARS-CoV-2 offer protection (immunity) from subsequent exposure.

Conclusion:

Testing is critical to differentiate COVID-19 from other respiratory diseases such as influenza or RSV (respiratory syncytial virus). Widespread testing will both inform a COVID-19 diagnosis and aid a greater understanding of disease prevalence, especially in infections that are asymptomatic.

Clinical classification and transmission of COVID-19¹⁴⁻²⁷

Clinical classification



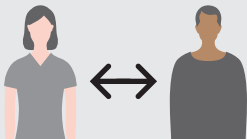
Incubation period
median 5 days,
range 1–27 days

Patients with
mild symptoms
in week 1...

...may progress
in week 2

**Progression
may be rapid
and sudden.**

Human-to-human transmission



Possible transmission
during asymptomatic
phase 4–6 days before
the onset of symptoms.

Possible transmission after
remission of the symptoms

Possible
transmission

**Highest risk of transmission
during symptomatic phase**

Possible
transmission

Disease spectrum



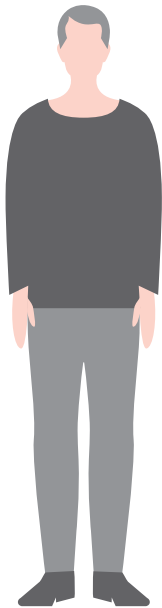
Asymptomatic	Symptomatic			Remission
No symptoms* 1.2–17.6%	Mild to Moderate 80%	Severe 10–15%	Critical 2–5%	
Infectious virus can be shed, viral loads may be comparable to symptomatic patients	No signs (mild) or some signs (moderate) of pneumonia on imaging	<ul style="list-style-type: none"> Respiratory distress of ≥ 30 breath per minute Oxygen saturation $\leq 93\%$ at rest $\text{PaO}_2/\text{FiO}_2 \leq 300$ mmHg Lung lesion progression $>50\%$ in 24–48h 	<ul style="list-style-type: none"> Respiratory failure requiring mechanical ventilation Shock Any organ failure requiring ICU care Case/fatality rate current estimation 0.3 to 4% 	

*Recent SARS-CoV-2 testing studies demonstrate a wide variety of asymptomatic patients between 1% and >80% partially due to different stages of outbreak, testing availability and population studied

Course of patients at risk and/or infected by COVID-19¹⁴⁻²⁷



Identification of high-risk patients



- Age >65 years
- Any age with severe obesity BMI >40
- Pre-existing pulmonary disease (chronic lung disease or moderate to severe asthma, COPD, lung cancer, pulmonary hypertension, emphysema (smoking, A1AT deficiency))
- Chronic kidney disease
- Diabetes
- History of:
 - hypertension (treated and untreated)
 - cardiovascular disease
 - liver disease
 - transplants or other immunosuppression (ex. cancer treatment)
- Patients with HIV or other immunocompromised conditions
- Patients with endocrine pathologies
- Use of biologic drugs



Population triage^{2,3,4}

Epidemiologic surveillance

Laboratory testing:

- RT-PCR
- Anti-SARS-CoV-2 antibodies



Recovery

Laboratory testing:

- Anti-SARS-CoV-2 antibodies (IgG, Total)

Confirm immunization (under investigation)



Diagnosis and Determination of Disease Status

Disease detection:

- Molecular testing (RT-PCR)

Immune Response:

- Anti-SARS-CoV-2 antibodies (IgG, Total)

Imaging:

- Chest CT
- Ultrasound
- X-ray



Monitoring

Laboratory testing:

- Arterial blood gas
- Complete blood count
- Acute phase proteins, inflammation & coagulation
- Liver, kidney, cardiac function biomarkers
- Additional testing related to comorbidities

Imaging:

- Chest CT (ground glass opacification)
- Ultrasound

The essential role of laboratory diagnostics in SARS-CoV-2 infection¹⁴⁻²⁷



Essential lab testing

Daily labs	CBC with differential (trend total lymphocyte count) Comprehensive metabolic panel: <ul style="list-style-type: none"> • Electrolytes: Na, K, Total CO₂, Chloride • Total protein and Albumin • Creatinine • Bilirubin, ALT, AST CPK (total creatine kinase) Lactate
Risk stratification	D-dimer, Ferritin, CRP, ESR, LDH, Cardiac troponin
Viral serologies	HBV, HCV, HIV Ab/Ag

Frequent laboratory abnormalities in patients with COVID-19[†]



Decreased

Blood lymphocyte count (35–75%)
Albumin (50–98%)
Hemoglobin (41–50%)



Increased

Neutrophil count
Erythrocyte sedimentation rate (ESR; up to 85%)
C-reactive protein (CRP; 75–93%)
Lactate dehydrogenase (LDH; 27–92%)
Alanine aminotransferase (ALT)

Aspartate aminotransferase (AST)
Total bilirubin
Cardiac troponin
Procalcitonin (6–25%)
Prothrombin time (PT)
D-dimer (36–43%)








[†]Approximate percentage of patients

Additional essential lab testing	Test	Potential clinical significance
Arterial blood gas	pH, PaCO ₂ , PaO ₂ , and aHCO ₃	For ventilator adjustments
Hematology	Lymphopenia with atypical lymphocytes Leukocytosis, Neutrophilia, low eosinophils Thrombocytopenia: Platelet count	Decreased immunological response to the virus Bacterial (super) infection Consumption (disseminated) coagulopathy
Hemostasis	Prothrombin time, D-Dimer	Activation of blood coagulation and/or disseminated coagulopathy PT and D-dimer are significant predictors of disease severity
Inflammation/Infection	CRP, Ferritin, IL6, TNF α , SAA Procalcitonin	Severe viral infection/viremia Bacterial (super) infection
Cardiac	High-sensitivity troponin, CK-MB, BNP/NT-proBNP	Increased levels may be associated with higher mortality [‡]
Liver	Albumin, ALT, AST, Bilirubin	Impairment of liver function, Liver injury
Renal	Creatinine, Cystatin C	Kidney injury

[‡]This information represents a potential novel clinical utility. Data have not been reviewed by FDA or any other regulatory agency

Impact of Comorbidities on COVID-19 Patients

Patients with comorbidities (like diabetes mellitus, hypertension, cardiovascular, chronic lung and chronic kidney disease) are particularly susceptible to COVID-19 infection and are likely to have more severe illness¹⁴⁻²⁶

	Comorbidities	Additional testing	Impact of COVID-19
	Cardiovascular disease	Troponin, Natriuretic peptides, CKMB	Precipitates cardiac complications such as: acute heart failure, myocardial infarction, myocardial injury, cardiac arrest.
	Chronic kidney disease	Blood: Creatinine, Cystatin C, eGFR Urine: Albumin	Challenges for patients on dialysis, in particular, in-center hemodialysis; uremic patients are particularly vulnerable to infection and may exhibit greater variations in clinical symptoms and infectivity.
	Heart/liver/kidney transplant	Immunosuppressant Drugs: Mycophenolate, Cyclosporine, Tacrolimus, Sirolimus, Everolimus	Patients may be more vulnerable due to immunocompromised status.
	Viral co-infection	Hepatitis B serologies (anti-HBs, anti-HBc, and HBsAg) Hepatitis C serology (anti-HCV), unless positive in past HIV 1/2/O, CD4 count	Viral serologies assist in interpretation of ALT elevations, present in ~25% of COVID-19 patients. HIV patients may get severe side effects when taking Tocilizumab (drug being used for COVID-19 pneumonia). [§] Hepatitis patients are at higher risk for liver complications.
	Diabetes	Blood glucose	Patients with diabetes who are infected with COVID-19 may see their glycemic control deteriorate during the illness.
	Chronic lung disease	LDH	Patients may be more vulnerable due to lung function insufficiency.
	Chronic liver disease	Albumin, AST, ALT, Total Protein, Bilirubin, PT INR	Patients may be more vulnerable due to liver function insufficiency.

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We are a leading medical technology company with over 120 years of experience and 18,000 patents globally. Through the dedication of more than 50,000 colleagues in 75 countries, we will continue to innovate and shape the future of healthcare.

Siemens Healthineers' SARS-CoV-2 molecular and serology tests have not been FDA cleared or approved. These tests have been authorized by FDA under an EUA for use by authorized laboratories. The molecular test has been authorized only for detecting the presence of antibodies against SARS-CoV-2, not for any other viruses or pathogens. The serology test has been authorized only for detecting the presence of antibodies against SARS-CoV-2, not for any other viruses or pathogens. The serology test has been authorized only for detecting the presence of antibodies against SARS-CoV-2, not for any other viruses or pathogens. These tests are only authorized for the duration of the declaration that circumstances exist justifying the authorization of emergency use of in vitro diagnostics for detection and/or diagnosis of COVID-19 under Section 564(b)(1) of the Act, 21 U.S.C. § 360bbb-3(b)(1), unless the authorization is terminated or revoked sooner.

Product availability may vary from country to country and is subject to varying regulatory requirements. Please contact your local representative for availability.

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