# Evolving Global and National Criteria for Identifying a Suspected Case of COVID-19

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**Research**

**Keywords:** COVID-19, Coronavirus, Suspected Case, Clinical Characteristics, Epidemiology Risk

**Posted Date:** April 2nd, 2020

**DOI:** https://doi.org/10.21203/rs.3.rs-20457/v1



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**Version of Record:** A version of this preprint was published at Journal of International Medical Research on August 1st, 2020. See the published version at https://doi.org/10.1177/0300060520938943.

# Abstract

Background: The outbreak of coronavirus disease 2019 (COVID-19) began in December 2019 and is spreading rapidly. Rapid and accurate identification of suspected cases is critical in suppressing viral spread. We aimed to highlight the discrepancies in the varying criteria used by international agencies and highly impacted individual countries worldwide.

Methods: The criteria from two international agencies and ten countries across Asia, Europe, and North America were reviewed. Each included information on the clinical causes of illness and epidemiology risk factors. Non-English language guidelines were translated into English by one of the co-authors who was fluent in that language.

Results: Although the majority of criteria are modified from the World Health Organization recommendations, the specific clinical features and epidemiological risks for triggering evaluation of COVID-19 in suspected patients differed widely among nations. The rationale for these differences may be linked to each individual country's resources, politics, experience with previous outbreaks or pandemics, health insurance systems, severity of the COVID-19 situation, and other undetermined factors.

Conclusion: There was no consensus on the single best criteria for identifying a suspected case of COVID-19.


# Introduction

The outbreak of coronavirus disease 2019 (also known as COVID-19) was first identified in December 2019. On February 11, 2020, the virus causing COVID-19 was officially named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). On March 11, the World Health Organization (WHO) declared that COVID-19 can be characterized as a pandemic. The clinical spectrum of COVID-19 is still evolving and far from complete. Therefore, one of the most challenging tasks for healthcare providers is to recognize COVID-19 early, to mitigate community spread and manage affected patients.

Respiratory droplets and direct contact are considered the primary means of transmission of other respiratory viruses, including SARS-CoV, Middle East respiratory syndrome–related coronavirus (MERS-CoV), and influenza. [1] Case reports from China described that most non-Wuhan residents with COVID-19 had visited Wuhan (the epicenter of this pandemic) prior to symptom onset, [1, 2] had contact with Wuhan residents, [1] or had close contact with confirmed cases. [2] For this reason, the transmission of SARS-CoV-2 is very likely to follow the same pattern of their predecessor coronaviruses.

Fever and dry cough are the two most commonly reported symptoms of COVID-19 [1–3]; WHO recommended using these symptoms to identify a suspected case of COVID-19 from the very beginning of the outbreak (Table 1). [4–6]

Table 1

Criteria for identifying a suspected case from international agencies (WHO and ECDC)

| Organization / Issue Date | Main Criteria | | | Remarks |
|---|---|---|---|---|
| | Clinical course of illness | & | Epidemiology Risk | |
| WHO (4) Feb 27, 2020 | Acute respiratory illness (Fever AND at least one sign/symptom of respiratory disease (e.g., cough, shortness of breath)) AND no other etiology that fully explains the clinical presentation. | AND | A history of travel to or residence in a country/area or territory reporting local transmission of COVID-19 disease during the 14 days prior to symptom onset. | |
| | Any acute respiratory illness. | AND | Having been in contact with a confirmed or probable COVID-19 case in the last 14 days prior to onset of symptoms. | |
| | Severe acute respiratory infection (fever and at least one sign/symptom of respiratory disease (e.g., cough shortness breath) AND requiring hospitalization AND no other etiology that fully explains the clinical presentation. | | | |
| ECDC (19) Mar 2, 2020 | Acute respiratory tract infection (sudden onset of at least one of the following: cough, fever, shortness of breath) AND with no other etiology that fully explains the clinical presentation. | AND | A history of travel to or residence in a country/area or territory reporting local transmission of COVID-19 disease during the 14 days prior to symptom onset. | Once local or community transmission has been reported in the country or area, all patients presenting with symptoms of acute respiratory infection in primary care or the accident and emergency department of a hospital (first contact with the healthcare system) will be considered as suspected cases. |

WHO = World Health Organization, ECDC = European Centre for Disease Prevention and Control.

| | | | |
|---|---|---|---|
| | Any acute respiratory illness. | AND | Having been in close contact with a confirmed or probable COVID-19 case in the last 14 days prior to onset of symptoms. |
| | Severe acute respiratory infection (fever and at least one sign/symptom of respiratory disease (e.g., cough, fever shortness breath) AND requiring hospitalization AND with no other etiology that fully explains the clinical presentation. | | |

WHO = World Health Organization, ECDC = European Centre for Disease Prevention and Control.

As the emergence and spread of COVID-19 in different countries have been evolving rapidly, the reporting of cases varies widely among countries. This has resulted in what appears to be a wide range of total number of cases in different countries. However, the number of confirmed cases reported by a specific country may not provide an accurate estimate of actual number of infected patients, because many factors, such as the limited supply of test kits, government policy, and criteria for identifying a suspected case, can potentially distort the data. Our objective was to analyze the criteria used in different counties for identifying a suspected case of COVID-19. For comparative analysis, we have translated these criteria into English where necessary (e.g. from China, Germany, Iran, Italy, Japan, South Korea, and Thailand).

# Methods

We reviewed publicly available information regarding COVID-19 from Jan 1, 2020 to Mar 14, 2020 issued by various public health organizations around the world, including international agencies (WHO and European Centre for Disease Prevention and Control (ECDC)) and the public health organizations in various countries or regions (China, Germany, Iran, Italy, Japan, South Korea, Taiwan, Thailand, United Kingdom (UK), and United States of America (USA)). For non-English documents, one of the co-authors who is fluent in that language translated the information into English.

We focused on the criteria of identifying a suspected case, and summarized the criteria in the form of clinical course of illness and epidemiology risk. This study is solely a qualitative analysis, and there was no statistical analysis undertaken.

# Results

The criteria from two international agencies and a total of ten countries (listed in alphabetical order) are summarized below:

# International Agencies

The summary of criteria of international agencies (i.e. the WHO and ECDC) are listed in Table 1. We also searched the Africa Centers for Disease Control and Prevention (Africa CDC) website. Africa CDC is currently using the WHO criteria, and has not released any continent-specific criteria.

The criteria of ECDC is almost identical to the WHO criteria, except that the epidemiology risk will be waived once there is a local or community outbreak.

# China

As part of the effort to slow down the spread of SARS-CoV-2 and reduce mortality, the National Health Commission released the first version of its diagnosis and treatment protocol for novel coronavirus pneumonia on January 16. In the subsequent two weeks, this protocol was updated frequently due to rapid spread of COVID-9 nationwide and emerging new data. By the end of January, the fourth version was released. [7] The newest version of this protocol was published on March 3 (Table 2), [8] and recommends using clinical manifestations and epidemiology risks to define suspected cases. Clinical manifestations consist of symptoms, radiographic features and complete blood count; epidemiology risks mainly focus on the hot zone (Hubei province, especially Wuhan), exposure to confirmed COVID-19 patients and evidence of community spread. Even though the 7th version of this protocol is similar to prior versions, there are several key differences. The 7th version includes fever and/or respiratory symptoms for identifying a suspected case; respiratory symptoms were not required in the 4th version (Table 3). In the 4th version the epidemiological risk factors were considered mandatory but the 7th version loosened this requirement, with individuals considered suspected cases without any epidemiology risk, as long as all of the three clinical manifestations were met.

Table 2

Criteria for identifying a suspected case from 10 countries

| Country / Issue Date | Main criteria | | | Remarks |
|---|---|---|---|---|
| | Clinical course of illness | & | Epidemiology Risk | |
| China (8) 7th version Mar 3, 2020 | Two of the following features are required.<br>(1) Fever AND/OR respiratory symptoms.<br>(2) Radiographic features suggesting COVID-19. [a]<br>(3) At early phase, WBC normal or mild decreased, OR lymphocyte count normal or decreased. | AND | One of the following risks are required: [b]<br>(1) Travel to/live in Wuhan or adjacent areas, or other areas with confirmed COVID-19 cases within 14 days of symptom onset.<br>(2) A close contact with a laboratory-confirmed COVID-19 patient within 14 days of symptom onset.<br>(3) A close contact with an individual who has fever or respiratory symptoms and comes from Wuhan or adjacent areas, or other areas with confirmed COVID-19 cases within 14 days of symptom onset.<br>(4) Clustered cases with fever AND/OR respiratory symptoms (Occurred in family, office, or school within a duration of 2 weeks). | a. Scattered small opacities and interstitial changes peripherally at the early phase; diffuse ground-glass opacities, infiltrates, or extensive consolidations in severe cases. Pleural effusions are uncommon.<br>b. If no epidemiology risk identified, all of the three clinical features must be met. |
| Germany (11) Mar 5, 2020 | Non-specific general symptoms OR acute respiratory symptoms of any severity | AND | Contact with confirmed cases within 14 days prior to the onset of the disease. | Well-founded suspicion. |
| | Acute respiratory symptoms of any severity with or without fever | AND | Stay in high-risk areas within 14 days prior to the onset of the disease. | |

ARDS = Acute respiratory distress syndrome, UK = United Kingdom, USA = United States of America

* High risk group is defined as: (1) immunodeficient patients (such as taking corticosteroids, having cancer, history of transplant, and HIV positive patients) or (2) patients with underlying diseases (such as cardiovascular disease, hypertension, diabetes, underlying respiratory disease, and body mass index > 40).

| Country / Issue Date | Main criteria | | | Remarks |
|---|---|---|---|---|
| | Clinical course of illness | & | Epidemiology Risk | |
| | Acute respiratory symptoms of any severity with or without fever | AND | Stay in regions with confirmed cases within 14 days prior to the onset of the disease. | Case under differential diagnostic clarification. |
| | Clinical or radiological indications of a viral pneumonia without alternative diagnosis | AND | No measurable epidemiological risks. | |
| Iran (20) Feb 27, 2020 | Chills, dry cough, sore throat with or without fever AND shortness of breath or hypoxia (Oxygen saturation at < 93%) | AND | (1) Any person with a close contact with a laboratory-confirmed COVID-19 patient within 14 days of symptom onset.<br>(2) a history of travel from affected geographic areas within 14 days of symptom onset. | |
| | (1) Fever with above symptoms without hypoxia, AND<br>(2) in high risk group* with positive CT scan or chest x-ray. | AND | | |
| Japan (21) Mar 4, 2020 | Non-vulnerable person:<br>Fever (≥ 37.5 °C) OR respiratory symptoms, for more 4 days. | AND | Potential exposure to COVID-19 | Considering test for nucleic acid amplification (such as PCR), when criteria met. Vulnerable person is defined as: (1) advanced age, (2) a person with diabetes, chronic heart failure, chronic obstructive pulmonary disease, and chronic kidney disease with dialysis, and (3) a person who is on immunosuppressants or chemotherapy. |
| | Vulnerable person:<br>Fever (≥ 37.5 °C) OR respiratory symptoms, for more 2 days. | AND | | |

ARDS = Acute respiratory distress syndrome, UK = United Kingdom, USA = United States of America

* High risk group is defined as: (1) immunodeficient patients (such as taking corticosteroids, having cancer, history of transplant, and HIV positive patients) or (2) patients with underlying diseases (such as cardiovascular disease, hypertension, diabetes, underlying respiratory disease, and body mass index > 40).

| Country / Issue Date | Main criteria | | | Remarks |
|---|---|---|---|---|
| | Clinical course of illness | & | Epidemiology Risk | |
| Italy (22) Mar 9, 2020 (This version is the same as ECDC definition on Mar 2, 2020) | Acute respiratory tract infection (sudden onset of at least one of the following: cough, fever, shortness of breath) AND with no other etiology that fully explains the clinical presentation. | AND | A history of travel to or residence in a country/area or territory reporting local transmission of COVID-19 disease during the 14 days prior to symptom onset. | Once local or community transmission has been reported in the country or area, all patients presenting with symptoms of acute respiratory infection in primary care or the accident and emergency department of a hospital (first contact with the healthcare system) will be considered as suspected cases. |
| | Any acute respiratory illness. | AND | Having been in close contact with a confirmed or probable COVID-19 case in the last 14 days prior to onset of symptoms. | |
| | Severe acute respiratory infection (fever and at least one sign/symptom of respiratory disease (e.g., cough, fever shortness breath) AND requiring hospitalization AND with no other etiology that fully explains the clinical presentation. | | | |
| South Korea (23) (7 – 1 edition) Mar 6, 2020 | Fever OR respiratory symptoms | AND | A history of contact with a symptomatic laboratory-confirmed COVID-19 patient, who develops symptoms within 14 days from contact. | |

ARDS = Acute respiratory distress syndrome, UK = United Kingdom, USA = United States of America

* High risk group is defined as: (1) immunodeficient patients (such as taking corticosteroids, having cancer, history of transplant, and HIV positive patients) or (2) patients with underlying diseases (such as cardiovascular disease, hypertension, diabetes, underlying respiratory disease, and body mass index > 40).

| Country / Issue Date | Main criteria | | | Remarks |
|---|---|---|---|---|
| | Clinical course of illness | & | Epidemiology Risk | |
| | Fever OR respiratory symptoms | AND | A history of travel to high risk geographic areas within 14 days of symptom onset. | |
| | Fever OR respiratory symptoms | AND | Shows contact with domestic collective outbreak or association according to the epidemiological database, who develops symptoms within 14 days from contact. | |
| | Referred by a physician to have coronavirus infection testing, such as having pneumonia due to unknown etiology. | | | |
| Taiwan (24) Mar 1, 2020 | Fever ≥ 38℃ OR acute upper airway symptoms<br>OR<br>Clinical, radiological or pathological diagnosis of pneumonia | AND | A history of travel from affected geographic areas, or in contact with people from areas with fever or acute airway symptoms, within 14 days of symptom onset.<br>OR<br>Have been in close contact with highly possible cases[c] or confirmed cases, including providing care/living together without proper protective equipment, OR direct contact with respiratory secretion/body fluid. within 14 days of symptom onset. | Must report to Taiwan CDC within 24 hours if compatible with the criteria.<br>Highly possible case: Although not laboratory confirmed, but compatible with clinical criteria, AND contact with confirmed cases within 14 days of symptom onset. |

ARDS = Acute respiratory distress syndrome, UK = United Kingdom, USA = United States of America

* High risk group is defined as: (1) immunodeficient patients (such as taking corticosteroids, having cancer, history of transplant, and HIV positive patients) or (2) patients with underlying diseases (such as cardiovascular disease, hypertension, diabetes, underlying respiratory disease, and body mass index > 40).

| Country / Issue Date | Main criteria | | | Remarks |
|---|---|---|---|---|
| | **Clinical course of illness** | **&** | **Epidemiology Risk** | |
| | Clinical, radiological or pathological diagnosis of pneumonia. | AND | Healthcare providers OR Cluster cases, within 14 days of symptom onset. | |
| | Diagnosis of community-acquired pneumonia without travel history of affected geographic areas, clinicians have ruled out possible causes and highly clinical suspicion of novel pathogens | | | |
| Thailand (25) (3rd version) Mar 2, 2020 | Fever AND any symptoms of respiratory illness (e.g. cough, runny nose, sore throat, respiratory distress, or dyspnea). | AND | Any of the following conditions in the last 14 days prior to onset of symptoms:<br>(1) A history of travel from affected geographic areas.<br>(2) Living in the same household with any person who has a history of travel in (1).<br>(3) Working in close contact with international tourists.<br>(4) Having been in contact with a confirmed or probable COVID-19 case<br>(5) Being a healthcare provider that involved with or having a contact with suspected case. | Criteria for Airport Health Control. |
| | (1) Fever AND any symptoms of respiratory illness (e.g. cough, runny nose, sore throat, respiratory distress, or dyspnea).<br>(2) Pneumonia | AND | | Criteria for healthcare facility. |
| | Pneumonia with | AND | No need to consider the | Criteria for healthcare facility |

ARDS = Acute respiratory distress syndrome, UK = United Kingdom, USA = United States of America

* High risk group is defined as: (1) immunodeficient patients (such as taking corticosteroids, having cancer, history of transplant, and HIV positive patients) or (2) patients with underlying diseases (such as cardiovascular disease, hypertension, diabetes, underlying respiratory disease, and body mass index > 40).

| Country / Issue Date | Main criteria | & | Epidemiology Risk | Remarks |
|---|---|---|---|---|
| | Pneumonia with one of the following conditions:<br>(1) A close contact with a confirmed or probable COVID-19 case in the last 14 days prior to onset of symptoms.<br>(2) A healthcare provider<br>(3) No improvement after treatment<br>(4) Unexplained etiology<br>(5) Severe case or death with unexplained etiology | AND | No need to consider the epidemiologic risk | Criteria for healthcare facility. |
| | **Clinical course of illness** | | | |
| | A cluster of patients with acute respiratory tract infection that have negative tests on flu confirmed by rapid test or rapid thermocycling process. | AND | Meet the cluster definition below:<br>(1) For healthcare providers, having 3 people working in the same department (same healthcare facility for the small healthcare facility) within a week.<br>(2) For non- healthcare providers, having 5 people within a week. | Criteria for a cluster of patients. |
| UK (26) | The patient | | | Inpatient definition |

ARDS = Acute respiratory distress syndrome, UK = United Kingdom, USA = United States of America

* High risk group is defined as: (1) immunodeficient patients (such as taking corticosteroids, having cancer, history of transplant, and HIV positive patients) or (2) patients with underlying diseases (such as cardiovascular disease, hypertension, diabetes, underlying respiratory disease, and body mass index > 40).

| Country / Issue Date | Main criteria: Clinical course of illness | & | Epidemiology Risk | Remarks |
|---|---|---|---|---|
| UK (26) Mar 13, 2020 | The patient requiring hospital admission with: (1) Either clinical or radiological evidence of pneumonia, OR (2) Acute respiratory distress, OR (3) Influenza like illness. | | | Inpatient definition |
| | New continuous cough and/or high temperature | | | Patients who meet the following criteria and are well enough to remain in the community (stay at home) |
| USA (27) Mar 4, 2020 | Fever AND/OR symptoms of acute respiratory illness. | AND | (1) Any person, including healthcare workers, with a close contact with a laboratory-confirmed COVID-19 patient within 14 days of symptom onset, OR (2) A history of travel from affected geographic areas within 14 days of symptom onset. | Fever is either measured temperature ≥ 100.0°F (37.78 °C) or subjective fever. |
| | Healthcare providers can use their judgement to determine if the patient should be tested. | | | |

ARDS = Acute respiratory distress syndrome, UK = United Kingdom, USA = United States of America

* High risk group is defined as: (1) immunodeficient patients (such as taking corticosteroids, having cancer, history of transplant, and HIV positive patients) or (2) patients with underlying diseases (such as cardiovascular disease, hypertension, diabetes, underlying respiratory disease, and body mass index > 40).

Table 3

Earlier versions of criteria for identifying a suspected case from China, Japan, South Korea, and United States of America.

| Country / Issue Date | Main criteria | | | Remarks |
|---|---|---|---|---|
| | Clinical course of illness | & | Epidemiology Risk | |
| China (7) 4th Version Jan 27, 2020 | Two of the following features are required.<br>(1) Fever,<br>(2) Radiographic features suggesting COVID-19,<br>(3) At early phase, WBC normal or mild decreased, OR lymphocyte count decreased. | AND | One of the following risks are required.<br>(1) Travel to/live in Wuhan or other areas with community spread of COVID-19 within 14 days of symptom onset.<br>(2) A close contact with an individual who has fever or respiratory symptoms and comes from Wuhan or other areas with community spread of COVID-19 within 14 days of symptom onset.<br>(3) Clustered cases, or epidemiological link to a confirmed COVID-19 patient. | Scattered small opacities and interstitial changes peripherally at the early phase; diffuse ground-glass opacities, infiltrates, or extensive consolidations in severe cases. Pleural effusions are uncommon. |
| Japan (28) Feb 3, 2020 | Patient with fever or respiratory symptoms (mild to severe) | AND | A history of close contact with the confirmed novel coronavirus case | |
| | Patient with fever (≥ 37.5°C) AND respiratory symptoms. | AND | A history of travel to or residence near the outbreak area of novel coronavirus within 14 days before onset of symptoms. | |
| | Patient with fever ≥ 37.5°C) AND acute respiratory symptoms. | AND | A history of close contact with a person who traveled to or has residence near the outbreak area of novel coronavirus within 14 days before onset of symptoms. | |
| | Patient with severe fever AND respiratory symptoms that require ICU or ICU-like treatment, resulting in an inability for clear patient diagnosis. | | | Physician should consider the patient a possible suspect case of coronavirus without laboratory confirmation. |

| Country / Issue Date | Main criteria | | | Remarks |
|---|---|---|---|---|
| | Clinical course of illness | & | Epidemiology Risk | |
| UK (29) Mar 10, 2020 | The patient requiring hospital admission with:<br>(1) Either clinical or radiological evidence of pneumonia, OR<br>(2) Acute respiratory distress, OR<br>(3) Influenza like illness. | | | |
| | (1) Acute respiratory infection of any degree of severity, including at least one of shortness of breath (difficult breathing in children) or cough (with or without fever) OR<br>(2) Fever with no other symptoms | AND | In the 14 days before the onset of illness:<br>(1) Travel to specified countries and areas. This includes transit, for any length of time, in these countries, OR<br>(2) Contact with confirmed cases of COVID-19. | |
| USA (30) Feb 28, 2020 | Fever OR symptoms of lower respiratory illness (e.g. cough or shortness of breath). | AND | Any person, including healthcare workers, with a laboratory-confirmed COVID-19 patient within 14 days of symptom onset. | Fever is either measured temperature ≥ 100.0°F (37.78 °C) or subjective fever. |
| | Fever AND symptoms of lower respiratory illness (e.g. cough or shortness of breath). | AND | A history of travel from affected geographic areas within 14 days of symptom onset. | |
| | Fever with severe acute lower respiratory illness (e.g. pneumonia, ARDS) requiring hospitalization and without alternative explanatory diagnosis (e.g., influenza). | AND | No identified source of exposure. | |
| USA (16) Jan 17, 2020 | Fever AND symptoms of lower respiratory illness (e.g., cough, shortness of breath) | AND | In the last 14 days before symptom onset,<br>(1) History of travel from Wuhan City, China, OR<br>(2) Close contact with a person who is under investigation for 2019-nCOV while that person was ill. | |

| Country / Issue Date | Main criteria | | | Remarks |
|---|---|---|---|---|
| | Clinical course of illness | & | Epidemiology Risk | |
| | Fever OR symptoms of lower respiratory illness (e.g., cough, shortness of breath) | AND | In the last 14 days before symptom onset, Close contact with an ill laboratory-confirmed 2019-nCoV patient. | |

In addition, the Chinese protocol emphasizes the utility of chest imaging and complete blood count while evaluating a suspected case. The imaging findings in COVID-19 vary from localized pure ground glass opacities, through consolidated lesions to lung whiteout. Based on chest imaging along, it is difficult to distinguish from other viral pneumonia. [9] However, when the outbreak erupted in Hubei province, the demand of testing kits exceeded the supply dramatically; as a result, National Health Commission revised its recommendations in the 5th version of Chinese protocol and allowed the diagnosis of COVID-19 to be based on clinical manifestations and characteristic chest imaging, without requiring serological or polymerase chain reaction (PCR) confirmatory tests. [10] Whether this approach is cost-effective is debatable, but in that unique context, it did facilitate the evaluation of suspected cases. Interestingly, the first published case series described clinical features of COVID-19 in hospitalized patients and highlighted the fact that more than 50% of cases had normal white blood cell counts and lymphopenia. [3] Subsequent Chinese protocols adopted and integrated these new data quickly, to help improve the accuracy of assessing suspected cases.

# Germany

The Robert Koch Institute (Ministry of Health) set four different criteria for identifying suspected cases, as presented in Table 2. [11] Every patient who fulfills criterion 1 or 2 is classified as a suspected case, which needs to be reported to the responsible public health department and also undergo laboratory diagnostic testing for COVID-19. Criteria 3 and 4 are cases under differential diagnostic clarification; these cases will be tested for COVID-19 without reporting to the responsible public health department unless they have a positive test result. Criteria 3 and 4 show that the threshold of testing in Germany is set very low because there are only a few regions worldwide that have absolutely no COVID-19 case and every unclear pneumonia is tested in principle. To minimize the risk of spreading COVID-19 to other patients and healthcare providers, several hospitals have set up a special, separate area at which patients can get tested for COVID-19. Within the framework of influenza surveillance, samples from patients with acute respiratory diseases sent in by practices of the Working Group on Influenza have also been tested for SARS-CoV-2 at the Robert Koch Institute since February 24, in order to detect and monitor the circulation of SARS-CoV-2 at an early stage. [12]

# Iran

On February 19, two people were reported positive for COVID-19 in Qom, a holy state located South of Tehran. The disease spread dramatically thereafter. Within 3 days, COVID-19 was found in 3 other regions including Tehran, the capital, and the total number of confirmed cases and death increased dramatically. Iranian officials decided not to impose any quarantine though the government did cancel cultural and sporting events, closed universities, schools and offices and put restrictions on traveling between cities. Officials asked everyone to stay at home, even if not symptomatic or not in contact with any confirmed case.

The first official guideline for diagnosis and treatment of COVID-19 was published on February 27 (Table 2). Based on this guideline, a suspected case is defined as someone who has dry cough, chills, sore throat, with or without fever, or alternatively symptoms of upper/lower respiratory symptoms with positive imaging findings. A possible case is defined as an individual who meets criteria of a suspicious case and had close contact with someone with definite COVID-19 infection in the past 14 days or and had recently traveled to a COVID-19 epidemic area in the past 14 days.

The Iranian guideline recommends anyone with sore throat, chills, with or without fever to be evaluated for respiratory distress or hypoxia. If these are present, the patient should be referred to one of the designated medical centers for further evaluation and testing. Febrile patients who are in a high-risk group (as defined in Table 2) without respiratory distress, should be imaged; the recommended imaging modality is either chest radiograph or computed tomography (CT) scan. If imaging test is positive, the patient should be referred to a designated medical center. Febrile high-risk patients with normal imaging findings should be quarantined at home, may receive antibiotics and should be actively followed daily by public health representatives. Febrile patients who are not in a high-risk group and have no respiratory distress should be quarantined at home. Febrile patients who are in high-risk group but with normal chest radiograph or CT scan should be quarantined at home, and treated with hydroxychloroquine and oseltamivir.

According to the guideline, outpatients do not need to be tested for COVID-19. Patients with compatible clinical symptoms and radiologic findings are considered to have COVID-19 and treatment can be started in isolation at the designed medical centers. Confirmatory test should be done only for patients with a positive initial test who need intubating, and not all the patients need this confirmatory test.

# Italy

The first travel-related case of COVID-19 was confirmed in Rome on January 30. On the same day, the Ministry of Health’s decree suspended flights from and to China for 90 days. On January 31, the Italian government declared a state of emergency. However, the first case of secondary transmission was found in the Lombardy region (northern Italy) on February 18. After that, the number of confirmed COVID-19 cases dramatically increased in the North of Italy. Five days later, on February 23, the Council of Ministers closed these regions with outbreaks (Lombardy and 14 other provinces nearby). On March 9 a Prime Ministerial decree limited the movement of all citizens in the entire country, and suspended all sporting events, schools and Universities until through April 3, 2020. On the same day, the definition of a

suspected case of COVID-19 was revised and the latest definition of ECDC was fully adopted (as presented in Table 1 and Table 2 (Italy)).

# Japan

On January 16, the first confirmed case of a novel coronavirus was reported. The basic policy for countermeasures related to the novel coronavirus were then adopted at the ministerial meeting on January 21. Such countermeasures include: (1) border quarantine measures, (2) identification of suspected patients in Japan, (3) establishing operation centers for clinical laboratory testing, (4) ensuring the safety of all Japanese outside of Japan, and (5) providing prompt and accurate information.

Simultaneously, prophylactic countermeasures for viral infection, including safe coughing techniques and handwashing were widely promoted. Initially, the main testing targets were patients who had stayed in or traveled to Hubei Province, China, within 14 days. However, human-to-human transmission within Japan was soon detected and as a result, screening targets were expanded to four criteria (Table 3). However, the complexity of these criteria led to many other citizens requesting testing. The simpler screening criteria was published on February 17, as shown in Table 2.

Around this time, the focus of countermeasures changed to attempting to suppress direct transmission via a national social distancing strategy, announced by Prime Minister Shinzo Abe on February 29, 2020. Schools were requested to close temporarily. In addition, mass gathering events were recommended to be canceled, postponed or reduced in size. On March 6, the restriction on medical insurance was lifted, which enabled healthcare facilities to directly use private laboratories for testing COVID-19 without going through public health centers. [13] Consequently, many more tests could be performed. Additionally, a 14 days quarantine was mandated for all visitors from China and South Korea. [13]

# South Korea

The first confirmed case of COVID-19 was diagnosed in South Korea on January 20. Since then, the number of patients has exponentially increased. The surveillance guidelines from Korea Centers for Disease Control & Prevention have been revised several times, the most recent being the 7th edition. The guideline is as stated in Table 2, but asymptomatic patients have also been tested at the discretion of a physician, facilitated by the low cost of testing and the abundance of testing kits.

Easy access to testing in South Korea followed the decision of the Seoul-based company to develop test kits back in early January 2020, even before the first COVID-19 patient was diagnosed in the country. The kits were quickly developed, emergently approved, and underwent massive production. This response system was forged after the 2015 outbreak of MERS. The country’s aggressive approach to diagnosis led to high numbers of cases (more than 220,000 tests performed as of March 12, [14]), and innovative drive-through clinics allowed high volume efficient and safe testing, while limiting patient-provider contact. In addition, the government pays for the cost of testing if the patient is symptomatic or referred by a physician. For asymptomatic patients or those not referred by a physician, testing can be performed at a cost to the patient of 140 USD. [14]

The general public also receive emergency text alerts when a positive COVID-19 result is confirmed, including information about the patient's recent travel history. Though this has raised concerns about privacy, the technology has helped in surveillance of cases and has identified high-risk areas to avoid.

It is likely that South Korea's pro-active approach in testing a large number of people (by far the highest number outside of China) has resulted in a death rate among confirmed cases that is among the lowest in the World.

# Taiwan

Taiwanese officials began to take actions for this novel disease on Dec 31, 2019, when WHO was notified of a pneumonia of unknown cause in Wuhan, China. On Jan 15, 2020, the government listed this disease "Severe Pneumonia with Novel Pathogens" as a Category 5 certifiable disease (the same level as MERS-CoV and Ebola virus infection) and mandated cases be reported within 24 hours). The initial criteria were fever and acute upper airway symptoms with travel or a contact history with people from affected geographical areas (initially only Wuhan and the surrounding area). Indeed, the travel history was more emphasized than the clinical condition. However, after a few locally confirmed cases without a definite travel or contact history were found, the criteria were modified. In order to prevent underestimating possible community and nosocomial cases, pneumonia with a high clinical suspicion of novel pathogens, and healthcare providers as the occupation were added to the modified criteria of Feb 28.

# Thailand

On January 12, Thailand was the first country outside of China to reporting a case of COVID-19. Toward the end of January, Thailand still had the highest number of confirmed cases outside of China and remained in the list of top 5 affected countries until February 23. The total number of confirmed cases has increased more slowly on Thailand than many other countries and Thailand dropped out of the top 10 affected countries on March 1. The 3rd version of the criteria used for identifying a suspected case in Thailand was updated on March 2 and summarized in Table 2. The criteria are very stringent relative to those of other countries, requiring patients to present with both symptoms (fever and any symptoms of respiratory illness) and an epidemiological risk factor in order to qualify for free testing. Physicians do not advise testing for symptoms alone due to concerns over testing costs. [15]

# UK

Based on the WHO's declaration that the novel coronavirus outbreak was a public health emergency of international concern on January 30, the chief medical officers of the UK promptly raised the risk level of COVID-19 to the UK from low to moderate. A day after that, the first two cases of COVID-19 were confirmed. Since then, the definition of suspected case along with other guidance in UK has been updated frequently. The earlier versions of the UK criteria updated on Mar 10 (Table 3) seem to be a simplified version of WHO guidelines as there are two main conditions: clinical cause of illness with epidemiological risk and clinical cause of illness without epidemiological risk. One thing that is explicitly specified as a risk factor is transit, for any length of time, in an affected country. The clinical threshold for patients with

epidemiological risk was very low because it included patients with a fever but with no other conditions. Nevertheless, three days later (Mar 13), the definition was updated again to focus only on the clinical course of illness and defined two types of suspected cases: cases that qualified for in-patient admission and cases that should stay at home. This change in definition was were likely to be the result of a rapid increase in the number of patients coming to the hospital (Table 2).

# USA

On January 17, the Centers for Disease and Controls (CDC) issued the first guideline for identifying a suspected case. [16] Four days later, the first travel-related case of COVID-19 in the USA was reported. Before the end of January 2020, the first case of human-to-human transmission in the US was confirmed. As for many other countries, the situation has been evolving rapidly. On February 28, the CDC updated a new version of the criteria with the following major changes (other than expanding the list of affected geographic areas). Firstly the scenario of a severe unexplained clinical presentation without epidemiology risk should be considered for testing, and second, fever can be both subjective or confirmed. In fact, the first condition is aligned with the WHO guideline, but the other conditions are proactive measures from CDC. On February 29, the US Food and Drug Administration (FDA) issued a new policy that allowed certain laboratories tests for COVID-19 diagnostics before the FDA's approval. [17] On March 4, CDC updated the criteria again to expand to a wider group of symptomatic patients. The new criteria dropped the specific condition without epidemiologic risk, but also emphasized that physicians should also use their judgment to determine a suspected case for further investigation.

# Discussion

The COVID-19 situation varies from one country to another. Effective responses or countermeasures need a coordinated effort of not only public health organizations, but also involve both governmental and private sectors, including health care systems and the insurance industry, and most importantly the citizens themselves. To better understand the risk of spreading SARS-CoV-2 globally, all countries should ideally have the same criteria for identifying suspected cases. But in practice, there is no one-size-fits-all guideline in this pandemic and no defined best or practice criteria yet. Every country has set its own criteria based on the principle of ALARA (As low as reasonably achievable) given the available resources of the country, including budget, economic impact, insurance coverage, and so forth.

Based on all the criteria that we have reviewed, most criteria are similar to and likely adapted from the WHO's criteria, focusing on specific symptoms and epidemiological risk assessment. However, depending on resource allocation these criteria may fail to capture or severely underrepresent certain populations including: (1) asymptomatic cases, (2) patients with a financial barrier to access laboratory tests (due to lack of insurance coverage and high test charges) and (3) patients with a legal barrier to access healthcare system (including undocumented immigrants and the homeless). The proportion of cases in the latter two groups is dictated to a large extent by the government policy of individual countries.

It is notable that although the WHO advises against wearing mask for non-sick persons in community setting due to lack of evidence, the global shortage of disposable surgical masks is an expanding problem due to massive masking. [18] Therefore, the masking policy should be carefully implemented in conjunction with criteria and other measures to prevent supply shortage and panic.

Our study has several limitations. First, at the moment of writing this paper, the pandemic is still ongoing; and the criteria are still being frequently updated. However, we do not anticipate dramatic changes among those criteria; and it is important to nevertheless review them now in real-time in the middle of the pandemic, in order to address countermeasures critically. Secondly, the non-English documents were translated by one of the co-authors, who are not certified translators. However, the authors' medical knowledge and professional background should ensure a high degree of accuracy.

# Conclusions

In summary, some governments may initially have had political incentives to keep the reported infected cases low. As the virus spreads widely and death tolls rises, governments will likely appreciate the necessity of being transparent and cooperative. Even though the idea of universal testing is attractive, the cost, supply, and availability is currently limiting its widespread implementation in many areas. Adapting updated criteria and other countermeasures should help contribute to flattening the curve of this novel global pandemic. Therefore, there was no consensus on the single best criteria for identifying a suspected case of COVID-19.

# Abbreviations

Africa CDC
Africa Centers for Disease Control and Prevention
ALARA
As low as reasonably achievable
ARDS
Acute respiratory distress syndrome
CDC
Centers for Disease and Controls
COVID-19
Coronavirus disease 2019
CT
Computed tomography
ECDC
European Centre for Disease Prevention and Control
FDA
Food and Drug Administration
nCoV

Novel coronavirus
SARS-CoV-2
Severe acute respiratory syndrome coronavirus 2
UK
United Kingdom
USA
United States of America
WBC
White blood count
WHO
World Health Organization

# Declarations

**Ethics approval and consent to participate**: Not Applicable

**Consent for publication**: Not Applicable

**Availability of data and materials:** The data used in this article were cited in the references section.

**Competing interests:** No competing interests

**Funding:** None

**Authors' contribution:** AA: Study design and planning; AA, AM, BH, FR, JK, JY, MM, MTC, SFM, TK: Data analyses, interpretation, writing.

**Acknowledgements:** We would like to thank (1) Dr. Sejung Hong for providing information about South Korea, (2) Dr. Panita Prasathinphimai and Dr. Varalee Yodsurang about Thailand, and (3) Maximilian Härtel about Germany.

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