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REVIEW ARTICLE

Infectious Disease

Novel coronavirus 2019 (COVID-19): Emergence and implications for emergency care

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Abstract

A novel coronavirus (COVID-19) causing acute illness with severe symptoms has been isolated in Wuhan, Hubei Province, China. Since its emergence, cases have been found worldwide, reminiscent of severe acute respiratory syndrome and Middle East respiratory syndrome outbreaks over the past 2 decades. Current understanding of this epidemic remains limited due to its rapid development and available data. While occurrence outside mainland China remains low, the likelihood of increasing cases globally continues to rise. Given this potential, it is imperative that emergency clinicians understand the preliminary data behind the dynamics of this disease, recognize possible presentations of patients, and understand proposed treatment modalities.

KEYWORDS

global health, infectious disease, public health

1 | INTRODUCTION

Human coronavirus infections have once again been brought to global attention following the December 2019 emergence of a novel coronavirus (COVID-19) isolated from pneumonia cases clustered at a market in Wuhan, China. These ribonucleic acid (RNA) viruses' animal reservoirs, zoonotic transmission, high mutation rates, and demonstrated human-to-human spread has made them of particular public health concern. The current potential for global dissemination of the COVID-19, given the co-occurrence of Lunar New Year celebrations, in addition to the growing number of reported cases, adds urgency to understanding this outbreak. The confirmation of cases in 29 countries as of February 8, 2020 (Figure 1) underscore the potential for COVID-19 to rapidly evolve into a global pandemic. We provide a summary of the origins, epidemiology, and emergency department clinical management of COVID-19.

2 | WHAT IS A CORONAVIRUS?

2.1 | Background on human coronaviruses

Based on genome sequencing, all known human coronaviruses have emerged from animal reservoirs.[1] These RNA viruses have high mutation rates that allow them to adapt to varied hosts, increasing their potential for rapid human-to-human spread once a spillover event has occurred.[1] The COVID-19 is the seventh identified human coronavirus, and appears to have notable similarities to 2 other highly pathogenic human respiratory coronaviruses, severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV),[2] both of which have generated large-scale public health responses in the last 2 decades.[3]

The COVID-19, SARS-CoV and MERS-CoV belong to the family of betacoronoviruses, and likely share a common reservoir in bats.[4]

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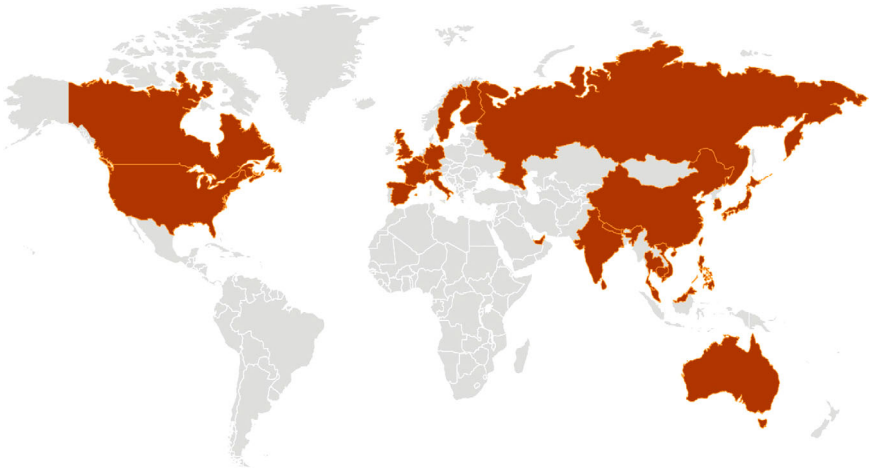

FIGURE 1 Current countries with known cases of COVID-19 as of February 7, 2020. Source: www.CDC.gov, accessed February 9, 2020

Intermediate hosts for zoonotic transmission to humans proposed for each of these 3 pathogenic strains include civets (SARS-CoV), dromedary camels (MERS-CoV),[1] and an unconfirmed but likely mammalian source (COVID-19).[5] These betacoronaviruses typically produce respiratory and gastroenteritis symptoms in human and animal hosts, respectively. The remaining identified human coronaviruses (HCoV-229E, HKU1, NL63, OC43) are limited in their severity of disease and often fail to produce symptoms greater than the common cold in immunocompetent hosts.[6]

2.2 | Recent coronavirus epidemics: SARS-CoV and MERS-CoV

Comparisons of the current COVID-19 outbreak are being made to 2 recently emerged coronaviruses from zoonotic spillover events; SARS-CoV (2002–2004, originating from Guangdong Province, China) and the multiple MERS-CoV outbreaks over the period (2012–2016, originating from Saudi Arabia). Further, all 3 pathogenic coronavirus syndromes seem to present with similar symptoms of cough, fever, and pneumonia. The current COVID-19 outbreak has eclipsed both the 2002 SARS outbreak and the 2012–2016 MERS outbreak in number of cases and is closing in on a similar death toll; however, both SARS and MERS appear to have had higher case-fatality rates (Table 1) and worse severity of illness.[7] In comparison to seasonal influenza globally, coronaviruses represent a smaller burden of disease, and fall well short of the 1918 Influenza pandemic (Table 1).

3 | NOVEL CORONAVIRUS-2019

3.1 | Emergence of COVID-19

On December 27, 2019, 3 adult patients presented with severe pneumonia to a hospital in Wuhan, China; a 49-year-old woman, a 61-year-old man, and a 32-year-old man. The woman was a known retailer in a seafood and wet animal wholesale market, while the older man was a frequent visitor. Similar circumstances and patients had been involved with the SARS-CoV outbreak, leading to suspicions of an n-CoV, and further testing revealed an n-CoV as the likely etiologic agent in all 3 cases.[2]

3.2 | Transmission

Multiple reports have confirmed human-to-human transmission of the COVID-19.[8] When person-to-person spread has occurred with MERS-CoV and SARS-CoV, it is thought to have happened mainly via respiratory droplets produced when an infected person coughs or sneezes, similar to how Influenza and other respiratory pathogens spread. Inoculation via "fomite-to-face" contact is also likely a significant contributor to the spread of the virus.[8–10] Recently, the first case of asymptomatic transmission was reported, though the theory remains unproven.[11] This development raises concerns that the COVID-19 may be similar to other viruses such as chickenpox and measles in that transmission may be possible during the incubation period or by patients with mild disease.

3.3 | Estimated morbidity and mortality

As of February 9, 2020, the mortality and morbidity rates of COVID-19 remain in flux. Currently, a case fatality rate (CFR) of slightly >3% has been reported, with some reports as high as 5%.[9,10] For comparison, MERS and SARS exhibited CFRs of 35% and 15%, respectively.[9] Mortality among COVID-19 victims seems highest for the elderly and those with multiple comorbidities.

3.4 | Predictive epidemiologic modeling

Current epidemiologic models suggest transmission patterns similar to SARS and 1918 influenza pandemic. The World Health Organization (WHO) model, formulated by Ferguson and colleagues, suggests a basic reproductive number, R_0 (the number of new cases that can develop from 1 confirmed case) of 2.6–3.1, 2-fold higher than for

TABLE 1 Comparison of COVID-19 to SARS, MERS, 1918 pandemic influenza, and seasonal influenza

	COVID-19[a,7–9,38]	2002–2004 SARS[39,40]	2012–2016 MERS[41–43]	1918 Pandemic influenza[16,44]	Seasonal influenza (global)[44–46]
R_0[b]	2.2	3	1.9–3.9	1.4–2.8	0.9–2.1
Total cases	37,525	8906	2494	500 million	7,780,000
Deaths	813	744	858	50 million	389,000
Case fatality rate (%)	3.1	8	34	10	0.05

[a]COVID-19 cases as of February 8, 2020.
[b]The number of new cases that can develop from 1 confirmed case.

seasonal Influenza.[12] Multiple other published models report similar ranges.[12–14] These models make assumptions regarding the latent and incubation periods based upon extrapolation from MERS-CoV and SARS-CoV. These models and the virus's behavior, thus far suggest the capability for sustained human-to-human transmission. Current rates of transmission are likely underestimated and will continue to evolve as the virus continues its spread, reporting practices evolve, and more data accrue. Many patients with infection likely experience only mild symptoms, do not present for evaluation, and thus, have not been included in statistics to date.

4 | CLINICAL COURSE AND MANAGEMENT

4.1 | Presentation

Knowledge of the COVID-19 presentation is limited by case reports of those presenting to the hospital and the unknown number of asymptomatic patients. To date, the average incubation period is estimated to be a median of 5 days with a range between 2 and 14 days.[8,15] Based on an early descriptive study of patients admitted to a Wuhan regional referral hospital with confirmed COVID-19 pneumonia, the majority had fever (83%–98%) or cough (76%–82%) and roughly one-third had shortness of breath. Less common symptoms included myalgias (11%), rhinorrhea (10%), headache (8%), chest pain (2%), and gastrointestinal symptoms (3%).[2] The vast majority of patients presented with >1 symptom. Patients were mostly men with a median age of 59 years.[2,10,16]

To date, over 29 countries have had confirmed cases of COVID-19, although most cases have been in mainland China, with reported cases in all provinces.[18] Outside of China, the patients with COVID-19 infection have a median age of 45 years (range of 2–74 years) and are most male (71%). Approximately one third of patients had complications such as acute respiratory distress syndrome, acute renal injury, septic shock, ventilator-associated pneumonia, but it is unclear whether these cases were initial presentations or later stage disease.[2] Approximately 23%–32% of patients were admitted to the ICU, primarily for increased oxygen support. The majority of patients were sustained on nasal cannula, a smaller subset required high flow or non-invasive ventilation, and an even smaller group requiring mechanical ventilation (4%–10%) or extracorporeal membrane oxygenation (<5%).[2,10,15] These data, however, do not include the global burden of COVID-19. Approximately 80% of COVID-19 deaths were in patients over 60 years old.[2,8] Over 75% of COVID-19 deaths had comorbid medical conditions such as hypertension, diabetes, or cardiovascular disease.[17] The vast majority of attributable deaths have occurred in China, although the Philippines and Hong Kong have also suffered 1 death each.[19]

4.2 | Diagnosis

Because the signs and symptoms of COVID-19 are similar to other viral respiratory syndromes, health care professionals must obtain a detailed travel history in any patient presenting to the emergency department with fever and respiratory symptoms (Figure 2). Any patient with flu-like symptoms and travel to China or close contact with a person with confirmed COVID-19 in the past 14 days should be considered a patient under investigation (PUI).[20] A close contact is anyone within 6 feet of a confirmed COVID-19 case for a prolonged period of time. Anyone with direct contact from secretions of a confirmed COVID-19 patient is also a close contact.

People who have traveled from Hubei and household members living with confirmed COVID-19 not adhering to home care or isolation precautions are considered high risk exposures. Medium risk exposures include those traveling in China but outside of Hubei province without high risk exposures and household members using consistently proper home care and isolation precautions. Low risk exposures include being in the same indoor environment such as a waiting room for a prolonged period with a confirmed COVID-19 case but not meeting the definition of close contact. No risk is identifiable for those who are in brief passing of a patient with confirmed COVID-19.

Diagnosis of COVID-19 is performed via molecular assays of respiratory specimens at WHO-designated regional referral laboratories.[18] On February 7, the CDC began the distribution of test kits for regional testing. More widely available testing is anticipated to be available soon. For institutions where testing is unavailable, testing by the CDC remains the only option. Confirmation of another viral respiratory illness in a PUI should not delay COVID-19 testing. The decision to remove a patient from PUI status should be made after full clinical evaluation and consultation with public health authorities.

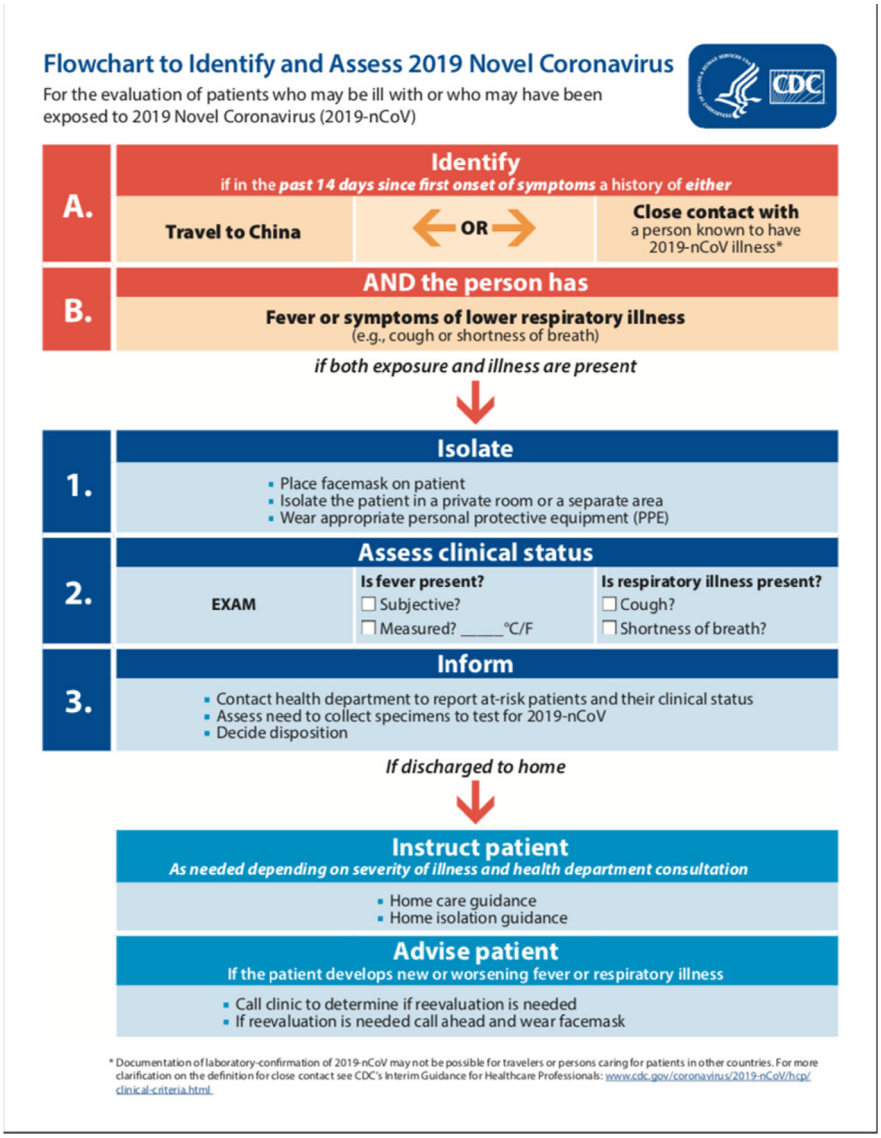

FIGURE 2 US CDC recommended flowchart to identify and assess potential COVID-19. Source: www.CDC.gov, accessed February 9, 2020

4.3 | Prevention

Currently, the transmission dynamics of COVID-19 are poorly understood. Infection prevention guidance or COVID-19 is based upon guidance previously developed for MERS and SARS as well as interim guidelines provided by the WHO and CDC.[21,22]

In health care settings, triage and out-of-hospital protocols should identify a PUI before or upon ED arrival to minimize exposure to other patients and providers. Measures should include screening questions (including travel history) and respiratory and hand hygiene. After identifying a PUI, both hospital infection control and the local health department should be contacted immediately to prevent further spread amongst patients and health care workers. Any PUI should be given a surgical mask and placed in a private room or negative pressure room if available.[21]

Like MERS and SARS, it is assumed the COVID-19 can be spread by the airborne route. Surgical face masks may be helpful for larger fluid droplets associated with coughing and sneezing, but they are unlikely to help with small airborne contaminants.[23] Where available, respirators with an adequate seal and air movement directed through filters should be more effective.[24–26] The proper usage of respirators and other personal protective equipment (PPE) including donning, fit, and frequent changing combined with proper hand hygiene represent the most effective method of preventing transmission in health care settings.[23,27,28]

If a patient needs to be hospitalized and an airborne infection isolation room is not available, the patient should be transferred to a facility with appropriate capabilities. Isolation rooms and care processes should be configured to minimize the number of health care personnel exposed to the patient as well as the duration of contact. It is paramount that all health care professionals use standard, contact, droplet, and airborne precautions in addition to an eye shield. PPE is especially important during aerosol-generating procedures (eg, intubation) when transmission is likely increased.[22,29] After a patient vacates the room, it is unknown how long COVID-19 says airborne. Entrance to the vacated room requires respiratory protection for a

period that is specific to the ventilation and clearance rates for the room.

4.4 | Disposition

Not all COVID-19 exposed or afflicted patients will need hospital admission. However, the decision to discharge a PUI for home isolation should be made in consultation with the local public health authorities.[30] Patients should be directed to use appropriate hand hygiene, wear a simple facemask when around others, and remain isolated to a single room in the house whenever possible.[30] Patients should only leave the house for medical attention after calling in advance to inform the medical office of their COVID-19 PUI status.[31] Although patients with mild symptoms can be discharged, there are reports of clinical decline in the second week of illness with over 50% of patients having dyspnea around day 8.[31] Therefore, discharge may be inappropriate for patients who are unable to adhere to recommendations, return precautions, self-monitoring, or those with inadequate housing. Patients with evidence of severe illness (hypotension, tachycardia, hypoxia, or other signs of shock) or those with comorbidities (older age, immunocompromised, chronic conditions such as diabetes, cardiovascular, or chronic lung disease) will require admission to isolation units and/or the ICU.

4.5 | Standard/supportive care

The WHO has published comprehensive, evidence-based guidelines for caring for patients with severe acute respiratory infections thought to be related to COVID-19.[20,32] The mainstay of treatment for suspected COVID-19 infections is supportive care. In patients suspected of COVID-19 infection, viral testing should be initiated early for disease confirmation and symptomatic treatment initiated as needed. Intravenous fluids should be used judiciously in patients without overt signs of fluid depletion as they may worsen oxygenation with increasing disease severity. In patients presenting with severe respiratory symptoms with radiographic findings, broad spectrum antibiotics should be administered early, since it is often not possible to differentiate between bacterial pneumonia and COVID-19 infections.[20,32] As with MERS and SARS, steroids should be avoided.

4.6 | Lessons learned from SARS/MERS and emerging treatments

Beyond supportive care, there are no proven alternative treatments for coronavirus infections, although several potential therapies have been suggested and tested in limited settings. Data from both the SARS and MERS epidemics have demonstrated worse long-term outcomes with the use of corticosteroids, and the use of steroids should only be reserved for patients requiring treatment for other disease processes.[32–34]

While currently not supported by the CDC or WHO guidelines, retrospective studies of the use of the protease inhibitors lopinavir and ritonavir during the SARS outbreak demonstrated improved survival when compared to case-matched patients receiving standard therapy.[35,36] Ribavirin, however, resulted in worse SARS outcomes when compared to case-matched control patients.[37] In contrast, based upon limited data, Ribavirin seems to be associated with improved MERS survival.[37] Similar randomized trials evaluating lopinavir/ritonavir for MERS have been designed, but are not yet completed. Current reports confirm that the Chinese Health Ministry is treating COVID-19 infected patients with lopinavir/ritonavir, but there are no data on the outcomes.

5 | CONCLUSION

The WHO has declared COVID-19 a Public Health Emergency of International Concern. Currently, other seasonal infections cause more global disease than COVID-19. However, there are concerning elements to this emerging infectious agent, including a greater R_0, initial greater estimated mortality, and no inherent immunity in global populations. Though data remains limited, it is imperative that emergency clinicians understand the dynamics of this emerging epidemic at both the individual- and population-based levels, learn how to recognize those patients at risk or suffering from COVID-19, and prepare to treat these patients in their clinical practice.

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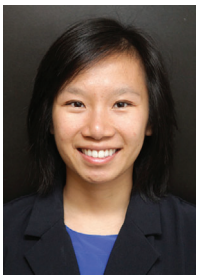

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