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Review

Imaging Reality: A review of COVID-19 Pandemic

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Abstract

Recently, coronavirus disease 2019 (COVID-19) has been the main universal health concern and the most important challenge to the world. This disease affects all age groups, genders and, races. Due to lack of definitive medication detection of the disease in an early stage and prevention of its transmission plays an important role in its control. Transcription Polymerase Chain Reaction (RT-PCR) and chest computed tomography (CT) are the most common diagnostic methods for COVID-19. Besides a review on the general founding of the COVID-19 pandemic, we tried to collect a hand on report focusing on radiological knowledge and its applications, limitations, and instructions.

Keywords: COVID-19, Radiology, Pandemic, Computed tomography

1. Introduction

Recently, coronavirus disease 2019 (COVID-19) has been the main universal health concern and the most important challenge to the world. It reached several countries in about 30 days and became known as one of the most dangerous pandemics. After reaching 200 countries, it became a global threat which led to the death of many individuals in the entire world [1-4].

This enveloped single-stranded RNA virus is distinctly present in both animals and people and can be easily transmitted from human to human, the way this condition spreads from person to person has made it a public threat. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is almost 50% genetically identical to the Middle East respiratory syndrome coronavirus (MERS-CoV) and about 79% identical to SARS-CoV. Initial studies revealed bats were the key reservoirs of coronavirus in China [5]. Unfortunately, this virus has the potential of significant genetic mutations that is unknown to the innate immune system of the human body and therefore could have an extensive impact on human health [1, 3, 6]. Lack of information and also accurate treatments resulted in the death of many people around the world [1, 6].

2. Epidemiology

As of early October 2020, 66 countries recorded less than one death per 100,000 population (including 21 mostly small countries without any deaths), while 17 countries exceeded 50 deaths per 100,000 [7]. Based on the World Health Organization (WHO) report until November 10th, 2020, there have been

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50,676,072 confirmed cases of COVID-19, including 1,261,075 deaths. Some piece of evidence showed death rates were higher in men in comparison with women [8].

Climatic-environmental and non-environmental conditions such as family, social structure, body immunity, rainfall, temperature and humidity, air pollution, cigarette smoking, or drinking alcohol are factors that would affect the morbidity and mortality of COVID-19 [9]. This respiratory virus is highly active between 5 to 20 °C that indicates the temperature is an effective factor in the virus transmission. A higher prevalence of coronavirus was observed in North America and Southern Europe relative to Southeast Asia and the western Pacific. The temperature is considered one of the effective factors in this issue [3, 9].

There are contradictory pieces of evidence about the role of humidity. According to the WHO, humidity between 40 and 80% is most likely to increase virus transmission. Increasing the size of droplets in higher humidity will increase the probability of their deposition. Therefore, it is expected that higher humidity decreases the transmission of the virus. This concept is true in some parts of Iran, Spain, Russia, and Turkey, where high humidity has reduced virus transmission, but in parts of the United States and northern Europe it has been so different, there may be a link between the prevalence and mortality of coronavirus with smoking and air pollution [9]. Tourism and social scientific, religious or political ceremonies may also contribute to the global spread of the virus [10].

3. Morbidity and transmission

This infection can be highly contagious and be mainly transmitted through inhalation of contaminated droplets, close contact, contaminated surfaces, and hands in contact with the eyes, and mouth [1, 11]. In newborns, it can be transmitted vertically [12]. Gastrointestinal transmission is still under investigation, although this virus has been found in the feces and urine of infected individuals [1, 12].

It can be transmitted to an average of 2-3 people from asymptomatic or symptomatic patients and even from individuals in their incubation period, and people close to these patients, such as healthcare staff and their family members, are at risk of catching the disease [6]. National limitations can play an important role in breaking the COVID-19 transmission chain [13].

COVID-19 can cause mild to severe clinical symptoms such as pneumonia, respiratory failure, and death [5, 6]. The disease affects all age groups and genders, but deaths are more common in people between the ages of 50 and 80 [3]. Patients with older ages and underlying diseases are at higher risk of severe to fatal disease. In children under the age of 19, this rate was very low at about one percent [14]. A meta-analysis study showed that the most prevalent comorbidities associated with COVID-19 were hypertension, diabetes, cardiovascular disease, liver disease, lung disease, malignancy, cerebrovascular disease, COPD and asthma. Of which, hypertension 46% (37%-55%) and diabetes 21% (16%-27%) were the most prevalent, respectively [15].

The clinical presentations of this disease vary; it may initially be similar to the flu and pneumonia and present with symptoms such as fever, shortness of breath, myalgia, fatigue, headache, sore throat, dry cough loss of smell and taste. Large-vessel stroke was reported among hospitalized COVID-19 patients younger than 50 years old [15, 16].

The digestive system may be a potential route for COVID-19 infection. Based on Zhou et al. results, 26% of COVID-19 patients experienced gastrointestinal (GI) symptoms. The frequency of GI symptoms in female patients was significantly higher than in male patients. Higher clinical manifestations such as sore throat, dizziness, and fatigue have been reported in patients suffering GI symptoms. Hemoglobin level in the GI symptom group was also significantly lower than in the non–GI symptom group [17]. Stool samples with positive COVID-19 nucleic acid were reported among patients which suggests the possibility of transmission through feces [18]. Sleep dysfunction is frequent and neurological manifestations (infrequent) of COVID-19 in patients and even health care workers who are directly involved in patient care [19, 20].

The most common complication of COVID-19 was pneumonia which may develop into severe respiratory conditions, arrhythmia, and shock. This complication can be seen in more severe COVID-19 cases to a great extent, acute respiratory distress syndrome (ARDS) has been found in COVID-19 patients undergoing autopsy, this condition can cause

organ failure and may be life-threatening due to its association with low blood oxygenation levels [4].

4. Diagnosis

The synthesis of a double-stranded DNA molecule from an RNA mold via Transcription Polymerase Chain Reaction (RT-PCR) is the standard laboratory method for detecting COVID-19 coronavirus. This technique uses swabs taken from the nasopharynx and/or oropharynx. For patients with pneumonia, lower respiratory tract secretions may also be tested. The sputum specimens are more reliable and have a lower false-negative rate for COVID-19 detection than throat swabs [21, 22]. The sensitivity varies depending on the timing of specimen collection during illness [23-25]. The sensitivity of throat samples is reported as 60% at the initial phase of illness. Higher sensitivity has been observed in patients with mild (82%) to severe (89%) conditions [25].

Currently, radiographic imaging techniques are extensively used in Covid-19 diagnosis. Chest X-ray is used as a basic tool for COVID-19 diagnosis. Although some signs of illness might fade by the overlying tissue, it is still valuable especially in following illness in severe cases [26]. The false-negative rate is high using chest radiographs, especially in early and mild cases [27].

Chest computed tomography (CT) is generally feasible, reliable, and rapid. It has high sensitivity with a very low rate of missed diagnosis. [28-31]. Ai et al. studied 1014 patients' data; taking RT-PCR results as a reference, chest CT predicted 97% of COVID-19 suspicious cases correctly [32]. Fang et al. based on 51 patients' data evaluated the relative sensitivity of CT and RT-PCR as 98% and 71% respectively. Generally, RT-PCR and chest CT are comparable in COVID-19 diagnosis and no significant difference has been found between them [27]. However, CT findings are non-specific and overlap with other viral infections. A study of 62 healthcare centers in 34 countries showed that chest CT is used often (76%) for COVID-19 assessment rather than initial diagnosis (22%) [33]. Most organizations do not recommend diagnostic imaging when RT-PCR and immunoassays are available and patients have mild disease. But in the absence of these methods, chest radiographs or CT are so valuable in patients with moderate to severe clinical features of COVID-19 infection [34].

Kim et. al. studied the diagnostic value of chest CT and RT-PCR through meta-analysis. Based on their finding the pooled sensitivity was 94% for chest CT and 89% for RT-PCR. They evaluated the pooled specificity of chest CT as 37%. The positive predictive value (PPV) for chest CT ranged from 1.5% to 30.7% and the negative predictive value (NPV) ranged from 95.4% to 99.8%. For RT-PCR, the PPV ranged from 47.3% to 96.4%, while the NPV ranged from 96.8% to 99.9%. Due to the low PPV of CT, the application of this screening method may cause unnecessary public exposure. The sensitivity of the chest CT depends on disease severity, comorbidities, and the proportion of asymptomatic patients. The RT-PCR requires swab samples taken from the nasopharyngeal, throat, or sputum. It is difficult and prone to error in elderly patients. Therefore the sensitivity of RT-PCR is lower when the proportion of elderly people is higher [35].

5. Radiographic features

The most common CT findings reported in COVID-19 pneumonia are bilateral, multi-lobar, subpleural areas of Ground Glass Opacity (GGO) with or without consolidations affecting the lower lobes [23, 29, 36, 37]. GGO has also been frequently reported to have round morphology [36]. In the intermediate phase of infection (4–14 days from symptom onset), a so-called "crazy-paving pattern" is seen. Peak radiologic abnormalities occur at around day 10, followed by gradual regression starting two weeks after symptom onset [23]. Bronchovascular thickening in lesions is common.

There are no particular differences in CT features between adults and pediatrics. Generally, COVID-19 signs in pediatric CTs are milder except for bronchial wall thickening, which was more common in pediatric patients [38]. Evidence that shows a single fraction of low dose whole lung irradiation (0.3 – 1.5 Gy) delivered at the middle of mediastinum via two parallel opposed anterior-posterior external radiation fields) would improve respiratory symptoms of COVID-19 in patients with moderate pulmonary involvement [39-41].

6. CT Protocol

A low-dose, single-phase (inspiratory breath-hold if possible), fast, non-contrast CT of the entire chest (apex to the base) is sufficient for the evaluation of most patients with COVID-19 infection [33, 34]. Contrast may disturb the GGO interpretation. It should be considered that generally, patients are

suffering from shortness of breath or cough. Therefore, fast scanning protocols will decrease the probability of repetitive scanning. Although High-Resolution Computed Tomography (HRCT) is used widely for COVID-19 diagnosis [42-44] no specific benefit or need for it has been reported [34].

Generally, the radiographic examination should prescribe in pregnant patients with specific cautions. Firstly, the patient should be informed about possible risks and benefits. The CT scan request, patient file, and clothing must be marked in red as a label for high-risk patients. During COVID-19 pandemic specific disinfection strategies should be considered. Disinfection protocols are more important in case of the pregnant patients. Personal protection equipment for the corona virus-like masks, gloves, gowns, goggles, and disinfectants must be available for the patients. Preventing exposure to other patients reduces the risk of COVID-19 transmission [45].

Strict infection control must consider by the radiology department to ensure the prevention of transition. Depending on the degree of exposure, personnel should use protective equipment properly. Types of equipment include a surgical cap, goggles, a surgical or N95 face mask, a filtering facepiece respirator (N95), gloves, a fluid-impermeable gown, coveralls, and shoe covers. Hand hygiene is necessary before and after each examination [46].

7. Conclusion

As a global health issue, COVID-19 has attracted lots of attention all around the world. Despite plenty of unknowns, our knowledge about the virus is increasing day by day. In this review, we tried to collect a brief and hand on report of founding this pandemic.

Authors' contributions

Study design and supervision: MehdiM, MaralM, BG. Data collection and interpretation: MH, NE, CT. Drafting: MH, NE, CT, MaralM, BG. Critical revisions; Mehdi M, BG. All authors read and approved the final version of manuscript.

Conflict of interests

None.

Ethical declarations

Not applicable.

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