Severe acute respiratory syndrome coronavirus 2 pandemic and older people: what we know about the clinical, laboratory, imaging features, and clinical outcomes

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The ongoing pandemic of coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is an emerging and rapidly evolving situation. Older people represent a uniquely vulnerable group during any infectious disease outbreaks due to their altered physiology, increased susceptibility to infections, presence of comorbidities, malnutrition, and compromised immunological and mechanical functions. The clinical symptoms, laboratory, and imaging features of SARS-CoV-2 are similar to younger adults but rapid disease progression, a high proportion of severe to critical cases, and a high fatality rate are more observed in the older people. To date, no targeted therapy is available for SARS-CoV-2, many drugs are still being tested for efficacy and safety due to the novelty of the virus and little knowledge about it among the older people. In this article, we summarize the clinical, laboratory, radiological features, and clinical outcomes of SARS-CoV-2 infection in the older people and present the predictive factors associated with fatal clinical outcomes among them.

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Introduction

The current coronavirus disease 2019 (COVID-19) pneumonia outbreak, caused by the severe acute respiratory syndrome 2 (SARS-CoV-2) virus, is spreading globally at an accelerated rate, leading the World Health Organization (WHO) on March 11, 2020, to declare this infection as a global pandemic [1]. It has been emerged to be the third highly contagious coronavirus leading to an epidemic in the 21st century after severe acute respiratory syndrome (SARS-CoV) (outbreak in 2002) and the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) (outbreak in 2012) [2]. The novel SARS-CoV-2 is a member of the Betacoronavirus genus, which also includes SARS-CoVand MERS-CoV, sharing with them the routes of transmission and clinical manifestations. SARS-CoV-2 can be transmitted from person-to-person [3]. The clinical spectrum of SARS-CoV-2 infection appears to be wide, ranging from mild upper respiratory tract infection to severe viral pneumonia that may progress to acute respiratory distress syndrome or multiorgan dysfunction and even death [4].

Like SARS-CoV and MERS-CoV, all individuals are generally susceptible to SARS-CoV-2 infection, but older people are more vulnerable to develop a severe infection, be at a greater risk of a cascade of complications, and admission to the intensive care unit (ICU) or even death in severe cases. Therefore, this article aims to focus on the clinical, laboratory, radiological features and clinical outcomes of older people with SARS-CoV-2 infection in order to investigate the predictive factors of fatal clinical outcome and thus providing some insights into the evidence for stratifying risk and helping to improve clinical practice and reduce mortality among them as illustrated in Fig. 1.

Methods

Literature search

A literature research was conducted using keyword filters to select articles related to ‘clinical features’, ‘laboratory

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findings', 'imaging features', 'outcomes' in combination with 'SARS-CoV-2", COVID-19', 'elderly', 'aging', 'older adults' This research was carried out on articles published in the PubMed and Scopus databases for the English language from January 1, 2020 to May 31, 2020. We excluded all editorials, letters to the editor, and studies that discussed the psychological disorders and mental health among older adults during the COVID-19 pandemic. Table 1 summarizes the included studies addressing the characteristics of SARS-CoV-2 infection in older adults.

Literature review

Potential mechanisms that increase the risk of severe acute respiratory syndrome coronavirus 2 infection in older people

Changes in the physiological functions of the respiratory system

Changes in lung anatomy and immune systems in older people increase their susceptibility to severe infection and hypoxia. Changes in the older people's lung anatomy and

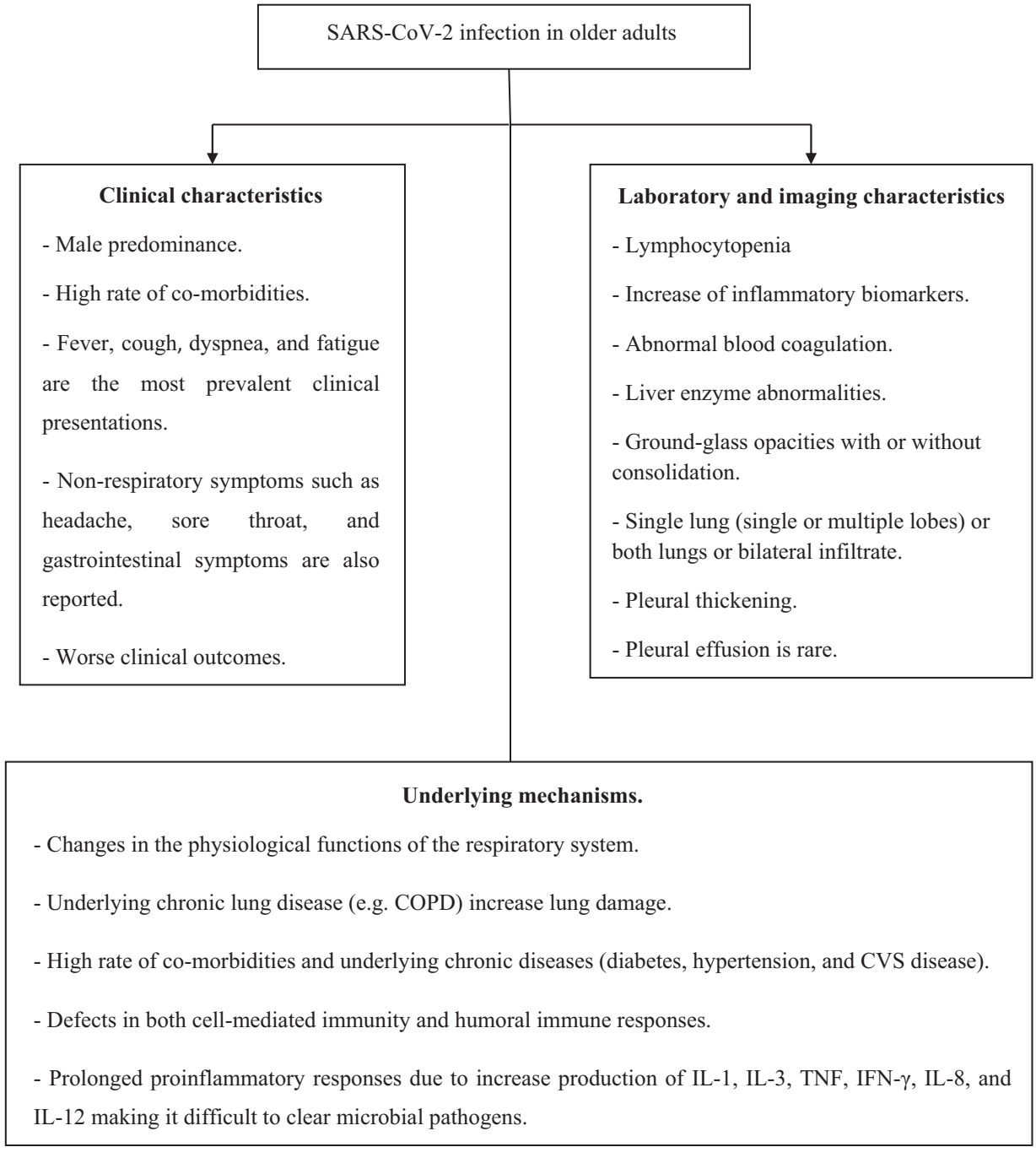

Fig. 1. Underlying mechanisms, clinical, laboratory, and imaging features of SARS-CoV-2 infection in older adults. SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

muscle atrophy leading to changes in the physiological functions of the respiratory system such as coughing and sneezing which are less efficient, making it difficult for them to clear the microbial pathogen, when infects the airways and reduced lung reserve [5]. In addition, the lung damage accumulated in older people from underlying chronic lung disease and habits like smoking or breathing polluted air can further increase their vulnerability, so when the microbial pathogen strikes, it can lead to severe pneumonia that may progress to respiratory failure. It was found that smoking and patients with chronic lung disease had a higher dipeptidyl peptidase IV (DPP4) expression, which was inversely correlated with lung function and diffusing capacity parameters [6]. Older people are physically frail and more likely to have one or more comorbidities and underlying chronic diseases that put them at a greater risk to suffer severely, develop more serious complications and also affect the disease prognosis. Hypertension, diabetes, cardiovascular disease, preexisting liver, and renal diseases, and cancer are the most common comorbidities among them. Angiotensin-converting enzyme 2 (ACE2) is highly expressed in type II alveolar cells (AT2), myocardium, kidney, gastrointestinal tract, and pancreas [7]. Recently, hypertension is emerging as a serious risk factor in older people with SARS-CoV-2 in particular, predisposing this population to increased COVID-19 disease severity and mortality. Hypertension is known to be associated with high levels of renin–angiotensin (RAS) [8], and when SARS-CoV-2 penetrates cells by binding to ACE2 in the lung [9], facilitating the virus replication, delaying virus clearance, and contributing to the severity of lung injury by reducing ACE2 cell surface expression, upregulating angiotensin II signaling, and compromising the anti-inflammatory function in RAS signaling [10]. Therefore, it is hypothesized that the increase in ACE2 levels with angiotensin-converting enzyme inhibitors (ACEIs) and angiotensin receptor blockers (ARBs) treatment is more likely to correct these changes [11]. Diabetes is another common co-morbidity among older people making them more vulnerable to COVID-19 disease severity and mortality. Diabetes can damage the nervous system, facilitate cellular binding and virus entry, and decrease the body's efforts to clear the virus from the lungs. Diabetes can also suppress immune cells by diminishing the function of T cell and increasing susceptibility to hyperinflammation and cytokine storm syndrome. Unlike hypertension, the link of diabetes to ACE2 expression levels in the lung in humans is still unknown, but it has been found that the type of diabetes treatment may affect ACE2 expression. It was suggested that administration of insulin downregulates ACE2 expression [12] whereas hypoglycemic agents such as thiazolidinediones (TZDs; pioglitazone) and glucagon-like peptide-1 (GLP-1) agonists (liraglutide) upregulate ACE2 expression [13].

Immune system

Age-related changes primarily affect the adaptive immune response, as evidenced by major defects in both cell-mediated immunity and humoral immune responses. In contrast, the innate immune response shows preservation to a greater degree even in extreme old age [14]. $CD4^+$ T cells recognize and respond to neoantigens with aging as there is a gradual loss of T cell repertoire from naive $CD8^+$ T cells [15]. Interleukin 6 (IL-6) production generally increases with increasing age. IL-4 production by $CD4^+$ cells appears to decrease with age, but this is compensated by excess IL-4 synthesis by cytotoxic $CD8^+$ cells and natural killer (NK) T cells [16]. On the other hand, production of IL-1, IL-3, tumor necrosis factor (TNF), interferon gamma (IFN-γ), IL-8, and IL-12 is generally intact and increases in the elderly. Thus, elderly patients generally have more prolonged proinflammatory

Table 1. List of publications on older adults included in the review.

Study	Country origin	Study design	Study size
Wang *et al.* [19]	China	Retrospective study	339 patients with COVID-19 admitted to Renmin Hospital of Wuhan University
Liu *et al.* [20]	China	Retrospective study	56 patients
Zhu *et al.* [21]	China	Retrospective study	72 symptomatic patients with COVID-19
Zhou *et al.* [22]	China	Retrospective, multicenter study	191 patients with laboratory confirmed COVID-19 (135 from Jinyintan Hospital and 56 from Wuhan Pulmonary Hospital)
Deng *et al.* [23]	China	Retrospective study	109 fatal and 116 recovered COVID-19 cases admitted to two tertiary hospitals in Wuhan
Huang *et al.* [24]	China	Retrospective study	36 nonsurvivors infected with SARS-CoV-2 in the Fifth Hospital of Wuhan
Grasselli *et al.* [25]	Italy	Retrospective case series	1591 patients with confirmed COVID-19 referred for ICU admission
Li *et al.* [26]	China	Retrospective study	204 patients diagnosed with COVID-19 in Renmin Hospital of Wuhan University
Lian *et al.* [27]	China	Retrospective study	788 patients with confirmed COVID-19
Niu *et al.* [28]	China	Retrospective study	141 patients con-firmed with COVID-19
Guo *et al.* [29]	China	Retrospective, multicenter study	105 patients confirmed with COVID-19
Chen *et al.* [30]	China	Retrospective study	203 patients were diagnosed with COVID-19

COVID-19, coronavirus disease 2019; ICU, intensive care unit; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

responses than younger persons, which makes it difficult for them to clear microbial pathogens leading to poor outcomes and there is a dysfunction in signaling attenuation by counter-regulatory cytokines as IL-10 [17].

Demographic and clinical features of older people with severe acute respiratory syndrome coronavirus 2 infection

SARS-CoV-2 appears to discriminate not only by age but also by sex. It was found that older males are more susceptible to SARS-CoV-2 infection than older females as shown in Table 2. Similar to younger adults, SARS-CoV-2 appears to pose a particular threat to older males and has a unique prediction for them; this may be due to the biological, lifestyle, and behavior differences between males and females. Unlike the SARS-CoV outbreak, which was caused by a similar coronavirus. SARS-CoV was found to infect females more than males regarding WHO report from 30 different countries and areas [18].

Due to immune dysfunction, the high prevalence of underlying chronic health conditions and comorbidities is another propensity of SARS-CoV-2 infection in older people increasing their susceptibility to higher attack rates, adverse clinical outcomes, and death. The most common reported comorbidities among older people are hypertension, diabetes, cardiovascular diseases, and cerebrovascular diseases [19–30].

In older people with confirmed SARS-CoV-2, fever, cough, dyspnea, and fatigue are the most prevalent clinical presentations, which are consistent with the general symptoms of viral infection and pneumonia. Severe pneumonia may develop and progress into respiratory distress leading to hypoxia, respiratory failure, multiorgan failure, shock, and death.

Nonrespiratory symptoms of SARS-CoV-2 such as headache, sore throat, and gastrointestinal symptoms have been reported in older people. These symptoms should not be overlooked rather than waiting for respiratory symptoms to emerge, and high suspicion should be raised by clinicians who care for older people due to atypical presentation and disorders in this category. Similar to younger adults, the most common reported gastrointestinal symptoms among older people are diarrhea, vomiting, and abdominal pain during the course of the disease [19–24,26,27,29,30]. Evidence from previous SARS and MERS studies has found that coronavirus has a tropism to the gastrointestinal tract. These studies revealed that 10.6% of individuals with SARS and up to 30% of individuals with MERS had diarrhea [3]. Given that both SARS-CoV and MERS-CoV can be excreted through feces and remain viable under conditions conducive to transmission. In general, some individuals with SARS-CoV-2 develop diarrhea during their disease course but at a lower frequency compared to SARS. This indicates the possible tropism of SARS-CoV-2 to the gastrointestinal tract. Diarrhea results from the interaction between SARS-CoV-2 and ACE2 due to the receptor-binding domain on SARS-CoV-2 that can bind to human ACE2 with high affinity, leading to viral spread [31]. The viral receptor ACE2 is known to be highly expressed in alveolar AT2 cells in the lungs, but it is also found to be highly expressed in proximal and distal enterocytes resulting in malabsorption and diarrhea [32]. A recent study also demonstrated that SARS-CoV-2 RNA was detected in the patient's stool [33]. Another possible mechanism is changes in the composition and function of digestive tract flora mutually affecting the respiratory tract through immune regulation, the so-called "gut–lung axis" [34]. These data provide a potential alternative transmission route for SARS-CoV-2 through the fecal contents that could have a clear impact regarding transmission precautions.

Laboratory findings of older people with severe acute respiratory syndrome coronavirus 2 infection

Similar to younger adults, lymphocytopenia, increase of inflammatory biomarkers (elevated C-reactive protein, elevated IL-6 level, elevated lactate dehydrogenase level (LDH) and high procalcitonin level), abnormal blood coagulation (increased d-dimer level), liver enzyme abnormalities [high aspartate aminotransferase (AST) and alanine transaminase (ALT) levels], and hypoalbuminemia are the most common reported laboratory abnormalities among older people as in Table 3 [19,20,22–24,26,27,29,30].

Similar to previous studies of SARS-CoV and MERS-CoV in critically ill patients [35], Lymphocytopenia was found to be a prominent laboratory feature in patients with SARS-CoV-2. Since lymphocytes are the main target cells of viral infections, SARS-CoV viral particles can kill lymphocytes either by damaging the cytoplasmic components or apoptosis causing persistent consumption and/or insufficient regeneration of lymphocytes [35]. In addition, it was found that lymphocytopenia during SARS-CoV-2 may aggravate inflammatory responses, leading not only to pulmonary injury but also the injury of extra-pulmonary organs including the liver due to increased IL-6, IL-10, IL-2, and IFN-γ levels [36]. Therefore, the severity of lymphocytopenia may indicate either the severity of virus invasion or the status of the antiviral immunity, and thus can predict the disease severity and clinical outcomes.

Inflammatory responses triggered by a viral infection, evidenced by elevated C-reactive protein, elevated IL-6 levels, elevated LDH levels, and elevated procalcitonin levels, play a critical role in the severity of lung disease [37] in addition to the presence of abnormal blood

Table 2. Demographic and clinical characteristics of older adults with confirmed SARS-CoV-2 infection.

Reference	Older adults with SARS-CoV-2 infection	Age in years	Sex (male/female)	Preexisting co-morbidities	Main manifestations
Wang *et al.* [19]	339/339 (100%)	71 ± 8	166/173	- Hypertension (40.8%) -Diabetes (16.0%) - Cardiovascular disease (15.7%).	- Fever (92.0%) - Cough (53.0%) - Dyspnea (40.8%) - Fatigue (39.9%) - Chest tightness (26%) - Anorexia (27.8%) - Diarrhea (12.7%)
Liu *et al.* [20]	18/56 (32.14%)	68 (65.3–69.8)	12/6	-Hypertension5 (27.8%) - Diabetes 3 (16.7%) - Coronary heart disease 2 (11.1%) - Persistent atrial fibrillation 1 (5.6%) - Liver disease1 (5.6%)	-Fever (77.8%) - Cough (43.3%) - Vomiting (16.7%) - Fatigue (11.1%)
Zhu *et al.* [21]	28	68.4 ± 6.0	16/12	- NA	-Fever 24 (85.7%) - Cough 13 (46.4%) - Fatigue 9 (32.1%) - Dyspnea 8 (28.6%) -Abdominal pain or diarrhea 6 (21.4%)
Zhou *et al.* [22]	54/191 (28.3%)	69 (63–76)	38/16	-Hypertension26 (48%) - Diabetes 17 (31%) - Coronary heart disease 13 (24%) - Chronic obstructive lung disease4 (7%) - Chronic kidney disease 2 (4%) - Other 11 (20%)	-Fever 51 (94%) - Cough 39 (72%) - Sputum 14 (26%) - Fatigue 15 (28%) - Myalgia 8 (15%) - Nausea or vomiting 3 (6%) - Diarrhea 2 (4%)
Deng *et al.* [23]	109/225 (48.4%)	69 (62–74)	73/36	-Hypertension 40 (36.7%) -Lung disease 22 (20.2%) - Diabetes 17 (15.6%) -Heart disease 13 (11.9%) -Malignancy 6 (5.5%) -Others 31 (28.4%)	-Fever 95 (87.2%) - Dyspnea 77 (70.6%) - Cough 47 (43.1%) - Sputum35 (32.1%) - Diarrhea 19 (17.4%) - Palpitations 11 (10.1)
Huang *et al.* [24]	36/36 (100%)	69.22 (9.64)	25/11	-Hypertension 21 (58.3%) -Cerebrovascular diseases 8 (22.2%) - Diabetes 7 (19.4%) - Chronic obstructive pulmonary disease 4 (11.1%) -Chronic renal diseases 3 (8.3%) - Cancer 1 (2.8%) - Hyperlipidemia 1 (2.8%)	-Fever 34 (94.4%) - Cough 28 (77.8%) - Short of breath 21 (58.3%) - Fatigue 17 (47.2%) - Dyspnea 14 (38.9%) - Sputum8 (22.2%) - Diarrhea 3 (8.3%)
Grasselli *et al.* [25]	961/1591 (60.4%)	63 (56–70)	783/178	-Hypertension (37.8%) -Cardiovascular disease (18.2%) - Hypercholesterolemia (16.2%) - Diabetes (14%) -Malignancy (7.2%) -COPD (3.4%) - Chronic kidney disease (2.5%) -Chronic liver disease (1.9%) - Other (14.3%)	-NA
Li *et al.* [26]	204/204 (100%)	68 (60–95)	100/104	- Hypertension 74 (36.3%) - Cardiac disease 44 (21.6%) - Diabetes 36 (17.6%) – COPD 21 (10.3%) - Cancer 9 (4.4%) - Chronic renal failure 5 (2.5%)	- Sore throat (3.4%) - Nausea or vomiting (4.4%). - Rigor (5.4%). - Myalgia (8.8%) - Diarrhea (13.2%) - Anorexia (15.2%) - Fatigue (15.2%) - Chest distress (16.2%) - Sputum production (18.1%) - Dyspnea (31.9%) - Cough (49%) - Fever (78.9%)

Table 2 (*continued*)

Reference	Older adults with SARS-CoV-2 infection	Age in years	Sex (male/female)	Preexisting co-morbidities	Main manifestations
Lian *et al.* [27]	136/788 (17.3%)	68.28 ± 7.314	58/78	- Hypertension 53 (39%) - Diabetes 24 (17.7%) - Chronic liver disease 6 (4.4%) - Cancer 3 (2.2%) - Chronic renal disease 2 (1.5%) - Heart disease 6 (4.4%) - COPD 3 (2.2%) - Immunosuppression 1 (0.7%)	- Fever 114 (84.6%) - Cough 85 (62.5%) - Sputum production 49 (36.03%). - Hemoptysis 3 (2.2%) - Sore throat 17 (12.5%) - Nasal obstruction 2 (1.5%) - Muscle ache 20 (14.7%) - Fatigue 24 (17.5%) - Shortness of breath 17 (12.5%) - GI symptoms 11 (8.1%) - Headache 8 (5.9%)
Niu *et al.* [28]	60/141 (42.6%)	-Age 65–79 y ($n = 44$) - Age ≥80 y ($n = 16$)	34/26	- Hypertension 15 (48.4%) - Coronary heart disease 5 (16.1%). - COPD 9 (29%) - Diabetes 3 (9.7%) - Cerebrovascular disease 2 (6.5%) - Other 8 (25.8%)	- Fever 47 (78.3%) - Cough 34 (56.7%) - Dyspnea 18 (30%) - Fatigue 14 (23.3%) - Headache 4 (6.7%)
Guo *et al.* [29]	20/105 (19%)	81.0 (79.3–83.0)	10/10	- Hypertension 10 (50%) - Diabetes 4 (20%) - Cardiac disease 5 (25%) - Chronic pulmonary disease 4 (20%) - Chronic kidney disease 0 - Chronic liver disease 1 (5%) - Cerebral infarction 2 (10%)	- Fever 12 (60%) - Cough 16 (80%) - Fatigue 5 (25%) - Myalgia 0 - Dyspnea 8 (40%) - Diarrhea 1 (5%) - Anorexia 2 (10%) - Vomiting 0 - Headache 0
Chen *et al.* [30]	55/203 (27.1%)	74 (65–91)	34/11	- Hypertension 21 (38.2%) - Diabetes 12 (21.8%) - Cardiovascular disease 11 (20%) - Cerebrovascular disease 8 (14.5%) -Malignancy 5 (9.1%) - Chronic liver disease 2 (3.6%) - Chronic renal disease 3 (5.5%) - COPD 7 (12.7%) -Tuberculosis 1 (1.8%)	- Fever 52 (94.5%) - Dry cough 38 (69.1%) - Chest distress 35 (63.6%) - Fatigue 5 (9.1%) - Shortness of breath 32 (58.2%) - Myalgia or arthralgia 11 (20%) - Anorexia 5 (9.1%) - Headache 3 (5.5%) - Diarrhea 3 (5.5%) - Abdominal pain 3 (5.5%) - Nausea 1 (1.8%) - vomiting 1 (1.8%) - Chest pain 1 (1.8%) - Dizziness 1 (1.8%) - dyspnea 1 (1.8%)

COVID-19, coronavirus disease 2019; ICU, intensive care unit; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

coagulation function, which characterized by increased levels of d-dimer, is another common laboratory abnormality among older people. Increased d-dimer levels may be associated with fatal outcomes in patients with infection or sepsis and in patients on ventilators. The possible mechanisms of coagulation activation may be related to the persistent inflammatory response, induction of procoagulant factors, and hemodynamic changes, which predispose to ischemia and thrombosis. It was found that these laboratory abnormalities are similar to those previously reported in patients with SARS-CoV and MERS-CoV infections suggesting that SARS-CoV-2 infection is associated with a defect in cellular immunity, and coagulation activation. Therefore, close monitoring of dynamic changes in these inflammatory indices is mandatory to help judge the disease progression among older people, aiming to avoid a fatal outcome.

Apart from a lung injury, damage to other organs is of concern for SARS-CoV-2 infection. Liver injury may also occur among older people with SARS-CoV-2 that is characterized by abnormalities in liver enzymes (high AST and ALT levels) and hypoalbuminemia during the course of the disease. Currently, the mechanisms of liver injury are unclear; the liver injury may be related to virus-induced cytopathic effects on hepatocytes, immune-mediated inflammation, or drug hepatotoxicity [38,39]. There is also another suggestion that SARS-CoV-2 may directly bind to ACE2-positive cholangiocytes to dysregulate liver function [40,41]. However, further

investigations are needed to find out whether SARS-CoV-2 may target the liver in a similar manner to SARS-CoV or other mechanisms that have a role in liver injury. Hypoalbuminemia may be another form of liver injury from SARS-CoV-2 due to impaired liver synthesis or a part of the disease pathophysiology as albumin is a negative acute-phase protein. There are multifactorial reasons for decreased albumin synthesis during inflammation and infection including increased leakage into the interstitial space, accelerated catabolism, and the effect of monocytic products such as IL-1 and IL-6, and TNFα [42]. Albumin is also an indicator of nutritional status of the body and can be observed in malnourished patients. Regardless of its cause, the hypoalbuminemia observed among the elderly may have a strong predictive value on morbidity and mortality as the body loses virus resistance, leading to disease progression and fatal clinical outcomes.

Chest imaging findings of older people with severe acute respiratory syndrome coronavirus 2 infection

The most common reported chest radiologic abnormalities among older people are ground-glass opacities with or without consolidation, a single lung (single or multiple lobes) or both lungs may be affected or bilateral infiltrate, pleural thickening, and rarely pleural effusion [20–22,24,26,27,29,30] as shown in Table 3. It seems that older people are more prone to have extensive lung lobe involvement, interstitial changes, and pleural thickening. These chest radiologic findings are of great significance for early detection, early diagnosis, and improving prognosis. However, chest radiologic imaging studies of SARS-CoV-2 are preliminary and unknown aspects need to be further investigated.

Disease spectrum, complications, and clinical outcomes of older people with severe acute respiratory syndrome coronavirus 2 infection

SARS-CoV-2 presents unique features in these older people as evidenced by an increase in the proportion of severe-to-critical patients and fatality rate compared to the whole population as shown in Tables 4 and 5.

Concerning complications and mortality, the main complications include ARDS, bacterial infection, acute cardiac injury, acute kidney injury, and sepsis, followed eventually by multiple organ failure and death [19–24,26,27,29,30].

The development of ARDS is the most common complication among older adults. This may be due to lung aging associated with an inability of lung cells and multiple structural and functional changes in the respiratory tract, leading to decreased lung function, altered pulmonary remodeling, diminished regeneration, and increased susceptibility to lung disease [43].

Sepsis is another common complication, which may be directly caused by SARS-CoV-2 infection since bacterial infections are considered a leading cause of sepsis but viral infection can also cause sepsis syndrome. Further investigations are needed to understand the pathogenesis of sepsis in SARS-CoV-2 infection.

Severe acute respiratory syndrome coronavirus 2 fatality rate in older people

Estimating the risk for hospitalization and the case fatality rate for SARS-CoV-2 in real-time during an epidemic is very challenging. Therefore, among those infected with SARS-CoV-2, the risk for hospitalization due to severe disease increases substantially with age. The rates are 11.8%, 16.6%, and 18.4% for adults aged 60–69 years, 70–79 years, and 80 years or older, respectively [44,45]. Furthermore, the percentage of hospitalized older people who need ICU care is 27–71% with an infection fatality rate (IFR) is 2.2–9.3% [46]. The case fatality rate also increases substantially with age, from less than 1% among children aged 9 years or younger to nearly 8% for people aged 80 years or older. Based on these data, the case-fatality rate (CRF) was determined to be 3.6% for adults aged 60–69 years, 8% for adults aged 70–79 years, and 14.8% for adults aged 80 years or older [45]. Comparing available case fatality rate of SARS-CoV-2, with that of SARS-CoV (52.5%, and 69.6% for adults aged 65–69 and 75–79 years, respectively) and MERS-CoV (10%, 15%, and 5% for adults aged 60–69, 70–79, and 80 years or older, respectively) [47,48]. The chance of survival after SARS-CoV-2 infection is about 95% in the absence of comorbidities for people aged 60 years and older. However, many SARS-CoV-2- infected individuals 60 years of age or older have one or more have one or more co-morbidities that significantly increase their vulnerability when facing this disease and reduce the chance of survival. The cumulative number of diagnosed cases and the fatality rate is still rising not only in older people but also in younger adults.

Conclusion

Given the fast evolution of the ongoing pandemic of SARS-CoV-2 infection. The situation changes hour to hour and day to day and no one knows how long this pandemic will last. Like SARS-CoV and MERS-CoV, SARS-CoV-2 has been found to have a negative impact on older adults more than any other subpopulation. The symptoms, laboratory, and imaging features of SARS-CoV-2 are similar to younger adults, but rapid disease progression, a high proportion of severe to critical cases, and a high fatality rate are more observed in older adults. Elderly patients exhibited more preexisting comorbidities, atypical presentations, laboratory abnormalities, and are more prone to have extensive lung lobe involvement, interstitial changes, and pleural thickening than younger adults. Early detection and diagnosis of SARS-CoV-2 infection among

Table 3. Laboratory and radiographic findings of older adults with confirmed SARS-CoV-2 infection.

	Abnormal laboratory findings	Imaging features
Wang *et al.* [19]	- Lymphocytopenia - liver enzyme abnormalities - High C-reactive protein	- NA
Liu *et al.* [20]	- Lymphocytopenia - Decreased Albumin - High C-reactive protein	- CT imaging findings i-Site a- Multiple lobes Lesion 16 (88.9%) b- Single lobe Lesion 2 (11.1%)
Zhu *et al.* [21]	- NA	- CT imaging findings i-Site a- Single lobe Lesion 2 (7.1%) b- Multiple lobes Lesion 7 (25%) c- Whole lung 19 (67.9%) ii-Density a- Pure ground-glass 15 (53.6%) b- Ground-glass opacity with consolidation 25 (89.3%) c- Consolidation 6 (21.4%) iii-Interstitial change a- Reticular pattern or honey combing 20 (71.4%) b- Subpleural line 14 (50%) Iv.Pleural reaction a- Pleural thickening 20 (71.4%) b- Pleural effusion 2 (7.1%)
Zhou *et al.* [22]	- Lymphocytopenia - Decreased Albumin - High ALT level - High C-reactive protein - High Creatinine level - High LDH - High cardiac troponin I - Elevated D-dimer levels	- Imaging features (Chest radiographs or CT scan) a- Consolidation 40 (74%) b- Ground-glass opacity 44 (81%) c- Bilateral pulmonary infiltration 45 (83%)
Deng *et al.* [23]	- Lymphocytopenia - High ALT, AST levels - High C-reactive protein	- NA
Huang *et al.* [24]	- Lymphocytopenia - Anemia - High ALT, AST level - Decreased Albumin - High C-reactive protein - High procalcitonin level - HighIL-6 level - High LDH - Elevated D-dimer levels - High creatinine level	- CT imaging findings a- Bilateral pneumonia
Grasselli *et al.* [25]	- NA	- NA
Li *et al.* [26]	- Lymphocytopenia (49.1%) - Anemia (84.8%) - Decreased Albumin (89.9%) - High procalcitonin level (63%)	- Unilateral infiltrates (5.8%). - Bilateral infiltrates (94.2%). - Multifocal opacities
Lian *et al.* [27]	- Lymphocytopenia (30.9%) - Anemia - Decreased Albumin - High ALT levels. - High creatine kinase, LDH levels. - High C-reactive protein	- Multiple mottling and ground-glass opacity 59 (43.4%). - Unilateral pneumonia 15 (11.03%). - Bilateral pneumonia 57 (41.9%)
Niu *et al.* [28]	- NA	- NA
Guo *et al.* [29]	- Lymphocytopenia - Elevated D-dimer levels - High LDH levels. - High C-reactive protein - Prolonged prothrombin time. - High creatinine level	- Unilateral pneumonia 2 (10%) - Bilateral pneumonia 18 (90%) - Multiple mottling and ground-glass opacity 7 (35%)
Chen *et al.* [30]	- Lymphocytopenia - High ALT, AST levels - Decreased Albumin - High LDH levels. - High creatinine level - High C-reactive protein	- Bilateral distribution 54 (98.2%) - Pleural effusion 13 (23.6%) - CT progress (mean interval 5 days) 20 (36.4%)

SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

Table 4. Spectrum of the disease and complications of older people with confirmed SARS-CoV-2 infection.

	Spectrum of disease	Complications
Wang *et al.* [19]	- Moderate100 (29.5%) - Severe159 (46.9%) - Critical 80 (23.6%)	- Bacterial Infection 143 (42.8%) - Acute kidney injury 27 (8.1%) - ARDS 71 (21%) - Liver Enzyme Abnormalities 96 (28.7%) - Acute cardiac injury 70 (21%) - Arrhythmia 35 (10.4%) - Cardiac insufficiency 58 (17.4%) - Shock 8 (2.4%)
Liu *et al.* [20]	- PSI score (121 (95–148) - PSI grade IV and V 4 (22.2%)	- ARDS 4 (22.2%) - Acute cardiac injury 3 (16.7%) - Acute liver and kidney injury 7 (38.9%) - Secondary infection 4 (22.2%) - Shock 1 (5.6%)
Zhu *et al.* [21]	- NA	- NA
Zhou *et al.* [22]	- Severe 12 (22%) - Critical 42 (78%)	- Sepsis 54 (100%) - Respiratory failure 53 (98%) - ARDS 50 (93%) - Septic shock 38 (70%) - Acute cardiac injury 32 (59%) - Heart failure 28 (52%) - Coagulopathy 27 (50%) - Acute kidney injury 27 (50%) - Secondary infection 27 (50%) - Hypoproteinaemia 20 (37%) - Acidosis16 (30%)
Deng *et al.* [23]	- Severe 95 (87.2%)	- ARDS 98 (89.9%) - Acute cardiac injury 65 (59.6%) - Acute kidney injury 20 (18.3%) - Shock 13 (11.9%) - Disseminated intravascular coagulation 7 (6.4%)
Huang *et al.* [24]	- Severe 36 (100%)	- ARDS 36 (100%) - Electrolyte disturbance 16 (44.4%) - Acute kidney injury 1 (2.8%)
Grasselli *et al.* [25]	- NA	- NA
Li *et al.* [26]	- NA	- Respiratory failure (the most frequently complication) - Sepsis. - Acute respiratory distress syndrome (ARDS) - Heart failure - Septic shock. - Coagulopathy - Acidosis.
Lian *et al.* [27]	- Severe/Critical Type 33 (24.3%) - Mild 102 (75%) - Severe 22 (16.2%) - Critical 12 (8.8%)	- ARDS 23 (16.9%) (The most common complication). - Liver injury 10 (7.4%). - Acute kidney injury 3 (2.2%) - Septic shock 1 (0.74%)
Niu *et al.* [28]	- Mild 28 (46.7%) - Severe 32 (53.3%)	- NA
Guo *et al.* [29]	- Mild 0 - Moderate 13 (65%) - Severe 5 (25%) - Critical severe 2 (10%)	- ARDS 6 (30%) - Acute cardiac injury 4 (20%) - Acute kidney injury 3 (15%) - Acute hepatic injury 0 - Sepsis 4 (20%) - Allergic eruption 0 - Pneumothorax 1 (5%)
Chen *et al.* [30]	- Stable 7 (12.7%) - Serious 24 (43.6%) - Critical 24 (43.6%)	- ARDS - ARDS with multiple organ damage (MOD) - Heart failure - Myocardial infarction

ARDS, acute respiratory distress syndrome; MOD, multiple organ damage; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

older people are important which can delay the development of severe cases and prevent fatal outcomes.

The implications of all the available evidence

Because elderly patients are prone to multisystem organ dysfunction and even failure, lymphocytopenia, increased inflammatory biomarkers, abnormal blood coagulation, liver enzymes abnormalities, and hypoalbuminemia could help clinicians to identify at an early stage elderly patients with COVID-19 who have a poor prognosis and fatal clinical outcomes. This allows the risk of deterioration to be stratified to prevent fatal clinical outcomes. Close

Table 5. Clinical outcomes of older adults with confirmed SARS-CoV-2 infection.

	Duration of illness onset to admission or till death and hospital stays (days)	Clinical Outcome
Wang *et al.* [19]	-Time from illness onset to hospital admission = 10 (7–14) - Hospital length of stay = 28 (15–28)	-Survivors (274/339) (80.8%) -Nonsurvivors (65/339) (19.2%)
Liu *et al.* [20]	-NA	-Survivors 17/18 (94.4%) - Nonsurvivors 1 (5.6%)
Zhu *et al.* [21]	-NA	-NA
Zhou *et al.* [22]	-Time from illness onset to hospital admission = 11 (8–15) - Time from illness onset to death = 18·5 (15 –22) - Hospital length of stay = 7·5 (5–11)	-Nonsurvivors 54/191 (28.3%)
Deng *et al.* [23]	-Time from illness onset to hospital admission = 10 (6.5,12) - Hospital length of stay = 8 (4,13)	-Nonsurvivors 109/225 (48.4%)
Huang *et al.* [24]	-Median time from illness onset till death = 17	-Nonsurvivors 36/36 (100%)
Grasselli *et al.* [25]	-NA	-Survivors 111/961 (11.6%) - Nonsurvivors 322/961 (33.5%) - Still in ICU 525/961 (54.7%)
Li *et al.* [26]	-Median time between the onset of symptoms and admission was 10 (7–14).	- Still hospitalized 74 (36.3%). - Discharged 54 (26.5%). - Nonsurvivors 76 (37.3%).
Lian *et al.* [27]	-Timing from onset of illness to hospitalization was 3 (1–6)	- Still in ICU 13 (9.5%). - Discharged/ stay in hospital 31 (22.8%).
Niu *et al.* [28]	-Mean time from illness onset to visit hospital was 3.6 days.	-Hospitalized 32 (53.3%) - Discharged 23 (38.3%) - Death 5 (8.3%).
Guo *et al.* [29]	- Illness onset to hospital admission was 4 (2–6.8) - Onset of admission to discharge was 20 (14 – 27)	- Discharge 15 (75%) - Death 2 (10%)
Chen *et al.* [30]	-Time from illness onset to first hospital admission was 7.1 (1–15). - Length of stay was 12 (1 – 75).	-Nonsurvivors 19/55 (34.5%). - Survivors 36/55 (65.5%)

ICU, intensive care unit; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

monitoring and access to high-quality medical treatments should be prioritized for this population group.

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Conflicts of interest

There are no conflicts of interest.

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