Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Original Article

Comparative Analysis of Clinical Characteristics, Imaging and Laboratory Findings of Different Age Groups with COVID-19

Xuemei Liu[1]*, Jie Lv[1]*, Lin Gan[2], Ying Zhang[1], Feng Sun[1], Bo Meng[3], Andrew Jheon[3], Fang Yan[1], Bin Li[1], Zhou Xuan[1], Xiumin Ma[1,4], Muhuyati Wulasihana[1]

[1]State Key Laboratory of Pathogenesis, Prevention and Treatment of High Incidence Diseases in Central Asia, First Affiliated Hospital of Xinjiang Medical University, [4]Clinical Laboratory Center, Tumor Hospital Affiliated to Xinjiang Medical University, Urumqi, China, [2]Faculty of Medicine and Health Sciences, Macquarie University, New South Wales, Australia, [3]School of Dental Medicine, University of California San Francisco, San Francisco, USA

*These authors contributed equally to this study

Abstract

Objective: This study aims to provide scientific basis for rapid screening and early diagnosis of the coronavirus disease 2019 (COVID-19) through analysing the clinical characteristics and early imaging/laboratory findings of the inpatients. **Methods:** Three hundred and three patients with laboratory-confirmed COVID-19 from the East Hospital of People's Hospital of Wuhan University (Wuhan, China) were selected and divided into four groups: youth (20–40 years, $n = 64$), middle-aged (41–60 years, $n = 89$), older (61–80 years, $n = 118$) and elderly (81–100 years, $n = 32$). The clinical characteristics and imaging/laboratory findings including chest computed tomography (CT), initial blood count, C-reactive protein [CRP]), procalcitonin (PCT) and serum total IgE were captured and analysed. **Results:** (1) The first symptoms of all age groups were primarily fever (76%), followed by cough (12%) and dyspnoea (5%). Beside fever, the most common initial symptom of elderly patients was fatigue (13%). (2) Fever was the most common clinical manifestation (80%), with moderate fever being the most common (40%), followed by low fever in patients above 40 years old and high fever in those under 40 years (35%). Cough was the second most common clinical manifestation and was most common (80%) in the middle-aged. Diarrhoea was more common in the middle-aged (21%) and the older (19%). Muscle ache was more common in the middle-aged (15%). Chest pain was more common in the youth (13%), and 13% of the youth had no symptoms. (3) The proportion of patients with comorbidities increased with age. (4) Seventy-one per cent of the patients had positive reverse transcription–polymerase chain reaction results and 29% had positive chest CT scans before admission to the hospital. (5) Lesions in all lobes of the lung were observed as the main chest CT findings (76%). (6) Decrease in lymphocytes and increase in monocytes were common in the patients over 40 years old but rare in the youth. Eosinophils (50%), red blood cells (39%) and haemoglobin (40%) decreased in all age groups. (7) The proportion of patients with CRP and PCT elevation increased with age. (8) Thirty-nine per cent of the patients had elevated IgE, with the highest proportion in the old (49%). **Conclusion:** The clinical characteristics and imaging/laboratory findings of COVID-19 patients vary in different age groups. Personalised criteria should be formulated according to different age groups in the early screening and diagnosis stage.

Keywords: Age, clinical characteristics, coronavirus disease 2019, imaging, laboratory investigations

Introduction

Coronavirus disease 2019 (COVID-19) is a highly infectious respiratory inflammatory disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).[1-3] Since the first case emerged in Wuhan, Hubei Province, China, in December 2019, there have been more than 80,000 confirmed cases in the country, which has become one of the most important public health events in China. By March 2020, the epidemic in China has been basically controlled, but it is still spreading rapidly all over the world. At present, there have been numerous studies on the case analysis of COVID-19.[4-8] However, there are few reports on the clinical characteristics

Access this article online

Quick Response Code:

Website: www.ijmm.org

DOI: 10.4103/ijmm.IJMM_20_133

Address for correspondence: Prof. Xiumin Ma, State Key Laboratory of Pathogenesis, Prevention and Treatment of High Incidence Diseases in Central Asia, First Affiliated Hospital of Xinjiang Medical University, Urumqi, China. Clinical Laboratory Center, Tumor Hospital Affiliated to Xinjiang Medical University, Urumqi, China.
E-mail: maxiumin1210@sohu.com
Prof. Muhuyati Wulasihana, State Key Laboratory of Pathogenesis, Prevention and Treatment of High Incidence Diseases in Central Asia, First Affiliated Hospital of Xinjiang Medical University, Urumqi, China.
E-mail: muhuyati@163.com

Received: 15-04-2020 **Revised:** 27-05-2020
Accepted: 07-06-2020 **Published Online:** 25-07-2020

How to cite this article: Liu X, Lv J, Gan L, Zhang Y, Sun F, Meng B, *et al*. Comparative analysis of clinical characteristics, imaging and laboratory findings of different age groups with COVID-19. Indian J Med Microbiol 2020;38:87-93.

of diseases in different age groups. Based on the analysis of the clinical characteristics and early imaging/laboratory findings of COVID-19 patients in different age groups treated in the East Hospital of People's Hospital of Wuhan University, this article summarises the clinical features of patients in different age groups with the intention to facilitate the development of accurate screening criteria for rapid screening and early diagnosis of the disease.

Methods

Participants

A total of 303 patients with laboratory-confirmed COVID-19 infections consecutively admitted to the East Hospital of People's Hospital of Wuhan University (Wuhan, China) from 30 January to 15 February 2020 were selected. All patients were positive for SARS-CoV-2 RNA by nasopharyngeal swab nucleic acid test. This study has been approved by the Medical Ethics Committee of the East Hospital of People's Hospital of Wuhan University.

Study subject

All patients were divided into four groups according to their age, including youth (20–40 years, n = 64), middle-aged (41–60 years, n = 89), older (61–80 years, n = 118) and elderly (81–100 years, n = 32). The initial symptoms, concomitant symptoms, the highest body temperature during the course of the disease, comorbidities and the methods of pre-admission diagnosis (positive reverse transcription–polymerase chain reaction [RT-PCR] or chest computed tomography [CT]) were recorded, and the quantity of lesions in the lung lobes on chest CT was captured as well. The laboratory values of leucocytes, lymphocytes, monocytes, eosinophils, red blood cells, haemoglobin upon the initial blood count, C-reactive protein (CRP), procalcitonin (PCT) and total serum IgE were compared with the normal reference values. The number of cases in each group with increased or decreased laboratory values was recorded and compared.

Statistical analysis

All data were analysed by IBM SPSS Statistics 19.0, Armonk, New York, American, and the difference of $P < 0.05$ was considered statistically significant.

Results

The first symptoms of COVID-19 patients in different age groups are shown in Table 1. The initial symptoms were primarily fever (76%), followed by cough (12%) and dyspnoea (5%). In the elderly, fatigue was the main initial symptom (13%), while cough and dyspnoea were not common (1%). Some patients reported diarrhoea, general muscle soreness, headache, dizziness, haemoptysis, nausea and vomiting as the first symptoms (≤1%).

The clinical symptoms of COVID-19 patients of all ages are shown in Table 2. Among all age groups, fever was the most common clinical manifestation (80%), followed by cough (69%), dyspnoea (45%), fatigue (30%), diarrhoea (17%) and anorexia (12%). The symptoms of cough (80%), dyspnoea (58%), fatigue (39%), diarrhoea (21%) and muscle soreness (15%) were more common in the middle-aged group than in other age groups. Chest pain was more common (13%) in the youth, with dyspnoea (22%) being less common. Gastrointestinal (GI) symptoms such as diarrhoea, nausea and vomiting were more common in the middle-aged and the older. In the elderly, apart from fever (75%), cough (53%) and dyspnoea (38%), the other common clinical manifestations were fatigue (34%) and anorexia (25%). About 13% of the youth did not have any clinical symptoms.

The distribution of the highest body temperature during the course of disease of patients of each age group is shown in Table 3. About 40% of the patients with fever of all ages had moderate fever (38.1°C–39.0°C), followed by 24% of low fever (37.3°C–38.0°C) and 17% of high fever (39.1°C–40.0°C). Other than moderate fever, high fever (39.1°C–40.0°C) was more common in the youth and low fever (37.3°C–38.0°C) was more common in the middle-aged.

The number of patients with or without comorbidities in each age group is shown in Table 4. With the increase of age, the proportion of patients with comorbidities increased, especially in the elderly (94%). Most of the young patients (87%) had no comorbidities. The most frequently observed comorbidities were hypertension (59%), diabetes (28%), coronary heart disease (12%) and chronic obstructive pulmonary disease (12%).

The methods of pre-admission diagnosis (positive RT-PCR or chest CT) are shown in Table 5. About 71% of the patients were diagnosed based on positive novel coronavirus's RNA nasopharyngeal swab nucleic acid test, and 29% were admitted to the hospital due to positive chest CT scans. These patients were also confirmed by positive RT-PCR after admission to the hospital.

The number of lung lobes with lesions on chest CT in different age groups is shown in Table 6. About 76% of the patients had lesions in all of the lung lobes, followed by 17% in 2–4 lobe involvement and 4% in single lung lobe involvement. In the middle-aged, the old and the elderly, about 80% of the patients had all lung lobes involved, while 58% of the patients in the youth had all lung lobes involved. In addition, 2–4 lobe involvement (22%) and single lobe involvement (11%) were also common in the youth.

The abnormalities observed in leucocytes, lymphocytes, monocytes, eosinophils, red blood cells and haemoglobin in patients of all ages are listed in Table 7. Most of the patients had normal leucocyte count (75%), and the proportion of patients who manifested with reduced (14%) and elevated (11%) leucocytes was similar. About 58% of the patients had decreased lymphocytes, 50% had decreased eosinophils, 39% had decreased red blood cells and 40% had decreased haemoglobin, whereas monocytes were increased in 32% of

Table 1: The initial symptoms of coronavirus disease 2019 patients in different age groups

Age range (years)	20-40 (*n*=64), *n* (%)	41-60 (*n*=89), *n* (%)	61-80 (*n*=118), *n* (%)	81-100 (*n*=32), *n* (%)	Total (*n*=303), *n* (%)
Fever	50 (78)	69 (78)	89 (75)	23 (72)	231 (76)
Cough	4 (6)	11 (12)	21 (18)	1 (3)	37 (12)
Dyspnoea	4 (6)	6 (7)	3 (3)	1 (3)	14 (5)
Diarrhoea	1 (2)	-	1 (0.8)	-	2 (0.7)
Muscle soreness	1 (2)	1 (1)	-	-	2 (0.7)
Fatigue	-	3 (3)	-	4 (13)	7 (2)
Headache	-	1 (1)	-	-	1 (0.4)
Haemoptysis	-	1 (1)	-	-	1 (0.4)
Nausea and vomiting	-	1 (1)	1 (0.8)	-	2 (0.7)
Dizziness	-	1 (1)	-	-	1 (0.4)

Table 2: Clinical symptoms of coronavirus disease 2019 patients in different age groups

Age range (in years)	20-40 (*n*=64), *n* (%)	41-60 (*n*=89), *n* (%)	61-80 (*n*=118), *n* (%)	81-100 (*n*=32), *n* (%)	Total (*n*=303), *n* (%)
Fever	52 (81)	73 (82)	94 (80)	24 (75)	243 (80)
Cough	40 (62.5)	71 (80)	81 (69)	17 (53)	209 (69)
Dyspnoea	14 (22)	52 (58)	58 (49)	12 (38)	136 (45)
Diarrhoea	8 (13)	19 (21)	22 (19)	2 (6)	51 (17)
Muscle soreness	5 (8)	13 (15)	5 (4)	2 (6)	25 (8)
Fatigue	13 (20)	35 (39)	32 (27)	11 (34)	91 (30)
Anorexia	10 (16)	5 (6)	12 (10)	8 (25)	35 (12)
Headache	2 (3)	6 (7)	3 (3)	1 (3)	12 (4)
Haemoptysis	1 (2)	1 (1)	1 (0.8)	-	3 (1)
Nausea and vomiting	-	7 (8)	7 (6)	1 (3)	15 (5)
Dizziness	-	5 (6)	2 (2)	-	7 (3)
Chest pain	8 (13)	3 (3)	4 (3)	1 (3)	16 (5)
Palpitation	-	2 (2)	-	1 (3)	3 (1)
Melena	-	1 (1)	-	-	2 (0.7)
Night sweat	-	2 (2)	-	-	2 (0.7)
Hoarseness	1 (2)	-	-	-	1 (0.4)
Throat pain	1 (2)	3 (3)	1 (0.8)	1 (3)	6 (2)
Runny nose	-	2 (2)	1 (0.8)	-	3 (1)
Shivering	-	-	1 (0.8)	1 (3)	2 (0.7)
Abdominal distension	-	-	1 (0.8)	-	1 (0.4)
Faecal and urine incontinence	-	-	1 (0.8)	-	1 (0.4)
Asymptomatic	8 (13)	2 (2)	1 (0.8)	2 (6)	13 (4)

Table 3: Range of body temperature in the course of disease of coronavirus disease 2019 patients in different age groups

Age range (years)	20-40 (*n*=64), *n* (%)	41-60 (*n*=89), *n* (%)	61-80 (*n*=118), *n* (%)	81-100 (*n*=32), *n* (%)	Total (*n*=303), *n* (%)
Low fever*	12 (23)	17 (23)	38 (32)	6 (19)	73 (24)
Moderate fever*	23 (44)	42 (58)	39 (33)	16 (50)	120 (40)
High fever*	18 (35)	14 (19)	17 (14)	2 (6)	51 (17)
No fever	11 (17)	16 (18)	24 (20)	8 (25)	59 (19)

*Low fever: 37.3°C-38.0°C, Moderate fever: 38.1°C-39.0°C, High fever: 39.1°C-40.0°C

the patients. The decrease of lymphocytes and the increase of monocytes were significantly different among different age groups. The proportion of lymphocytopenia was at least 67% in patients over 40 years old, and the percentage increased with age. The proportion of monocytosis was at least 25% in the same patient groups. In contrast, only 9% of the youth had lymphocytopenia and monocytosis. The proportion of leucocytosis, lymphocytopenia, eosinophilia and erythrocytopenia was the highest in the elderly. With the increase of age, the proportion of erythrocytopenia increased. Similarly, the proportion of decreased haemoglobin increased with age among those under 80 years old in our study.

Table 4: Presence of comorbidities of coronavirus disease 2019 patients in different age groups

Age range (years)	20-40 (*n*=64), *n* (%)	41-60 (*n*=89), *n* (%)	61-80 (*n*=118), *n* (%)	81-100 (*n*=32), *n* (%)	Total (*n*=303), *n* (%)
With comorbidities	8 (13)	39 (44)	72 (61)	30 (94)	149 (49)
Without comorbidities	56 (87)	50 (56)	46 (39)	2 (6)	154 (51)
Diabetes	1 (13)	16 (41)	19 (26)	5 (17)	41 (28)
Hypertension	1 (13)	23 (59)	47 (65)	17 (57)	88 (59)
Coronary heart disease	-	-	7 (10)	11 (37)	18 (12)
Hyperlipidaemia	-	-	9 (13)	-	9 (6)
Atrial fibrillation	-	-	2 (3)	-	2 (1)
Congenital heart disease	2 (25)	-	-	-	2 (1)
COPD	-	2 (5)	11 (15)	5 (17)	18 (12)
Pulmonary fibrosis	-	1 (3)	1 (1)	-	2 (1)
Asthma	-	-	1 (1)	1 (3)	2 (1)
Bronchiectasis	-	-	-	1 (3)	1 (0.7)
Chronic pneumonia	-	-	-	1 (3)	1 (0.7)
Depression	1 (13)	1 (3)	-	-	2 (1)
Hepatitis B	-	5 (13)	1 (1)	1 (3)	7 (5)
Chronic renal failure	-	2 (5)	-	1 (3)	3 (2)
Hypothyroidism	-	2 (5)	2 (3)	-	4 (3)
Hyperthyroidism	1 (13)	-	-	-	1 (0.7)
Cancer	-	-	2 (3)	1 (3)	3 (2)
Cerebral infarction	-	-	-	3 (10)	3 (2)
Gallstone	-	-	-	3 (10)	3 (2)
Ectopic pregnancy	1 (13)	-	-	-	1 (0.7)
Skin infection	1 (13)	-	-	-	1 (0.7)
Rheumatic heart disease	-	1 (3)	-	-	1 (0.7)
Chest deformity	-	1 (3)	-	1 (3)	2 (1)
Peptic ulcer	-	-	1 (1)	-	1 (0.7)
Gout	-	-	1 (1)	-	1 (0.7)
Abdominal aortic aneurysm	-	-	-	1 (3)	1 (0.7)
Hypoproteinaemia	-	-	-	1 (3)	1 (0.7)
Rheumatoid arthritis	-	-	1 (1)	-	1 (0.7)

COPD: Chronic obstructive pulmonary disease

Table 5: Comparison of pre-admission diagnosis of coronavirus disease 2019 patients in different age groups

Age range (years)	20-40 (*n*=64), *n* (%)	41-60 (*n*=89), *n* (%)	61-80 (*n*=118), *n* (%)	81-100 (*n*=32), *n* (%)	Total (*n*=303), *n* (%)
Nucleic acid detection	42 (66)	69 (78)	85 (72)	20 (63)	216 (71)
Chest CT	22 (34)	20 (22)	33 (28)	12 (38)	87 (29)

CT: Computed tomography

Table 6: Extent of involvement of lung lobes on computed tomography scan in patients with coronavirus disease 2019 in different age groups

Age range (years)	20-40 (*n*=64), *n* (%)	41-60 (*n*=89), *n* (%)	61-80 (*n*=118), *n* (%)	81-100 (*n*=32), *n* (%)	Total (*n*=303), *n* (%)
Single lobe	7 (11)	3 (3)	2 (2)	1 (3)	13 (4)
2-4 lobes	14 (22)	15 (17)	17 (14)	5 (16)	51 (17)
All lobes	37 (58)	71 (80)	97 (82)	25 (78)	230 (76)
Normal	4 (6)	-	2 (2)	1 (3)	7 (2)

The abnormalities on CRP, PCT and serum total IgE in patients of different age groups are shown in Table 8. The increase of CRP in COVID-19 patients was common (68%), and the proportion increased with age, reaching 91% in the elderly. The PCT was increased in 31% of the patients, and similarly, the proportion increased with age, reaching 66% in the elderly. The serum total IgE was increased in 39% of the patients, and the proportion in the old was the highest (49%).

Discussion

Since the first case of COVID-19 emerged in Wuhan, Hubei

Table 7: Main abnormal indexes of blood routine for the first time in hospitalisation of coronavirus disease 2019 patients in different age groups

Age range (years)	20-40 (*n*=64), *n* (%)	41-60 (*n*=89), *n* (%)	61-80 (*n*=118), *n* (%)	81-100 (*n*=32), *n* (%)	Total (*n*=303), *n* (%)	*P*
Leucopenia	12 (19)	14 (16)	14 (12)	3 (9)	43 (14)	>0.05
Leucocytosis	7 (11)	5 (6)	14 (12)	8 (25)	34 (11)	0.028
Lymphopenia	6 (9)	60 (67)	83 (70)	27 (84)	176 (58)	<0.001
Eosinopenia	31 (48)	47 (53)	51 (43)	23 (72)	152 (50)	0.034
Monocytosis	6 (9)	32 (36)	51 (43)	8 (25)	97 (32)	<0.001
Reduced RBC count	8 (13)	25 (28)	65 (55)	20 (63)	118 (39)	<0.001
Reduced haemoglobin	15 (23)	34 (38)	58 (49)	14 (44)	121 (40)	0.008

RBC: Red blood cell

Table 8: Comparison of inflammatory indexes at initial reporting in hospitalisation of coronavirus disease 2019 patients in different age groups

Age range (years)	20-40 (*n*=64), *n* (%)	41-60 (*n*=89), *n* (%)	61-80 (*n*=118), *n* (%)	81-100 (*n*=32), *n* (%)	Total (*n*=303), *n* (%)	*P*
Elevated CRP	37 (58)	57 (64)	82 (69)	29 (91)	205 (68)	0.01
Elevated procalcitonin	14 (22)	25 (28)	34 (29)	21 (66)	94 (31)	<0.001
Elevated serum IgE	20 (31)	28 (31)	58 (49)	13 (41)	119 (39)	0.031

CRP: C-reactive protein

Province, China, by the end of December 2019, the disease has begun to spread rapidly around the world. Caused by the novel coronavirus, COVID-19 pandemic has been recognised as an unprecedented global public health event and has become a significant threat to human life and health. Early screening, isolation and treatment of infected patients can effectively control the spread of the disease and reduce morbidity and mortality.

Our study summarises the onset, clinical characteristics and the initial imaging/laboratory findings in hospitalised patients diagnosed as COVID-19 in different age groups. Among these patients, fever was the most common initial symptom and clinical manifestation in all age groups. Therefore, early screening and monitoring of body temperature is a very important measure. On the other hand, about 19% of the patients had no fever in the course of the disease, and the proportion of these patients was not low, which suggested that clinicians should not solely rely on body temperature monitoring in early screening, as it is easy to miss some patients with no fever or other symptoms.[9] Cough and dyspnoea can be included in the history taking and preliminary screening as the first symptoms, especially in the middle-aged and the older. Our study also indicated that fever was the most common first symptom in the elderly, and fatigue was the second (13%) most common. Besides fever, fatigue and anorexia were the main clinical manifestations in the course of the disease. Therefore, in the screening of people over 80 years old, attention should be paid more to those without fever who have unexplained fatigue, poor mental state and poor appetite.

Although fever, cough, dyspnoea, fatigue, diarrhoea and anorexia were the most common clinical manifestations, the patterns of symptoms vary in different age groups. For example, dyspnoea was less common in the youth while 13% had chest pain, indicating that COVID-19 infection needs to be distinguished from pulmonary embolism, bacterial pleurisy and heart disease. In our study, the patients in the youth did not have the combined diseases as above, suggesting that chest pain is the specific clinical manifestation of young COVID-19 patients, which was different from other age groups. Moreover, it has been reported that diarrhoea and other GI symptoms were common in COVID-19 patients.[10,11] Our study found that diarrhoea, nausea, vomiting and other GI symptoms were common in patients aged 40–80 years. This suggests that there is some association between GI symptoms and age in COVID-19 patients. Therefore, clinicians should pay more attention to diarrhoea, nausea and vomiting and other GI symptoms in the early screening in people over 40 years of age.

Some previous studies had reported cases of asymptomatic COVID-19 patients.[12-15] Asymptomatic patients are one of the biggest challenges of COVID-19 prevention and control, because asymptomatic patients are hard to identify and will become an important potential source of infection. Our study showed that asymptomatic patients were mainly observed in the youth but relatively rare in the middle-aged, the older and the elderly. This indicates that when screening the young, clinicians should not only check the body temperature and clinical symptoms but also carefully take the epidemiological and clinical history. If there is a history of possible close contact with COVID-19 cases, further tests such as novel coronavirus nucleic acid test and chest CT should be done.

According to the diagnostic criteria of WHO's COVID-19 management guidelines,[16] in addition to the epidemiological

history, symptoms, presentation on full blood count and the increase of CRP, the gold standard of diagnosis is a positive result of the novel coronavirus on high throughput sequencing or real-time RT-PCR assay of nasopharyngeal swab specimens. However, disease screening using novel coronavirus nucleic acid detection has limitations in the early stage of disease outbreak, such as high false-negative rate and insufficient testing kit supply. If clinicians diagnose COVID-19 infection only by positive RT-PCR, it will result in a large number of missed or delayed diagnoses, leading to failure in early discovery and rapid control and eventually resulting in the spread of the disease. It could be seen from our study that 30% of the patients with laboratory-confirmed COVID-19 were admitted to the hospital due to positive chest CT scans, suggesting chest CT has certain sensitivity and specificity thus an important means of diagnosis for COVID-19, which has also been confirmed in some studies.[17-19] Needless to say, imaging diagnosis of COVID-19 relies on the level of interpretation on chest CT images by clinicians, emphasising the necessity of experienced radiologists.

Our study analysed the chest CT images of 303 patients with COVID-19 and found that the lesions involved all lung lobes in most patients, which was consistent with previous studies[20-22] and different from bacterial pneumonia. The amount of lesions on chest CT was different in different age groups. About half of the patients in the youth involved single lung lobe or 2–4 lobes. However, in patients over 40 years old, the proportion of single or 2–4 lobe lung involvement was low, but the proportion of diffuse lesions was high. Since the disease severity is directly proportional to the extent of lung lobe involvement, the conditions of patients over 40 years old were generally more serious than the youth. Therefore, clinicians should pay more attention to patients over 40 years old during management.

In the COVID-19 management guidelines, normal or decreased leucocyte count and decreased lymphocyte count are important diagnostic criteria. In our study, the results of the initial blood count upon admission (pre-treatment state), which represented the blood count level at the time of disease onset, revealed that 90% of the patients had normal or reduced leucocyte count, but about 10% of the patients had increased leucocyte count. The proportion of cases with leucocytosis was highest in the elderly (25%), which was significantly higher than that of other age groups. Similarly, PCT increased in 20% of the patients in the study, and the proportion of patients with elevated PCT increased with age. In the elderly, PCT level increased in 66% of the patients, which was also significantly higher than the proportion in other age groups. Considering the correlation with the extent of lung lobes involved, age and the severity of disease, increased leucocyte count and PCT level might be considered as markers of more severe clinical condition and worse prognosis in senior patients. This will provide an important strategy for clinicians to make personalised treatment plans for patients of different ages.

In our study, 58% of the patients had lymphocytopenia and the proportion increased with age. The lymphocytes decreased in 67% of the patients in the middle-aged and 84% in the elderly. However, in the youth, the proportion was only 9% ($P < 0.05$). This suggests that lymphocytopenia is not universal in all of the COVID-19 patients. As one of the diagnostic criteria, it is more suitable for screening people over 40 years old. Because the likelihood of lymphocytopenia increases with age, it is possibly related to the severity of disease and prognosis.

Previous studies have compared the blood cellular count of COVID-19 with other viral pneumonias and found that patients with COVID-19 infection were more prone to leucopenia, lymphocytopenia and eosinophilia.[23] Very few reported the changes of monocytes, erythrocytes and haemoglobin in COVID-19 patients' peripheral blood. Our study found that COVID-19 patients had monocytosis, significant eosinophilia, erythrocytopenia and decreased haemoglobin. About 50% of all the patients and 72% of the elderly had eosinophilia, suggesting that eosinophilia has a close relationship with COVID-19. Erythrocytopenia and decreased haemoglobin were other abnormal manifestations on blood count in COVID-19 patients found in our study, which were more common in the older and the elderly, and had a certain correlation with age. Similar to lymphocytopenia, monocytosis was more common in COVID-19 patients over 40 years old. These suggest that clinicians may consider utilising eosinophilia, erythrocytopenia and lowering of haemoglobin as early screening indicators and monocytosis as early screening indicators for people over 40 years old.

The elevation of CRP is one of the diagnostic criteria of COVID-19. Our study showed that the level of CRP increased in 68% of the patients, and the percentage increased with age, exceeding 90% in the elderly. It implies that CRP is related to the severity and prognosis of the disease. Some studies have found that the level of PCT is related to the severity of COVID-19.[24] Our study also found that the proportion of patients with PCT elevation increased with age. Combined with the analysis on the relationship between age, the extent of lung lobes involved and comorbidities, it suggests that the increase of PCT is possibly related to the severity of the disease and prognosis.

In this study, serum IgE level was increased in 39% of the COVID-19 patients and 49% in the elderly. It suggests that the total serum IgE level can be used as an important early screening marker, however, the relationship between the increase of serum IgE level and the significant eosinophilia still calls for further study.

Conclusion

To sum up, in view of the different clinical characteristics and imaging/laboratory findings of COVID-19 in different ages, personalised criteria should be formulated according to different age groups in the early screening and diagnosis stage. Epidemiological history and clinical manifestations

should be asked in detail. In addition to the most common clinical symptoms such as fever, cough and dyspnoea, it is also essential to be alerted to diarrhoea, nausea and vomiting, general muscle soreness, chest pain, fatigue, anorexia and other symptoms. Moreover, if young people have a history of possible close contact with confirmed cases, clinicians should conduct further examination even if they do not have any clinical symptoms. Full blood count, CRP and serum total IgE should be used as haematological tests for early screening. Early diagnosis should not only rely on viral nucleic acid detection, clinicians should also pay attention to the diagnostic value of chest CT.

The limitation of our study is that there is no correlation analysis between disease severity classification and other related factors in the 303 COVID-19 patients. The main reason for this limitation is that the hospital included in the study was a designated hospital for critically ill patients, and most of the patients' disease classification was severe. Hence, it could not be representative of the general patient population. In the follow-up study, we plan to analyse the disease classification and correlation index and include the treatment effect, prognosis and other observation indicators, so as to reveal the characteristics of COVID-19 more comprehensively from different aspects.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Wu YC, Chen CS, Chan YJ. Overview of the 2019 novel coronavirus (2019-nCoV). J Chinese Med Assoc 2020;83:1.
2. Lei Y, Zhang HW, Yu J, Patlas MN. COVID-19 infection: Early lessons. Can Assoc Radiol J 2020;71:251-2.
3. Lai CC, Shih TP, Ko WC, Tang HJ, Hsueh PR. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. Int J Antimicrob Agents 2020;55:105924.
4. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, *et al*. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: A descriptive study. Lancet 2020;395:507-13.
5. Sun P, Qie S, Liu Z, Ren J, Li K, Xi J. Clinical characteristics of hospitalized patients with SARS-CoV-2 infection: A single arm meta-analysis. J Med Virol. 2020;92:612-7.
6. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, *et al*. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA 2020;323:1061-9.
7. Zhang JJ, Dong X, Cao YY, Yuan YD, Yang YB, Yan YQ, *et al*. Clinical characteristics of 140 patients infected with SARS-CoV-2 in Wuhan, China. Allergy 2020;75:1730-41.
8. Chen L, Liu HG, Liu W, Liu J, Liu K, Shang J, *et al.* Analysis of clinical features of 29 patients with 2019 novel coronavirus pneumonia. Zhonghua Jie He He Hu Xi Za Zhi 2020;43:E005.
9. Bwire GM, Paulo LS. Coronavirus disease-2019: Is fever an adequate screening for the returning travelers? Trop Med Health 2020;48:14.
10. Song Y, Liu P, Shi XL, Chu YL, Zhang J, Xia J, *et al*. SARS-CoV-2 induced diarrhoea as onset symptom in patient with COVID-19. Gut 2020;69:1143-4.
11. Wu WS, Li YG, Wei ZF, Zhou PH, Lyu LK, Zhang GP, *et al*. Investigation and analysis on characteristics of a cluster of COVID-19 associated with exposure in a department store in Tianjin. Zhonghua Liu Xing Bing Xue Za Zhi 2020;41:489-93.
12. Al-Tawfiq JA. Asymptomatic coronavirus infection: MERS-CoV and SARS-CoV-2 (COVID-19). Travel Med Infect Dis 2020;35:101608.
13. Bai Y, Yao L, Wei T, Tian F, Jin DY, Chen L, *et al*. Presumed asymptomatic carrier transmission of COVID-19. JAMA 2020JAMA. 2020;323:1406-7.
14. Hu ZB, Ci C. Screening and management of asymptomatic infection of corona virus disease 2019 (COVID-19). Zhonghua Yu Fang Yi Xue Za Zhi 2020;54:E025.
15. Nishiura H, Kobayashi T, Miyama T, Suzuki A, Jung SM, Hayashi K, *et al*. Estimation of the asymptomatic ratio of novel coronavirus infections (COVID-19). Int J Infect Dis 2020;94:154-5.
16. World Health Organization. Clinical Management of Severe Acute Respiratory Infection (SARI) When COVID-19 Disease Is Suspected. World Health Organization; 2020.
17. Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W, *et al*. Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: A report of 1014 cases. Radiology 2020:200642.
18. Li Y, Xia L. Coronavirus disease 2019 (COVID-19): Role of chest CT in diagnosis and management. AJR Am J Roentgenol 2020;214:1280-6.
19. Xie X, Zhong Z, Zhao W, Zheng C, Wang F, Liu J. Chest CT for typical 2019-nCoV pneumonia: Relationship to negative RT-PCR testing. Radiology 2020:200343.
20. Zhou S, Wang Y, Zhu T, Xia L. CT features of coronavirus disease 2019 (COVID-19) pneumonia in 62 patients in Wuhan, China. AJR Am J Roentgenol 2020;214:1287-94.
21. Wu J, Wu X, Zeng W, Guo D, Fang Z, Chen L, *et al*. Chest CT Findings in Patients With Coronavirus Disease 2019 and Its Relationship With Clinical Features. Invest Radiol. 2020;55:257-61.
22. Shi H, Han X, Jiang N, Cao Y, Alwalid O, Gu J, *et al*. Radiological findings from 81 patients with COVID-19 pneumonia in Wuhan, China: A descriptive study. Lancet Infect Dis 2020;20:425-34.
23. Li YX, Wu W, Yang T, Zhou W, Fu Y, Feng Q, *et al*. Characteristics of peripheral blood leukocyte differential counts in patients with COVID-19. Zhonghua Nei Ke Za Zhi 2020;59:E003.
24. Lippi G, Plebani M. Procalcitonin in patients with severe coronavirus disease 2019 (COVID-19): A meta-analysis. Clin Chim Acta 2020;505:190-1.