BMJ Open Respiratory Research

Pneumonia in newly diagnosed patients infected with the Omicron variant: a population-based study of Chinese patients in Chongqing

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To cite: Wang H, Chen R, Guo J, *et al*. Pneumonia in newly diagnosed patients infected with the Omicron variant: a population-based study of Chinese patients in Chongqing. *BMJ Open Respir Res* 2023;**10**:e001729. doi:10.1136/bmjresp-2023-001729

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjresp-2023-001729).

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Received 28 March 2023
Accepted 28 July 2023

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ABSTRACT

Background Pneumonia is the main complication of the Omicron variant of SARS-CoV-2; however, the incidence proportions and prognostic factors for Omicron-associated pneumonia have not been established. We conducted this study to characterise the incidence proportions and influence of various factors on prognosis of Omicron-associated pneumonia.

Methods We collected data from 714 patients infected with the Omicron variant in The First Affiliated Hospital of Chongqing Medical University (Chongqing, China) who were divided into different groups for analysis.

Results We identified 313 patients with Omicron-associated pneumonia at the time of diagnosis of patients infected with the Omicron variant, representing 43.8% of the entire cohort. A total of 82 were 15–59 years old, 71 were 60–69 years old, 76 were 70–79 years old and 84 were >80 years old. 133 were female and 180 were male. Incidence proportions of pneumonia were highest among patients with cardiovascular (82.4% of the basic disease of the cardiovascular system subset) or kidney disease (92.3% of the kidney disease subset), whereas patients with lung cancer (35.7% of the lung cancer subset) had a lower incidence proportion. Several factors were associated with the prognosis of pneumonia in patients infected with the Omicron variant. Patients with a thrombosis or pleural effusion had a longer hospitalisation time. Paxlovid and immunoglobulins improved the prognosis of patients with severe pneumonia. The following measures were significantly different in patients as a function of disease severity: number of neutrophils and lymphocytes, partial oxygen pressure; and myoglobin, lactic dehydrogenase, aspartate transaminase and procalcitonin levels.

Conclusion Patients infected with the Omicron variant with coexisting cardiovascular or kidney disease, but not respiratory disease, had a higher incidence proportion of pneumonia. Paxlovid and immunoglobulins can be used in patients with severe infections to improve prognosis.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The incidence proportions and prognostic factors for Omicron-associated pneumonia have not been established. We conducted this study to characterise the incidence proportions and influence of various factors on prognosis of Omicron-associated pneumonia.

WHAT THIS STUDY ADDS

⇒ Patients infected with the Omicron variant with coexisting cardiovascular or kidney disease, but not respiratory disease, had a higher odd of pneumonia. Paxlovid and immunoglobulins can be used in patients with severe infections to improve prognosis.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study helps us to identify the incidence proportions for pneumonia to protect the susceptible population and helps us to optimise treatment programmes to improve the prognosis of patients.

INTRODUCTION

Since December 2022, the COVID-19 pandemic has been widespread in China. The Omicron variant of SARS-CoV-2 spread faster than any of the previous variants.[1 2] Pneumonia is the main complication of the Omicron variant, which can lead to acute respiratory distress syndrome (ARDS) and even death. Recent studies have reported that COVID-19 not only causes respiratory system symptoms but involves other systems and injures organs.[3 4] Based on the latest treatment guidelines, COVID-19 disease severity can be categorised as follows: no need to inhale oxygen (NNIO), routine oxygen inhalation (ROI), non-invasive ventilation (NIV) and mechanical ventilation (MV).[5] A previous study reported that the Omicron variant causes less severe symptoms than previous variants, and most patients have a good prognosis after treatment.[1 6 7]

The incidence proportions for pneumonia caused by the Omicron variant, however, have not been established. The prognostic factors for patients infected with the Omicron variant and pneumonia also warrant further studies. Currently, research is focused on identifying susceptible populations, reducing the

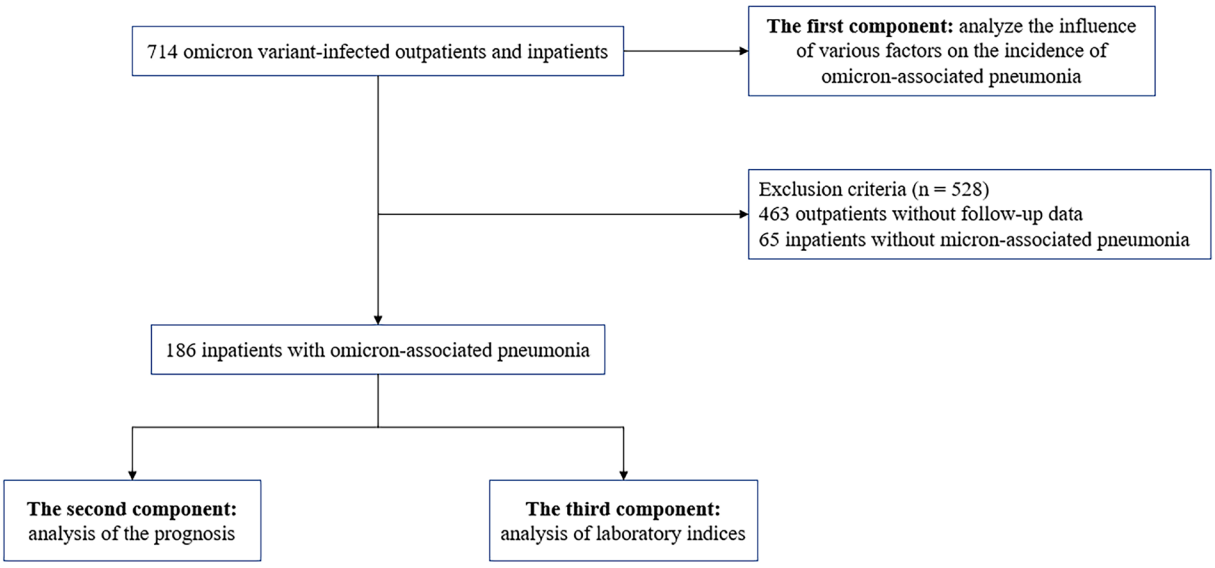

Figure 1 Study recruitment protocol.

incidence of pneumonia and improving the prognosis of critically ill patients. Based on these unknown factors, we conducted this study to characterise the following: (1) the incidence proportions of the Omicron variant-associated pneumonia, (2) prognosis of hospitalised patients with the Omicron variant-associated pneumonia and (3) laboratory indices of patients infected with the Omicron variant with different levels of severity.

METHODS

The included patients

A total of 714 outpatients and inpatients infected with the Omicron variant (age range, 15–97 years) from 3 areas of The First Affiliated Hospital of Chongqing Medical University (Chongqing, China) were included in our study between 20 December 2022 and 20 January 2023. These patients all had the positive nucleic acid or antigen test and were included in three components of our study: the incidence proportions of Omicron variant-associated pneumonia, prognosis of hospitalised patients with Omicron variant-associated pneumonia and analysis of laboratory indices (figure 1).

Incidence of pneumonia

The first component is the incidence proportions of Omicron-associated pneumonia. All patients infected with the Omicron variant (714 patients) were included to characterise the incidence proportions. According to the results of CT examination, we divided patients into two groups: pneumonia group and non-pneumonia group. Then, we collected patient basic information, including age, gender, basic diseases of the respiratory system (BDRSs), basic diseases of the cardiovascular system (BDCSs), diabetes mellitus, hypertension and other coexisting diseases for this component of the analysis.

Prognosis of pneumonia

The second component is the prognosis of hospitalised patients with pneumonia. In this component, we excluded outpatients (because they lack the follow-up data) and also excluded inpatients who were non-pneumonia on admission; the remaining 186 patients who were hospitalised because of Omicron-associated pneumonia were included in the prognosis analysis. Information was added for this component of the analysis, including cigarette smoking history, thrombosis, pleural effusion and drug regimens.

The diagnostic criteria and the severity of pneumonia were based on the latest guidelines.[5] According to the guidelines, the severity of pneumonia can be categorised as follows: NNIO, ROI, NIV and MV. There were no NNIO patients in our study, and we combined the patients who received NIV and MV into the same group by the reasons: (1) the restricted number of patients; (2) both had more severe symptoms than the ROI group and the overall survival of them had significant difference with ROI group (online supplemental figure 1); (3) overall survival was no significant difference between NIV and MV group in Kaplan-Meier curve (online supplemental figure 1). The drug regimens included glucocorticoids, immunosuppressants, paxlovid, azvudine and immunoglobulins. The patients were often prescribed different treatment regimens. In our hospital, glucocorticoids included methylprednisolone, prednisone and dexamethasone; the immunosuppressants included tocilizumab and baricitinib. A 7-day and 14-day hospital stay was used to determine the prognosis of the ROI group; most of the patients had an excellent prognosis and different lengths of hospitalisation. Only six patients died of pneumonia and these patients were included in the 14-day hospital group. Most of the patients in the NIV and MV groups had a longer length of hospitalisation or poor prognosis,

thus we used death as the outcome indicator to determine the prognosis.

Analysis of laboratory indices

The third component is the analysis of laboratory indices. The 186 inpatients with different severity of pneumonia were also included in the analysis of laboratory indices. The information included D-dimer, platelet count, number of neutrophils, number of lymphocytes, partial pressure of oxygen (PO_2) and myoglobin, lactic dehydrogenase (LDH), alanine aminotransferase, aspartate transaminase (AST), brain natriuretic peptide, procalcitonin (PCT) and interleukin 6 levels.

Patient and public involvement

None.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics V.25. Binary logistic regression and multivariate Cox regression analysis were used to characterise the incidence proportions and influence of various factors on the prognosis of pneumonia. Multivariate regression analysis was used to determine the difference of laboratory examination indices between the ROI group and the NIV and MV groups. All analyses were performed with a significance level of 0.05. The OR or HR with 95% CI were provided. Prism V.9.0.0, Franklin Street, Boston, Massachusetts, USA, was used to draw the diagrams.

RESULTS

Incidence of pneumonia in patients infected with the Omicron variant

Overall, 714 patients infected with the Omicron variant from 3 areas of The First Affiliated Hospital of Chongqing Medical University were included in this analysis. The basic patient information is shown in table 1. The χ^2 test revealed that age, gender, BDRSs, BDCSs, diabetes, hypertension and other coexisting diseases differed significantly between patients with or without pneumonia. Further outcomes regarding these factors-associated incidence proportions were identified based on logistic regression (table 1).

Among the 714 patients infected with the Omicron variant analysed for incidence, 15.5%, 12.7%, 12.6%, 21.1% and 8.6% had BDRSs, BDCSs, diabetes, hypertension and other basic disease, respectively. Among the entire cohort, 313 patients presented with pneumonia, reflecting 43.8%. Incidence proportions of pneumonia were highest among patients with cardiovascular (82.4% of the BDCSs subset) or kidney disease (92.3% of the kidney disease subset), whereas patients with lung cancer (35.7% of the lung cancer set) had a lower incidence proportion.

On binary logistic regression among patients with pneumonia, older patients, men (vs women, OR 1.66, 95% CI=1.14 to 2.41), BDCSs (vs healthy patients, OR=2.01, 95% CI=1.04 to 3.87) and kidney disease (vs healthy patients, OR=10.95, 95% CI=1.19 to 101.14) were associated with significantly greater odds of pneumonia. Neither diabetes nor hypertension was associated with a risk of pneumonia in the binary model. Lung cancer was associated with marginally lower odd of pneumonia (vs healthy patients, OR=0.38, 95% CI=0.16 to 0.89). Significant results are presented in table 1.

Prognosis of inpatients with pneumonia

We enrolled 186 hospitalised patients who were diagnosed with pneumonia, and according to the severity of the disease we divided the patients into two groups: ROI, and NIV and MV. The basic patient information is shown in online supplemental table 1. The results of logistic regression are shown in table 2.

The number of patients in the ROI group who remained in the hospital beyond 7 and 14 days was used to determine prognosis. The outcomes showed that older patients had the longest hospitalisation time. Most of the patients with BDRSs were discharged within 7 days, and patients with diabetes were discharged within 14 days. Patients with a thrombosis often remained in the hospital beyond 14 days (HR=159.83, 95% CI=6.86 to 3722.23) and patients with a pleural effusion often remained beyond 7 days (HR=50.87, 95% CI=3.87 to 668.06). Glucocorticoids and immunoglobulins did not shorten the hospitalisation time as results indicated that patients who were prescribed glucocorticoids and immunoglobulins often remained in the hospital>14 days; however, paxlovid was shown to reduce the hospitalisation time to 7–14 days.

The number of patients who died in the NIV and MV group was used to determine the prognosis. Patients with BDRSs had a higher risk of death than patients without BDRSs (HR=5.88, 95% CI=1.09 to 31.83); however, there was no significant difference for patients with chronic obstructive pulmonary disease (p>0.05). Paxlovid (HR=0.32, 95% CI=0.13 to 0.80) and immunoglobulins (HR=0.24, 95% CI=0.09 to 0.66) significantly reduced the risk of death.

Outcomes of laboratory indices

We analysed the laboratory indices of 186 hospitalised patients and divided the patients into two groups: ROI, and NIV and MV. The outcomes of logistic regression are shown in table 3.

The number of neutrophils and lymphocytes, PO_2 and myoglobin, LDH, AST and PCT levels were significantly different between the two groups. The mean and 95% CI of the data are shown in figure 2. Compared with the ROI group, the NIV and MV group had a higher number of neutrophils (OR=1.22, 95% CI=1.12 to 1.34) and higher myoglobin (OR=1.00, 95% CI=1.00 to 1.01), LDH (OR=1.01, 95% CI=1.00 to 1.01), AST (OR=1.01, 95% CI=1.00 to 1.02) and PCT levels (OR=1.13, 95% CI=1.27); but lower number of lymphocytes

Table 1 Binary logistic regression for incidence of pneumonia

	Pneumonia (n=313)	Non-pneumonia (n=401)	OR (95% CI)	P value*
Age				
15–29	3	48	1 (reference)	NA
30–39	18	117	NA	NA
40–49	23	74	4.79 (1.35 to 16.99)	0.015
50–59	38	60	8.81 (2.52 to 30.85)	0.001
60–69	71	48	21.11 (6.07 to 73.49)	< 0.001
70–79	76	38	24.68 (7.01 to 86.89)	< 0.001
>80	84	16	47.30 (12.44 to 179.90)	< 0.001
Sex				
Female	133	240	1 (reference)	NA
Male	180	161	1.66 (1.14 to 2.41)	0.008
BDRSs				
None	254	349	1 (reference)	NA
Lung cancer	10	18	0.38 (0.16 to 0.89)	0.026
COPD	28	12	NA	NA
Cancer and COPD	1	4	NA	NA
Others	20	18	NA	NA
BDCSs				
None	238	385	1 (reference)	NA
Yes	75	16	2.01 (1.04 to 3.87)	0.037
Diabetes				
None	248	376	1 (reference)	NA
Yes	65	25	NA	NA
Hypertension				
None	200	363	1 (reference)	NA
Yes	113	38	NA	NA
Other basic disease				
None	288	384	1 (reference)	NA
Tumour	15	7	NA	NA
Kidney	12	1	10.95 (1.19 to 101.14)	0.035
Others	18	9	NA	NA

*Only the variable with a significant difference (p<0.05) is listed; NA: p>0.05.
BDCSs, basic disease of the cardiovascular system; BDRSs, basic disease of the respiratory system; COPD, chronic obstructive pulmonary disease.

(OR=0.43, 95% CI=0.22 to 0.87) and PO_2 (OR=0.98, 95% CI=0.97 to 0.99).

DISCUSSION

Our study characterised the incidence proportions for Omicron-associated pneumonia, as well as the prognosis of inpatients with pneumonia, and also analysed the laboratory indices to evaluate the relationship with disease severity. All of the study patients were infected with the Omicron variant and received care at our hospital.

Age, gender, lung cancer, BDCSs and kidney disease all had a significant difference of incidence proportion on the incidence of pneumonia; age had the most apparent difference. As people age, immunity gradually wanes, thus older patients had a higher risk of pneumonia. COVID-19 as a respiratory system disease often causes respiratory symptoms and it is generally believed that patients with BDRSs will have more severe symptoms; however, we characterised that patients with BDRSs did not have the higher incidence proportion of pneumonia. In fact, patients with lung cancer had a lower odd of incidence of pneumonia. Influenza virus infection is also a type of respiratory system disease that can cause pneumonia. Several studies have reported the risk factors

Table 2 Cox and binary logistic regression for prognosis of inpatients with different severity

	ROI				NIV and MV	
	7 days in hospital		14 days in hospital		Death	
	HR (95% CI)	P value*	HR (95% CI)	P value*	HR (95% CI)	P value*
Age						
<60	1 (reference)	NA	1 (reference)	NA	NA	NA
60–69	14.26 (1.75 to 116.23)	0.013	NA	NA	NA	NA
70–79	NA	NA	NA	NA	NA	NA
>80	NA	NA	14.69 (1.25 to 173.07)	0.033	1 (reference)	NA
Sex						
Female	1 (reference)	NA	1 (reference)	NA	1 (reference)	NA
Male	NA	NA	NA	NA	NA	NA
BDRSs						
None	1 (reference)	NA	1 (reference)	NA	1 (reference)	NA
COPD	NA	NA	NA	NA	NA	NA
Others	0.05 (0.01 to 0.51)	0.011	NA	NA	5.88 (1.09 to 31.83)	0.040
BDCSs						
None	1 (reference)	NA	1 (reference)	NA	1 (reference)	NA
CAD	NA	NA	NA	NA	NA	NA
Others	NA	NA	NA	NA	NA	NA
Diabetes	NA	NA	0.06 (0.01 to 0.53)	0.011	NA	NA
Hypertension	NA	NA	NA	NA	NA	NA
Other basic disease	NA	NA	NA	NA	NA	NA
Smoking history	NA	NA	NA	NA	NA	NA
Thrombosis	NA	NA	159.83 (6.86 to 3722.23)	0.002	NA	NA
Pleural effusion	50.87 (3.87 to 668.06)	0.003	NA	NA	NA	NA
Glucocorticoid	3.98 (1.06 to 14.93)	0.040	17.48 (2.21 to 138.55)	0.007	NA	NA
Immunosuppressants	NA	NA	NA	NA	NA	NA
Paxlovid	6.06 (1.49 to 24.71)	0.012	0.11 (0.02 to 0.72)	0.021	0.32 (0.13 to 0.80)	0.014
Azvudine	NA	NA	NA	NA	NA	NA
Immunoglobulins	46.91 (1.64 to 1339.72)	0.024	10.25 (1.12 to 93.57)	0.039	0.24 (0.09 to 0.66)	0.005

*Only the variable with a significant difference (p<0.05) is listed; NA: p>0.05.
BDCSs, basic disease of the cardiovascular system; BDRSs, basic disease of the respiratory system; CAD, coronary heart disease; COPD, chronic obstructive pulmonary disease; MV, mechanical ventilation; NIV, non-invasive ventilation; ROI, routine oxygen inhalation.

for influenza virus-associated pneumonia, all of which demonstrated BDRSs to be a risk factor.[8–10] This outcome was in inconformity to the lower incidence proportion of Omicron-associated pneumonia in patients with lung cancer. Based on our study results, patients with BDCSs or kidney disease had a higher incidence proportion of pneumonia. Although COVID-19 is a respiratory infectious disease, we suggest that the main cause of pneumonia caused by Omicron is not a respiratory infection, but to circulatory system-related or kidney-related factors. The specific pathogenesis underlying Omicron variant infection-associated pneumonia warrants further study.

The prognosis for patients with Omicron variant infection-associated pneumonia depends on the severity of the disease, thus we divided patients into two groups to analyse the impact of each factor more accurately. Patients in the ROI group with BDRSs did not have a lengthy hospital stay and usually had a favourable prognosis. In contrast, patients in the NIV and MV group with BDRSs were at an increased risk of death, perhaps because BDRSs increase the risk of ARDS. Thrombosis is one of the complications of COVID-19 infection, and usually causes severe clinical symptoms.[11–13] According to the guidelines, we administered prophylactic anticoagulation therapy to patients without contraindications. For patients with contraindications or who failed prevention, thrombosis was still an important factor affecting prognosis. Steroid, as a type of anti-inflammatory drug, can effectively promote the absorption of pneumonia.[14] In clinical practice, we often prescribed the dose of steroid according to the severity (determined by patients' symptoms, imaging manifestations and blood gas indexes). We

Table 3 Multivariate logistic regression of the laboratory examination index

	ROI		NIV and MV	
	OR (95% CI)	P value	OR (95% CI)	P value
D-dimer	1 (reference)	NA	1.01 (0.99 to 1.03)	0.203
Platelet	1 (reference)	NA	0.99 (0.99 to 1.00)	0.575
Neutrophils	1 (reference)	NA	1.22 (1.12 to 1.34)	<0.001*
Lymphocyte	1 (reference)	NA	0.43 (0.22 to 0.87)	0.019*
PO_2	1 (reference)	NA	0.98 (0.97 to 0.99)	0.008*
Myoglobin	1 (reference)	NA	1.00 (1.00 to 1.01)	0.003*
LDH	1 (reference)	NA	1.01 (1.00 to 1.01)	<0.001*
ALT	1 (reference)	NA	1.00 (0.99 to 1.01)	0.190
AST	1 (reference)	NA	1.01 (1.00 to 1.02)	0.038*
BNP	1 (reference)	NA	1.00 (1.00 to 1.00)	0.152
PCT	1 (reference)	NA	1.13 (1.01 to 1.27)	0.039*
IL-6	1 (reference)	NA	1.00 (1.00 to 1.01)	0.132

*P<0.05.
ALT, alanine aminotransferase; AST, aspartate transaminase; BNP, brain natriuretic peptide; IL-6, interleukin 6; LDH, lactic dehydrogenase; MV, mechanical ventilation; NIV, non-invasive ventilation; PCT, procalcitonin; PO_2, partial pressure of oxygen; ROI, routine oxygen inhalation.

collected steroid programmes from every inpatient and performed the subgroups analysis (online supplemental figure 2–4). The outcomes showed higher dose of steroid was used in more severe patients. In the ROI group, versus without steroid therapy, the longer hospitalisation time in patients who prescribed steroid therapy may be due to the higher dose of steroid and its duration of treatment. Online supplemental figure 4) showed there is no best daily dose of steroid to reduce hospitalisation time and mortality. Therefore, we should adjust the dose of steroid according to the state of illness in time. Paxlovid as a new antiviral drug came into use in our hospital in December 2022. The effect of this drug was not evident in ROI patients, but paxlovid significantly reduced the risk of death in NIV or MV patients. Immunoglobulins are not recommended according to the guidelines, but our findings showed that immunoglobulins significantly reduced the risk of death in NIV or MV patients. Based on these outcomes, the efficacy of paxlovid and immunoglobulins in NIV and MV patients require further study.

The changes in the following laboratory indices were more apparent in the NIV and MV group than the ROI group: the number of neutrophils and lymphocytes and myoglobin, LDH, AST and PCT levels and PO_2. We believe these indices can be used to classify disease severity in patients infected with the Omicron variant. Neutrophils, lymphocytes and PCT are markers of infection, and an inflammatory response increases in which correlate with severity in pneumonia patients. Thus, the more severe infection, the stronger the inflammatory response. The PO_2 was lower in the NIV and MV patients than the ROI patients, which explains, at least in part, why patients with severe pneumonia progress to ARDS. The myoglobin, LDH and AST levels, which are markers of acute myocardial or liver injury, were higher in NIV and MV patients. These findings explained why patients with severe pneumonia also had severe myocardial and liver injuries. Previous studies have reported similar outcomes,[15–19] but currently there are no established laboratory indices for determining the severity of COVID-19. We hope these findings provide guidance and a larger cohort study can be conducted to determine the clinical usefulness of these indices.

Our study analysed the incidence proportions for pneumonia caused by Omicron infection, then determined the prognosis of hospitalised patients with pneumonia and finally compared the laboratory indices among patients with different levels of pneumonia severity. This was the first study to report the pathogenic characteristics of Omicron in Chinese patients since COVID-19 became prevalent in China in December 2022. In addition, to our knowledge, this is the first study to discuss the incidence proportion of Omicron-associated pneumonia in patients with different basic diseases. Further studies should be held to discuss the underlying relationship between Omicron-associated pneumonia and basic disease, which can help us to protect the susceptible population and also help us to research the specific pathogenesis underlying Omicron variant infection-associated pneumonia.

There were limitations in our study. Because of the limited number of patients, we could not classify the basic diseases more accurately. For example, with respect to the prognosis analysis, there were few cases in each type of BDRSs; specifically, only four hospitalised patients had lung cancer and two patients had interstitial lung disease, thus we created an ‘others’ category. The same issue arose for BDCSs and other coexisting diseases. In addition, for the same reason, we combined patients who received NIV and MV into the same group. According to guidelines, such patients had different levels of disease

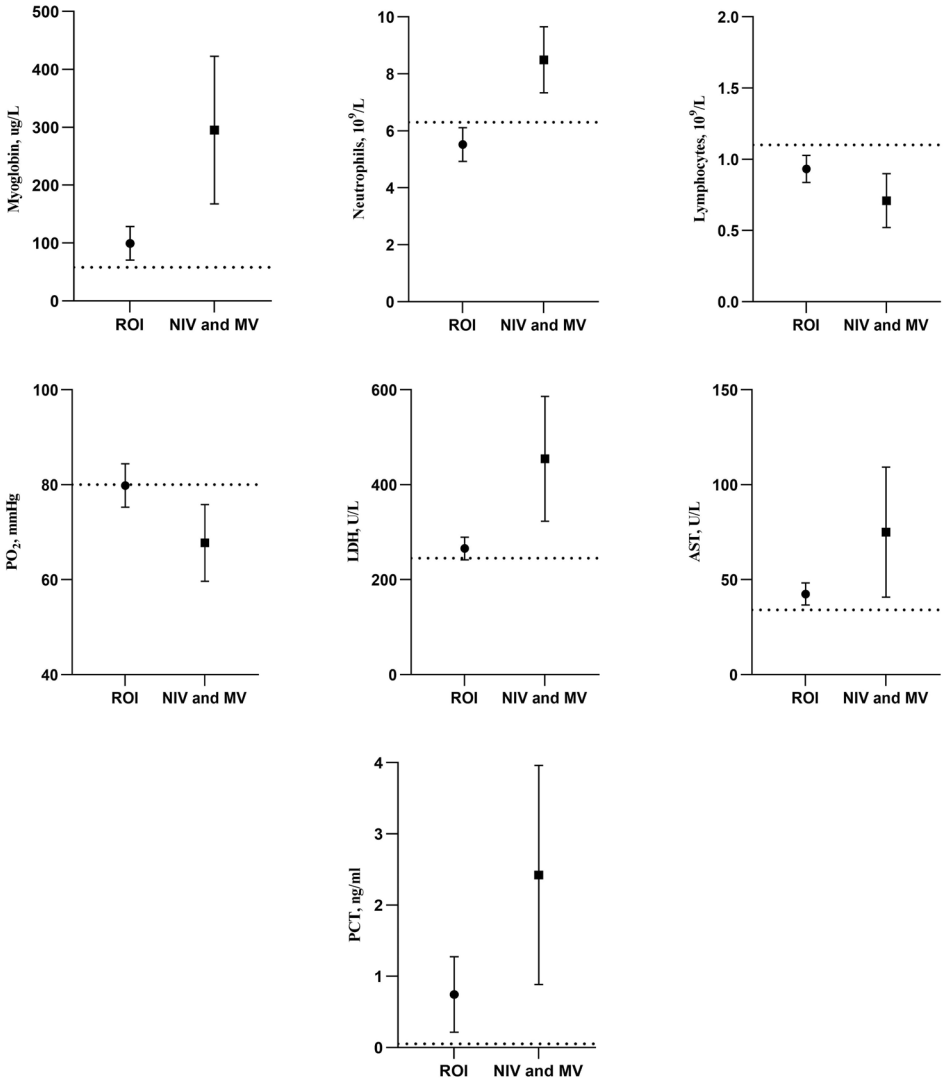

Figure 2 Different laboratory examination indices in the two groups. AST, aspartate transaminase; LDH, lactic dehydrogenase; MV, mechanical ventilation; NIV, non-invasive ventilation; PCT, procalcitonin; PO_2, partial pressure of oxygen; ROI, routine oxygen inhalation. Only the variable with a significant difference ($p<0.05$) is listed.

severity, but the symptoms were more serious than the patients in the ROI group. Further studies should be conducted to discuss the influence of these prognostic factors and laboratory indices in better defined groups.

Since December 2022, Omicron has caused a widespread pandemic in China. Individuals had different clinical symptoms and the prognosis is usually different. Pneumonia, especially severe pneumonia, mainly occurs in the elderly, which has a significant impact on survival. Thus, it is especially important to accurately identify the high-risk factors for pneumonia to protect the susceptible population. For patients who have been infected with the Omicron variant and have pneumonia, dividing the severity in time to formulate appropriate treatment programmes can result in a good prognosis for most patients. The treatment of COVID-19 warrants additional studies. Paxlovid, as a new type of antiviral drug, clearly improves the prognosis of severe pneumonia patients, but the high price may be an economic burden for many families. Optimising the diagnosis and treatment procedure of COVID-19 and formulating complete treatment programmes are very important.

CONCLUSION

Several factors were shown to associated with incidence proportions and prognosis of pneumonia in patients infected with the Omicron variant. Age, male gender, BDCSs and kidney disease were associated with significantly greater odds of pneumonia, but patients with lung cancer were associated with marginally lower odds of pneumonia. Patients with a thrombosis and pleural effusion were shown to have longer length of hospitalisation. Paxlovid and immunoglobulins improved the prognosis of NIV and MV patients. Many laboratory indices differed significantly between ROI patients and NIV and MV patients and can thus serve to determine the severity of disease.

Acknowledgements We thank Jijun Cai at The First Affiliated Hospital of Chongqing Medical University for software support.

Contributors HW: conceptualisation, methodology, software, validation, formal analysis, investigation, resources, data curation and writing—original draft. RC: methodology, software, validation, formal analysis, investigation, resources, data curation and writing—original draft. JG and LS: investigation, resources and data curation. JX: writing—review and editing and supervision. YC: guarantor, conceptualisation, methodology, validation, writing—review and editing and supervision.

Funding Chongqing Study abroad Innovation Program (No.cx2018141).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants. The ethics review board of the First Affiliated Hospital of Chongqing Medical University approved the study (K2023-070). This is a retrospective study that obtained permission from the ethics committee to waive informed consent.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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