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Clinica Chimica Acta 508 (2020) 98–102

Contents lists available at ScienceDirect

Clinica Chimica Acta

journal homepage: www.elsevier.com/locate/cca

Case report

Dynamic changes in routine blood parameters of a severe COVID-19 case

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ARTICLE INFO

Keywords:
Dynamic
Routine blood parameters
COVID-19

ABSTRACT

Background: Novel coronavirus infectious disease (COVID-19) has been spreading worldwide, and tracking laboratory indexes during the diagnosis and treatment of patients with severe COVID-19 can provide a reference for patients in other countries and regions.

Methods: We closely tracked the epidemiological history, diagnosis and treatment process, as well as dynamic changes in routine blood indicators, of a severe COVID-19 patient who was hospitalized for 26 days.

Results: Our study found that the patient's condition worsened in the first week after admission, white blood cells (WBCs), neutrophils, lymphocytes, monocytes, eosinophils, red blood cells (RBCs), hemoglobin, neutrophil lymphocyte ratio (NLR), platelets (PLT) and platelet lymphocyte ratio (PLR) decreased. On the 7th day of admission, the levels of these cells decreased to their lowest values, though the red blood cell distribution width (RDW) and C-reactive protein (CRP) level remained at high values. From 8 to 14 days of admission, the patient's condition improved, hypoxemia was corrected, and mechanical ventilation was discontinued. The number of WBCs, neutrophils, monocytes, eosinophils and lymphocytes increased gradually, and the erythrocyte parameters stopped declining and stabilized in a certain range; CRP decreased rapidly. On the 20th day of admission, the nucleic acid test was negative, WBC, neutrophil, CRP, NLR and PLR decreased gradually, and monocyte, lymphocyte, and eosinophil counts increased. Although RBCs and hemoglobin (Hb) levels continued to decrease, RDW gradually increased, indicating the recovery of hematopoiesis. In addition, it should be noted that monocytes and eosinophils were at extremely low levels within 10 days after admission; the recovery time of eosinophils was approximately 12 days after admission, which was earlier than other parameters, which might be of great value in judging the progress of the disease.

Conclusions: Dynamic changes in routine blood parameters might be helpful for the prognosis of COVID-19 patients and evaluation of the treatment effect.

1. Introduction

In December 2019, a new coronavirus infectious disease (COVID-19) appeared in Wuhan, Hubei Province. The homology of the new coronavirus and SARS-like coronavirus in bats is more than 85% [1]. Currently, the number of COVID-19 patients is rapidly increasing worldwide, and some countries and regions, such as Africa, lack medical resources [2]. Therefore, it is of clinical significance to track and monitor a patient's condition by using the dynamic changes in routine laboratory indicators, as they have a short turnaround time, and radioactivity is not involved. Herein, we report the epidemiological history and dynamic changes in routine blood parameters during the process of diagnosis and treatment of a woman who was confirmed to have severe COVID-19.

2. Case report

The patient was a 55-year-old female who had been working as a housemaid in Wenzhou for 3 years. The family members of the employer who returned from Wuhan had symptoms of upper respiratory tract infection in January 2020. The patient started to cough on January 9, 2020, mainly a dry cough without sputum but that was frequent and severe and accompanied by fever. Her initial temperature fluctuated at approximately 38.0 °C, and the heat type was unknown. Symptomatic supportive treatment was conducted at a local clinic, but her symptoms recurred.

On January 16, 2020, the patient returned to Taizhou, and clinical symptoms such as cough progressed, accompanied by relaxant fever, with a maximum body temperature of 39.6 °C, concurrent with nausea and vomiting and occasionally with hemoptysis. Then, the patient was

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https://doi.org/10.1016/j.cca.2020.04.034
Received 3 March 2020; Received in revised form 22 April 2020; Accepted 27 April 2020
Available online 13 May 2020

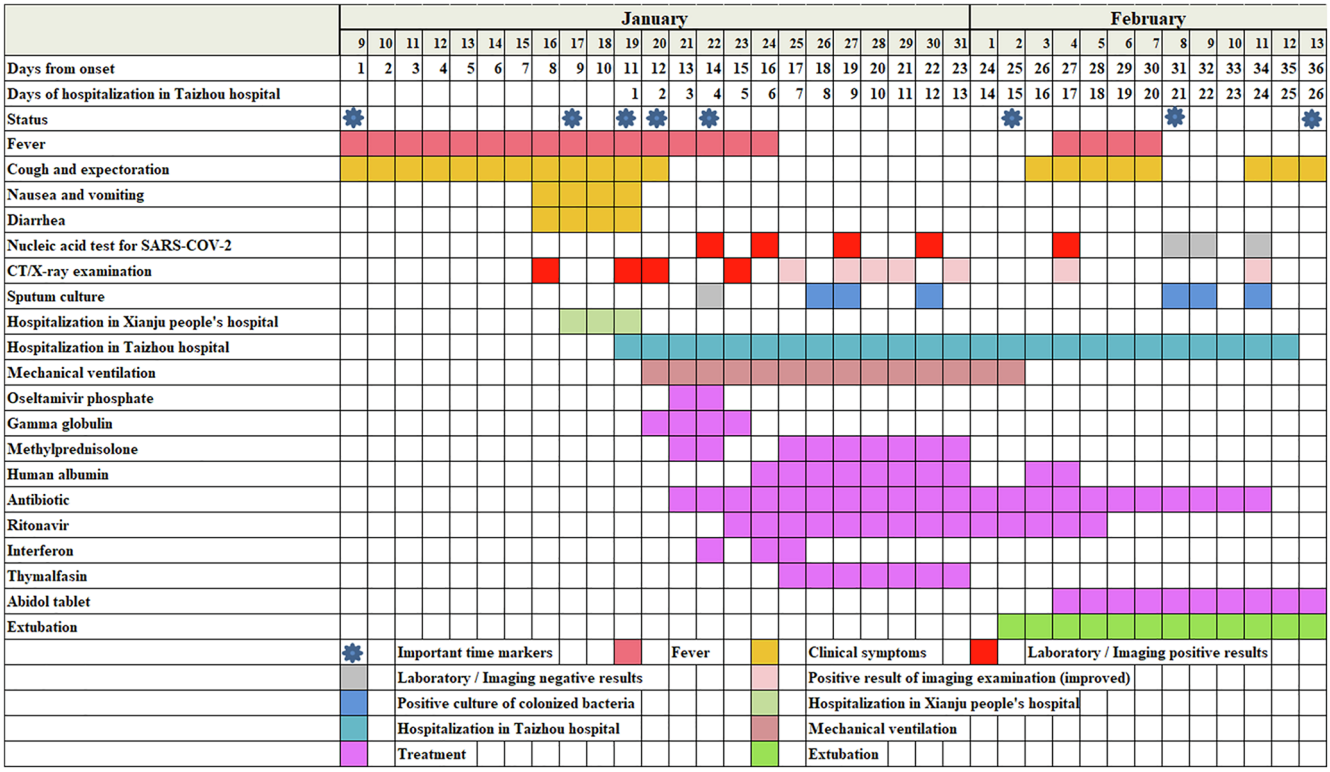

Fig. 1. Disease progression and medical intervention of the patient.

admitted to Xianju People's Hospital for anti-inflammatory treatment, but the symptoms did not improve.

The patient came to the emergency department (ED) of Taizhou Hospital, Zhejiang Province on January 19, 2020. Routine blood tests showed a high percentage of neutrophils (93.6%), a low percentage of lymphocytes (3.7%), and elevated CRP (287.5 mg/L) and PCT (0.33 ng/mL) levels. Arterial blood tests showed a pH of 7.40, with partial pressure of carbon dioxide ($PaCO_2$) 32 mmHg, partial pressure of oxygen (PaO_2) 51 mmHg, oxygen saturation (SaO_2) 86%, and fraction of inspired oxygen (FiO_2) 29%. Chest CT revealed multiple cloud flocculent shadows with a small amount of pleural effusion in the bilateral lungs, so the patient was hospitalized for severe pneumonia and respiratory failure at the ED. A confirmatory test of COVID-19 was positive on January 22, 2020, and the diagnosis, treatment process and disease progress of the patient are shown in Fig. 1.

3. Discussion

3.1. Laboratory investigation

Routine blood tests refer to the examination of blood condition and disease by observing the quantity change and shape distribution in blood cells, including white blood cells (WBCs), white blood cell classification count, red blood cell count (RBC), hemoglobin (Hb) and platelets (PLTs). Routine blood test indicators are sensitive to many pathological changes, which may assist in diagnosis when the cause of the disease is unknown. In addition, routine blood tests are a common indicator for the evaluation of medication or discontinuation and disease recurrence or recovery.

The fifth edition of the guidelines on the diagnosis and treatment of COVID-19 clearly point out that the total number of WBCs in the early stage of the disease is normal or decreased, accompanied by decreased lymphocytes and progressive lymphocytopenia in severe patients. The patient stayed in Taizhou Hospital for 26 days (Jan 19 to Feb 13 of 2020), and routine blood tests were performed almost daily. The dynamic changes in routine blood test indicators during hospitalization are shown in Fig. 2 and Fig. 3.

3.2. Dynamic changes in white blood cells and CRP of the patient during hospitalization

On the first day of admission, WBC counts were normal, and lymphocytes decreased, monocytes and eosinophils were also decreased. On the second day of admission, the patient's condition worsened, the total count of WBCs, neutrophils, lymphocytes, monocytes and eosinophils decreased, and they reached a nadir on the 7th day of admission. CRP was 208 mg/L on the 7th day, indicating a strong inflammatory response. At this stage, the virus prevailed, and the progressive decrease in WBCs was related to the direct invasion of the virus into hematopoietic cells or the aggravation of apoptosis and hematopoietic suppression caused by the infection of bone marrow stromal cells, which is basically consistent with the blood system performance after SARS virus infection [3].

From the 8th day to the 14th day of admission, WBCs, neutrophils, monocytes and eosinophils gradually increased and reached a peak on the 14th day. Although the number of lymphocytes did not reach the maximum value, it showed an upward trend. This result suggests that WBCs gradually led the fight against the virus. The CRP value decreased rapidly after admission and decreased to 8.7 mg/L on the 14th day, when the patient's condition was improved: hypoxemia was corrected, and tracheal intubation was removed. On the 17th day to 20th day of admission, the patient had a persistent fever, with CRP displaying a gradual upward trend. On the 21st day of admission, the nucleic acid test was negative, and CRP gradually reduced to normal.

From 15 to 25 days after admission, WBCs, neutrophils, monocytes and eosinophils decreased rapidly after reaching their peak, but lymphocyte levels continued to rise to kill the virus and returned to the normal reference range at 23 days after admission (Fig. 2).

In addition, it should be noted that monocytes and eosinophils were extremely low within 10 days after admission, which might indicate

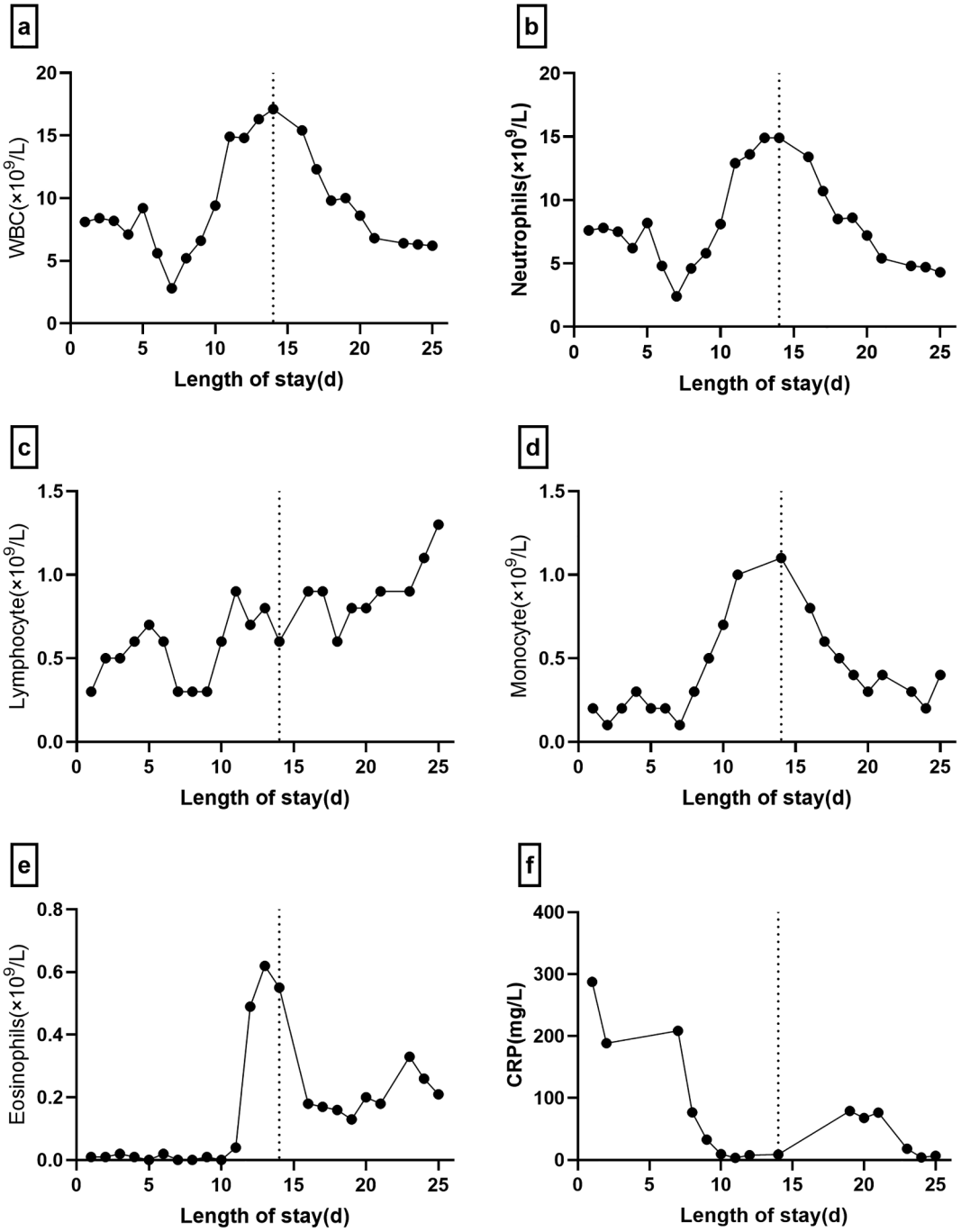

Fig. 2. Dynamic changes in WBC and CRP in the patient during hospitalization.

that the patient's condition was serious, and then gradually recovered to normal. The recovery time of eosinophils was approximately 12 days after admission, earlier than other parameters.

A retrospective study of 10 patients with postoperative immunosuppression revealed that among innate immune cells, eosinophils recovered on the second day, neutrophils on the third day, and monocytes on the fifth day but that acquired immune cells such as lymphocytes did not recover until the fifth day[4], which supported the results of our study. Therefore, we believe that eosinophils have important value for the clinical prognosis of COVID-19 patients.

3.3. Dynamic changes in erythrocyte parameters, PLT, NLR and PLR of the patient during hospitalization

Within 14 days after admission, the patient's condition was serious, hematopoiesis was inhibited and in the shock state, and mechanical ventilation was needed. RBC, Hb and RDW decreased gradually. On the 15th day, tracheal intubation was removed, and noninvasive ventilation and high-flow oxygen inhalation were used. The patient's condition was gradually stabilized, and the hematopoiesis function was gradually restored, which was consistent with the research of Terpos, which revealed that the condition of patients with COVID-19 is related to the

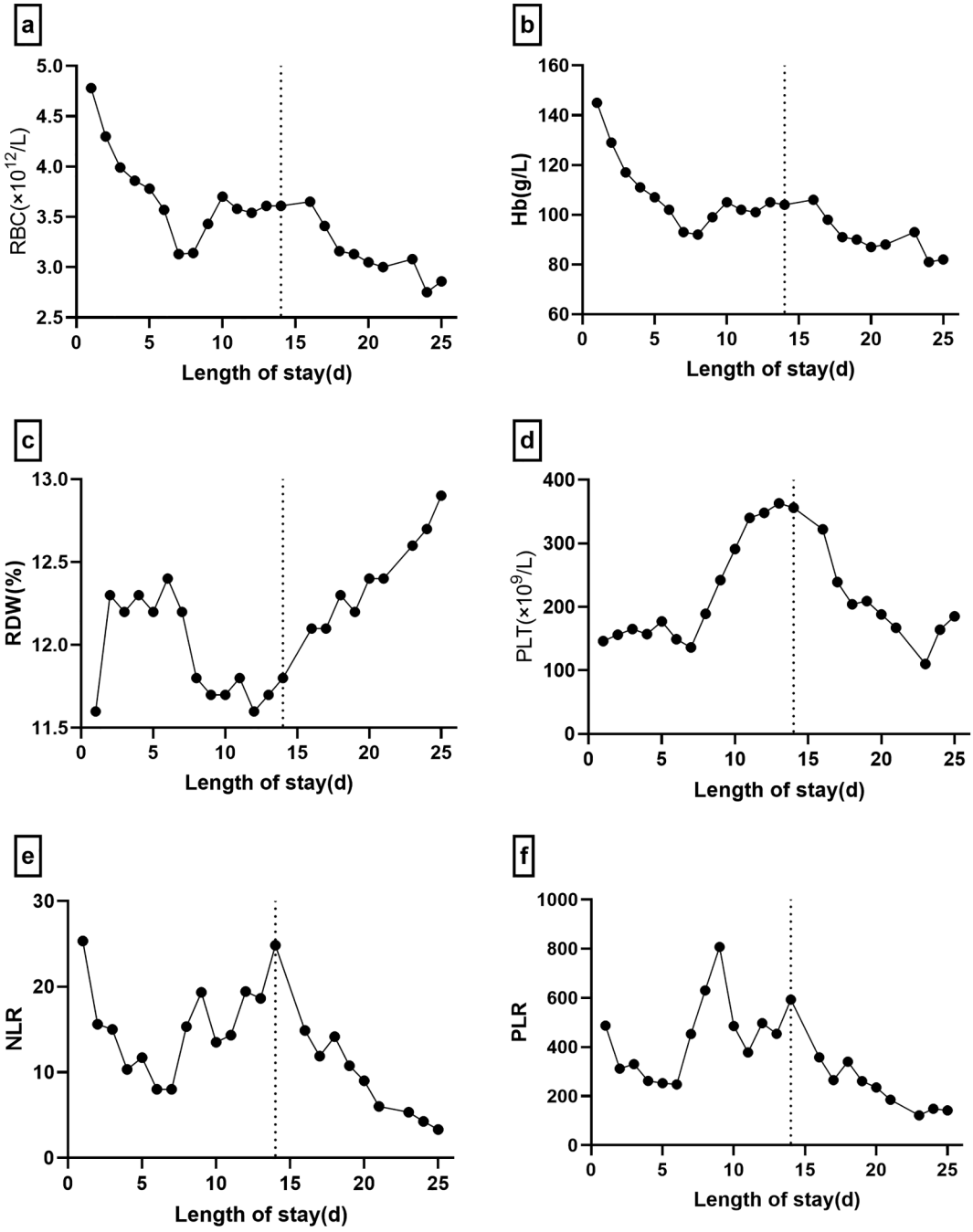

Fig. 3. Dynamic changes in erythrocyte parameters, PLT, NLR and PLR in the patient during hospitalization.

hematopoietic system [5]. In addition, although we found that RDW as gradually increased, a longer recovery time of RBC and Hb was required.

PLT was in the reference range during hospitalization, the trend was consistent with WBC and neutrophils, and there was a turning point approximately 14 days after admission. Possible causes of PLT changes were that PLT is an anti-inflammatory factor that increased due to recruitment. In addition, the stimulation of inflammation and immune factors increased thrombopoietin (TPO), thus promoting platelet production. Therefore, the trend was consistent with that of neutrophils.

The neutrophil–lymphocyte ratio (NLR) and platelet-lymphocyte ratio (PLR) gradually returned to normal after the patient's improvement on the 14th day. The NLR and PLR are proven to have clinical value in the prognosis of various diseases, such as malignant tumors, acute pancreatitis, cardiovascular disease and other related diseases [6,7], and it was inferred that the NLR and PLR may also be helpful in predicting the prognosis of COVID-19 patients. (Fig. 3)

3.4. Summary

WBCs in COVID-19 patients were normal or decreased, and lymphocytes and eosinophils were decreased.

Dynamic changes in WBCs, neutrophils, eosinophils, RDW, NLR and PLR could be helpful for the prognosis of COVID-19 patients. If these parameters recover after continuous reduction, the patient's condition should improve; otherwise, the prognosis may be poor. Low eosinophil counts revealed that the patient's condition was serious, and this parameter was more sensitive than other indicators.

It is suggested that laboratories and clinicians should pay more attention to dynamic changes in the above routine blood parameters,

which may become a new basis for monitoring patient condition and evaluating treatment effects. The way in which laboratory indicators such as eosinophils, NLR and PLR fluctuate during the progression of COVID-19 patients will soon be validated in a larger series.

Acknowledgment

This study was supported by grants from Taizhou Science and Technology Plan (1802ky18) (Zhejiang, China).

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