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Review Article

Laboratory Parameters in COVID 19

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Abstract

Coronaviruses are enveloped and positive-stranded RNA genome, responsible for the current pandemic, with millions of infected and tens of thousands of deaths. The clinical course of the disease may change with laboratory parameters such as: hypoalbuminemia, increase in C-reactive protein, serum ferritin, lymphopenia, leukopenia, thrombocytopenia, increase in prothrombin time, increase in the level of D-dimers, increase in alanine and aspartate transferase, increase in creatinine kinase and serum creatinine. These data are extremely important to assess the evolution of the disease and to direct therapeutic interventions. In this sense, the present study aimed to discuss the main laboratory parameters in COVID 19. Based on the data collected, it is suggested that lesions in the bone marrow, lung, liver, heart and kidneys are associated with the action of viral replication, intravascular coagulation disseminated, deposition of immune complexes and cytokine production, damaging the cells of these organs and altering the laboratory parameters associated with their activity, which can lead to multiple organ failure and, ultimately, lead to death in severe cases of infection. Attention to these parameters, associated with clinical data and other exams, will be predictors for the clinical evaluation of the patient with COVID 19, collaborating with better monitoring of this and directing therapeutic interventions.

Keywords: Laboratory parameters; Corononavirus; Prediction

Introduction

The coronavirus belongs to the family Coronovíridae, presenting a positive strand RNA genome and a viral envelope. This virus has been associated with outbreaks of Severe Acute Respiratory Syndrome (SARS 2002) and Respiratory Syndrome in the Middle East (MERS 2012), and more recently the COVID 19 pandemic, leading to tens of thousands of deaths and millions of infected worldwide [1-4].

The virus has a pleomorphic or spherical shape (Figure 1), with glycoproteins in the viral envelope structure. These glycoproteins are responsible for the viral connection to the host cell receptor, associated with viral hemagglutinins, contribute to the recognition and binding to the target cell [5-7].

The main route of transmission between people occurs through respiratory droplets emitted by sneezing and coughing by the infected person. Still, contact of people with contaminated surfaces and objects is reported, taking the hand to the mouth and eyes in this process [8-10]. After the initial contact, the virus binds to the host cell, a connection between viral glycoprotein and cell receptor, initiating it if so, viral replication (Figure 2). Following viral adhesion, the virus internalizes, phagosome formation, stripping and the release of the viral genome. From the release of the viral RNA, its transcription and translation are observed, leading to the synthesis of the components of the viral structure. Finally, the assembled viral particles are externalized by budding, and can infect new cells [7,8,11].

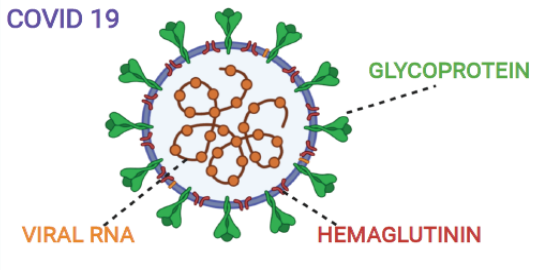

Figure 1: Structure of the coronavirus COVID 19. Source: Own authorship. "Created with BioRender.com".

Initially infected patients are asymptomatic for two to fourteen days, and may develop mild or severe symptoms. Among the most common mild symptoms are fever, fatigue/myalgia, dry cough and dyspnoea, in some cases abdominal pain, headache, palpitations and chest pain are observed. In more severe cases, the patient may progress to respiratory complications , renal and hematological, requiring admission to the Intensive Care Unit (ICU) [9-13].

These symptoms, associated with the patient's clinical history, such as contact with infected people, and laboratory findings are extremely important to assess the evolution of the disease and direct therapeutic interventions. In this sense, the present study aimed to discuss the main laboratory parameters in COVID 19.

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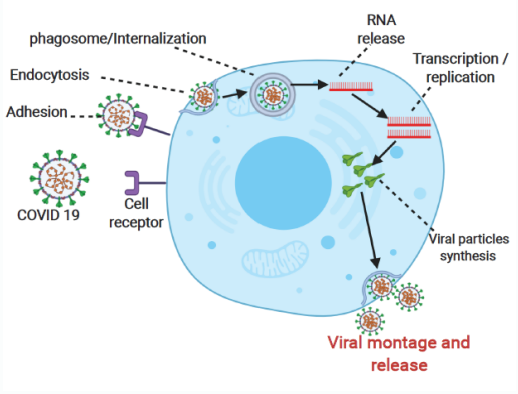

Figure 2: COVID 19. Replication cycle. Source: Own authorship. "Created with BioRender.com".

Viral pathophysiology

COVID 19 initially performs viral replication in the respiratory tract and then spreads to other organs and tissues. At the bone marrow level, the virus leads to apoptosis of cells in this organ, induced by replication, resulting in a reduction in hematopoiesis, leading to a reduction in leukocytes and platelets [14-16].

The presence of circulating viral particles induces the activation of neutrophils, macrophages and mast cells, leading to the synthesis of pro-inflammatory substances, such as cytokines. These substances act on the progenitor cells in the bone marrow, and cause inactivation of the synthesis of platelets and other components, such as leukocytes [15,16].

Circulating viral particles also induce the synthesis of circulating antibodies and immune complexes, which can bind to platelet and tissue surfaces, contributing to tissue damage and thrombocytopenia [14-16]. At the pulmonary level, viral replication induces hypoxia, cell death and lesions in the capillaries of this organ. Thus, it triggers the inflammatory process, which culminates in the activation of platelets and induces the formation of microcoagulation. This can become widespread, causing damage to other organs, such as the liver, heart and kidneys [14,17,18].

These inflammatory and pathological processes cause changes in the functioning of several organs, thus leading to hematological and biochemical changes, being important laboratory findings in the clinical follow-up of patients with COVID 19.

Laboratory parameters

The laboratory findings, which can be observed altered in infectious processes, including in COVID 19, are varied, being among the most common: hypoalbuminemia, increase in C-reactive protein, lymphopenia, leukopenia, thrombocytopenia, increase in prothrombin time, increase in the level of prothrombin D-dimers, increased alanine and aspartate transferase, increased creatinine kinase and serum creatinine. In addition, there is a drop in oxygen saturation at rest ≤ 93% and partial pressure of arterial oxygen ≤ 300 mm Hg; or (4) serious complications of the disease [17,19,22]. These findings can be correlated with pathophysiology, with the main data shown in Table 1. The reference values can vary according to the patient's age, sex and depending on the method and reagents used in the analysis Saito et al. [21].

The low oxygen saturation and Partial Oxygen pressure (PO_2) are important parameters, together with the increase in respiratory rate (≥ 30 breaths per minute) that can characterize the patient as severe. These clinical/laboratory data would be directly associated with the involvement of lung tissue under the influence of the viral particular [13,24]. Liu et al. [22] mention in their study with 76 patients followed up in China, all of them presented alterations in the mentioned parameters, for which 39%, of these were clinically classified as severe.

Regarding coagulopathies, thrombocytopenia, increases in D-dimer, prothrombin time and fibrinogen can be observed, which can be observed in up to 40% of patients with COVID 19. These would be associated with the influence of the virus and cytokine in the bone marrow, as well as well as the inflammatory process observed in the lung, mainly, which would trigger the activation of the coagulation cascade with risks of Disseminated Intravascular Coagulation, being important parameters, according to the International Society of Thrombosis and Hemostasis (SITH) for the prediction of this phenomenon [22,23]. Llitjos et al. [26] followed 26 patients in Intensive Care Units in France, with severe thrombocytopenia, increases in D-dimer, prothrombin time and fibrinogen in all cases. Despite therapeutic interventions with anticoagulants, 56% developed vascular thrombosis.

Table 1: Laboratory parameters in patients with COVID 19.

Laboratory parameters	Reference values	Pathophysiology
Oxygen saturation*	≤ 93%	Damage to lung tissue
Oxygen partial pressure*	≤ 300 mm Hg	Damage to lung tissue
Thrombocytopenia**	<140,000 cells/mm^3	Bone marrow damage, immune complexes, influence of cytokines and disseminated microagulation
Prothrombin time (INR)	>1.5	Disseminated microagulation
International Standardized Index		
Increased D-dimer and/or Fibrin Degradation Products (FDP)*	>494 ng/mL	Disseminated microagulation
Fibrinogen level*	<1.2 g/L	Disseminated microagulation
Lymphocytopenia**	<1000 cells/mm^3	Bone marrow damage
Leukopenia**	<4.500 cells/mm^3	Bone marrow damage
Alanine transaminase**	>41 U/L	Liver damage
Aspartate aminotransferase**	>40 U/L	Liver damage
C-reactive protein**7/	>8.0 mg/L	Inflammatory process
Hypoalbuminemia**	<4.0 g/dL	Liver and kidney injuries
Creatine Kinase (CK-MB)**	>200 U/L	Myocardial lesions
Creatinine**	>1.2 mg/dL	Kidney injuries

Lymphocytopenia and leukopenia result in part from the effect of the inflammatory cascade and viral activity at the bone marrow level, and can be seen in more than 40% of patients with moderate or severe clinical conditions. This, when it leads to risks of secondary infections, emphasizing the clinical severity of patients [27,28]. Ruan et al. [29] carried out a retrospective study with data from 68 patients who died in China, and observed that the majority presented changes in coagulation, lymphocytopenia and leukopenia, which associated with basic clinical conditions, diabetes or hypertension, contributed to the evolution of their death. Liu et al. [28] followed 137 patients in China, being observed in 72.3% of these lymphocytopenia and 80% with leukopenia. Some progressed to more severe pneumonia, septic shock and clotting disorder, leading to death.

Alanine transaminase and aspartate aminotransferase are liver enzymes that are used as diagnostic parameters for suspected liver damage. As previously mentioned, viral activity induces several inflammatory and hematological changes that lead to liver tissue damage, leading to increased levels of these enzymes [31,32]. Wang et al. [22] followed 105 patients in China, of these 89 patients were diagnosed with steatosis liver by abdominal ultrasound, and it was observed that 16.2% had changes in liver enzymes, ALT or AST.

C-reactive protein is increased in inflammatory and infectious processes, being one of the laboratory parameters observed with changes in COVID 19 [28,29,33]. Yang et al [33] evaluated 85 Chinese patients diagnosed with COVID 19, of which 96.47% showed an increase in C-reactive protein, being influenced by the severity level of the pathology.

Creatine Kinase (CK) is increased in infectious, ischemic and inflammatory processes in muscle tissues, including myocardium. Thus, it is possible to observe its increase in COVID 19, when the disease progression is associated with cardiac lesions [29,33]. Only one patient (10%) had high levels of CK. Lo et al. [34] followed Macao patients, being at the onset of the disease, altered in only one patient, however with the clinical evolution to moderate and/or severe symptoms, more than 50% had increased CK levels.

Finally, creatinine is one of the parameters for the analysis of kidney injuries, including those induced by COVID 19 [32,34]. Cheng et al. [35] evaluated 701 Chinese patients, of which approximately 14% evolved with increased creatinine, with renal complications that required specific treatment.

As noted above, the lesions observed in the bone marrow, lung, liver, heart and kidneys are associated with the action of viral replication, disseminated intravascular coagulation, deposition of immune complexes and cytokine production, damaging the cells of these organs and altering the laboratory parameters associated with their activity, which can lead to multiple organ failure and ultimately lead to death in severe cases of infection [16,19,36,37].

In this context, an attentive evaluation of these parameters, associated with the clinic and other exams, are fundamental for a better classification of COVID 19, and thus the improvement of the patients' prognosis. As a consequence, better resource planning will be possible for patients with clinical evolution to severity.

Conclusions

The data collected in this study allows us to conclude that the various laboratory parameters are important predictors of the clinical evaluation of patients with COVID 19, with coagulopathies, changes in leukocytes, lesions in the bone marrow, lung, kidneys, liver and heart resulting from inflammatory reactions, such as cytokine production; production and antibodies/immunocomplexes and viral replication.

Attention to these parameters, associated with clinical data and other exams, will be predictors for the clinical evaluation of the patient with COVID 19, collaborating with better monitoring of this and directing therapeutic interventions.

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